

**FACULTY OF AGRICULTURE
COMMON REGULATIONS FOR ALL
M.Sc. (AGRICULTURE/HORTICULTURE) PROGRAMMES OFFERED BY
THE FACULTY OF AGRICULTURE
WITH EFFECT FROM 2018-2019**

1. Short title and commencement

- These rules and regulations shall govern the post graduate studies leading to the award of degree of Master of Science (Agriculture/Horticulture) in the Faculty of Agriculture.
- They shall come into force with effect from the academic year 2018 – 2019.

2. Definitions

- An “Academic Year” shall consist of two semesters.
- “Semester” means an academic term consisting of 110 working days including final theory examinations.
- “Subject” means a unit of instruction to be covered in a semester having specific No., title and credits.
- “Credit hour” means, one hour lecture plus two hours of library or home work or two and half hours of laboratory/field practical per week in a semester.
- “Grade Point of a subject” means the value obtained by dividing the percentage of marks earned in a subject by 10 and the Grade Point is expressed on a 10 point scale.
- “Credit Point” means the grade point multiplied by credit hours.
- “Grade Point Average” (GPA) means the quotient of the total credit points obtained by a student in various subjects at the end of each semester, divided by the total credit hours taken by the student in that semester. The grading is done on a 10 point scale and the GPA has to be corrected to two decimals.
- “Overall Grade Point Average” (OGPA) means the quotient of cumulative credit points obtained by a student in all the subjects taken from the beginning of the first semester of the year divided by the total credit hours of all the subjects which he/she had completed up to the end of a specified semester and determines the overall performance of a student in all subjects during the period covering more than one semester. The OGPA has to be arrived at the second decimal place.

3. Courses offered

The details of various post-graduate degree programmes at Masters’ level offered in the Faculty of Agriculture are as follows:

- Agronomy
- Agricultural Entomology
- Agricultural Microbiology
- Genetics and Plant Breeding
- Seed Science and Technology
- Agricultural Biotechnology
- Horticulture -
- Fruit Science

- Vegetable Science
- Floriculture and Landscape Architecture
- Plantation, Spices, Medicinal and Aromatic Crops
- Plant Pathology
- Soil Science and Agricultural Chemistry
- Agricultural Extension
- Agricultural Economics

4. Eligibility for admission

Candidates for admission to the M.Sc.(Ag/Hort.) programme should satisfy the following requirements.

- 4.1. Candidates seeking admission to the M.Sc. (Ag./Hort.) Degree programme should have completed any one of the following four year degree programmes from Universities recognized by Annamalai University.
 - M.Sc. (Ag.) Agronomy, Agricultural Entomology, Genetics and Plant Breeding, Plant Pathology, Soil Science and Agricultural Chemistry, Seed Science and Technology and Agricultural Bio technology.
B.Sc. (Hons.) Agriculture / B.Sc.(Hons.) Horticulture/ B.Sc. (Ag.) / B.Sc.(Hort.) / B.Tech.(Hort.) / B.Sc.(Forestry) / B.Tech.(Agri. Bio-tech.) courses of four years duration of a recognized university.
 - M.Sc. (Ag.) Agricultural Microbiology
B.Sc. (Hons.) Agriculture / B.Sc.(Hons.) Horticulture/B.Sc. (Ag.)/B.Sc.(Hort.) /B.Tech.(Hort.)/ B.Sc.(Forestry)/B.E.(Agri.)/B.V.Sc./ B.F.Sc. B.Tech.(Agri. Bio-tech.)/ B.Sc. (Dairy Science)/ B.Sc. (Home Science) courses of four years duration of a recognized university.
 - M.Sc. (Ag.) Agricultural Economics
B.Sc. (Hons.) Agriculture / B.Sc.(Hons.) Horticulture/ B.Sc. (Ag.)/B.Sc.(Hort.) /B.Tech.(Hort.)/ B.Sc. (Forestry)/ B.Tech.(Agri. Bio-tech.) any other four year degree courses offered by Agriculture/ Veterinary/Fisheries Universities
 - M.Sc. (Ag.) Agricultural Extension
B.Sc.(Hons.) Agriculture/ B.Sc.(Hons.) Horticulture/ B.Sc. (Ag.)/ B.Sc. (Hort.)/ B.Tech.(Hort.)/ B.Sc.(Forestry)/B.E.(Agri.)/B.V.Sc./ B.F.Sc. B.Tech.(Agri. Bio-tech.)/ B.Sc. (Sericulture) / B.Sc. (Dairy Science)/ B.Sc. (Home Science) courses of four years duration of a recognized university.
 - M.Sc. (Hort.)
B.Sc. (Hons.) Agriculture / B.Sc.(Hons.) Horticulture/ B.Sc.(Hort.) / B.Tech.(Hort.) / B.Sc. (Ag.) / B.Tech.(Agri. Bio-tech.) courses of four years duration of a recognized university.
- 4.2. Candidates who have undergone the programme under conventional system should possess not less than a second class Bachelor's degree. The candidates under 4 point grade systems should possess a minimum OGPA of 2.5 out of 4.00 and 2.75 out of 4.00 in the subject concerned. For those under 10 point system a minimum OGPA of 6.00 out of 10.00 and 6.50 out of 10.00 in the subject concerned is required. However, this will not apply to SC/ST candidates for whom a pass in the degree concerned is sufficient.

4.3. An entrance test will be held separately for each Degree programme. Candidates shall be required to be present on the specified date and time for written test and interview at their own expenses.

5.1. Duration of the programme

The duration for the M.Sc. (Agriculture/Horticulture) programme will be of two years with four semesters. A student registered for Full- time M.Sc. (Agriculture/Horticulture) programme should complete the course within four years from the date of his/Her admission.

5.2 Credit Grade Point Requirements

A student enrolled for the Master's degree programme to earn eligibility for the degree is required to complete 55 credits as detailed below.

i) Major Subjects	20
ii) Minor Subjects	9
iii) Supporting subjects	5
iv) Seminar	1
vi) Research	20
Total credits	55

Minor courses: Minor courses are to be chosen by the students from the related discipline in consultation with the Head of the department and the Chairman based on their research specialization.

5.3 Non- credit Compulsory courses

Subject code	Course title	Departments offer the subjects	Credit
1	PGS 611	Agricultural research ethics and methodology	0 + 1
		Research ethics (Agricultural extension)	
		Research data analysis (Agricultural economics)	
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0+1
		Laboratory techniques for audio and video production (Agricultural extension)	
		Basic Analytical techniques (Agricultural economics)	
4	PGS 624	Library and information services (Library science)	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture (Agri. Economics)	1+0
6	PGS 716 e-course	Disaster management (Agronomy)	1+0
			2 + 4=6

5.4. Minimum Grade point requirement

A post graduate student should maintain a minimum Grade Point of 6.50 out of 10 to secure a pass in a subject. In the subjects in whom a student fails, he/she has to reappear for the examination to get a pass in that subject.

6. Attendance requirement

6.1. One hundred per cent attendance is expected of each student. A student, who fails to secure a minimum of 80 per cent of attendance in each subject separately for theory and practical, shall not be permitted to appear for the

final examination in that subject and will be required to repeat the subject when ever offered.

In case of new admission, who are permitted to join late due to administrative reasons, the attendance will be calculated from the date of joining of the student. However, for genuine reasons, condonation of attendance deficiency may be considered by the Vice-Chancellor on the recommendation of the Head of the Department and the Dean, Faculty of Agriculture on payment of condonation fee prescribed by the University.

- 6.2 Students absenting from the classes with prior permission of the Head of the Department/Dean, Faculty of Agriculture on official University business shall be given due consideration in computing attendance.

7. Advisory Committee

- 7.1. Each post-graduate student shall have an Advisory Committee to guide him/her in carrying out the research programme. The Advisory Committee shall comprise a Major Adviser (Chairman) and two members. Of the two members, one will be from the same Department and the other in the related field from the other Departments of Faculty of Agriculture. The Advisory Committee shall be constituted within three weeks from the date of commencement of the first semester.
- 7.2 For interdisciplinary research requiring expertise from teaching staff of other faculties, due permission need to be obtained from the Dean, Faculty of Agriculture to nominate them as Technical advisors. An official letter in this regard needs to be communicated to the individual concerned. However, they are restrained from the evaluation of Research/Seminar evaluation.
- 7.3. Major Adviser (Chairman)\
Every student shall have a Major Adviser who will be from his/her major field of studies. The appointment of Major Adviser (Chairman) shall be made by the Head of the Department concerned. The chairman in consultation with the Head of the Department will nominate the other two members. In the event of the Major Adviser being away on other duty/leave for a period of more than three months, the member of the Advisory Committee from the same Department will officiate as the Major Adviser.
- 7.4. Guidelines on the duties of the Advisory Committee
- Guiding students in drawing the outline of research work
 - Guidance throughout the programme of study of the students.
 - Evaluation of research and seminar credits.
 - Correction and finalization of thesis draft.
 - Conduct of qualifying and final Viva-Voce examination.
 - The proceedings of the Advisory Committee will be sent to the Head of the Department concerned within 10 working days.
 - Periodical review of the Advisory Committee proceedings will be made by the Head of the Department concerned.

8. Programme of Study

- 8.1 The student's plan for the post-graduate work, drawn up by the Advisory Committee, shall be finalized before the end of the first semester.

8.2 The programme shall be planned by the Advisory Committee taking into account his/her previous academic training and interest.

8.3 Programme of research work

The outline of research work of the student, in the prescribed manner and as approved by the Advisory Committee, shall be forwarded by the Chairman to the Head of the Department concerned by the end of the first semester.

9. EVALUATION OF STUDENTS' PERFORMANCE

9.1. Mid-semester examination (MSE)

9.1.1. Every teacher handling a subject shall conduct Mid-Semester Examination (MSE) as per the scheme drawn by the Head of the Department concerned /PG coordinator, and evaluate. The answer scripts will be shown to the student after valuation, and returned to the course teacher. The Head of the Department will be responsible to ensure the distribution of answer papers to the students. The marks obtained by the students should be sent to the Controller of Examinations through the Head of the Department concerned within fifteen working days.

9.1.2. Writing the mid-semester examination is a pre-requisite for writing the final theory and practical examinations. If a student does not appear for MSE, he/she is not eligible to appear for the final examinations. Such candidate has to reappear for the MSE as and when the respective examinations are conducted only after getting permission from the Dean, Faculty of Agriculture on payment of fee prescribed by the University.

9.1.3 The MSE marks will not be shown separately in the grade sheet but will be combined with the respective final theory and practical marks. MSE marks awarded in a course will be added to the supplementary examinations also.

9.1.4 The MSE marks will be furnished to the Head of the Department within 10 days after the conduct of MSE. If the student is not satisfied with the award of the marks, he/she shall appeal to the Dean, through Head of the Department within three working days after the announcement of marks. The appeal will be considered and the results reviewed by a Cell consisting of the Dean and the Head of the Department concerned. The decision of the Review Cell shall be final. If the Head of the Department himself is the course teacher, one senior member of the department concerned shall be nominated by the Dean.

9.1.5 The MSE of theory will be of one hour duration

9.1.6 If the student is not able to write the MSE due to deputation by the University, he/she may be permitted to take up missing MSE. Such examination should be completed ordinarily within 15 working days after the respective MSE.

9.1.7 A student who fails to attend a mid-semester examination due to unavoidable circumstances shall be permitted with prior approval of the Dean to take up missing examination of the particular course, on payment of fee prescribed by the University. Such tests should be completed ordinarily within 15 working days after the respective MSE.

The distribution of marks will be as indicated below.

Test	Subjects with Practical	Subjects without Practical	Subjects without Theory
Mid-Semester	20	30	30
Final theory	40	70	-
Final practical	40	-	70
Total	100	100	100

The question paper model and distribution of marks for Mid Semester examinations are as follows.

Mid-semester examination

For Subjects with practicals (20 marks)

1. Objective Type	10 out of 12	(10 x 0.5)	5 Marks
2. Definitions/ Concepts	5 out of 7	(5 x 1)	5 Marks
3. Short Notes	2 out of 3	(2 x 2 ½)	5 Marks
4. Essay Type	1 out of 2	(1 x 5)	5 Marks

For Subjects without practicals (30 marks)

1. Objective Type	10 out of 12	(10 x 0.5)	5 Marks
2. Definitions/Concepts	5 out of 7	(5 x 1)	5 Marks
3. Short Notes	4 out of 5	(4 x 2 ½)	10 Marks
4. Essay Type	2 out of 3	(2 x 5)	10 Marks

9.2. Final examinations

9.2.1. The final theory and practical examinations will be of three hours duration each conducted separately by the University.

9.2.2. Theory examinations will be conducted before practical examinations.

9.2.3. The final theory and practical examinations will be evaluated by two examiners (one will be the internal and another will be external)

9.2.4. The question papers for the final theory examinations will be set by the external examiners.

The question paper model and distribution of marks for final theory examinations are as follows.

Final theory examination

For subjects with practical (40 marks)

1. Definitions	5 out of 7	(5x1)	5 marks
2. Short Notes	5 out of 7	(5x2)	10 marks
3. Essay Type	Either or type (one question from each unit)	(5x5)	25 marks

For subjects without practicals (70 marks)

1. Definitions	5 out of 7	(5x2)	10 marks
2. Short Notes	5 out of 7	(5x4)	20 marks
3. Essay Type	Either or type (one question from each unit)	(5x8)	40 marks

9.2.5. Practical Examination

Practical examinations will be conducted separately towards the end of each semester. Proper maintenance and regular submission of practical records are required. Those who do not bring with them the certified practical records/ specimen collection/ assignments will not be allowed to appear for the practical

examination. The marks awarded for specimen collection and assignments shall be noted in the record, at the time of first appearance and will be taken into account for subsequent appearances.

The distribution of marks for final practical examination for courses with theory and practical and only practical is as follows

S.No.	Particulars	Courses with theory and practical	Courses only with practical
1	Practical part	25	55
2	Assignment/specimen collection	5	5
3	Record	5	5
4	Viva voce	5	5
Total		40	70

The pattern of practical part should be uniform in each Department

9.3. GRADING

- The student should secure 60 per cent marks separately in theory and practical and 65 per cent marks in aggregate to secure a pass in the subject. Students who secure marks below 65 per cent in a subject will be treated as Reappearance (RA).
- Each subject shall carry a maximum of 100 marks for purpose of grading. The grading shall be done as grade point, i.e., the percentage of marks earned in a subject is divided by ten. The grade point is expressed on a 10 point scale up to two decimals.
- The reappearance examinations for the candidates who fail in a subject or subjects will be held in the subsequent semester.
- Students who did not fulfill the required minimum attendance of 80 per cent will be awarded 'E' grade and has to repeat the subject.

9.4. Class ranking

In calculation of class equivalent for OGPA the following classification shall be adopted.

OGPA	Class
9.00 and above	- Distinction
8.00 to 8.99	- I Class
7.00 to 7.99	- II Class
6.50 to 6.99	- Pass

9.5. Non- Credit Compulsory Subjects

For Non-Credit Compulsory subjects the evaluation processes will be as that of the regular subjects, however, the marks obtained will not be taken into account to calculate the OGPA.

10. Credit Seminar

Seminar is compulsory for all the students and each student should present a seminar of 0+1 credit in the third semester.

10.1 The seminar topic should be only from the major field and should not be related to the area of thesis research.

The seminar topics are to be assigned to the students by the Chairman of the Advisory Committee in consultation with the Head of the Department concerned within 2 weeks after the commencement of the semester.

- 10.2. Under the guidance and supervision of the Chairman of the Advisory Committee, the student will prepare the seminar paper after reviewing all the available literature and present the seminar 2 weeks after completion of Mid-Semester Examination in the presence of the Head of the Department, Advisory Committee, staff members and PG students.
- 10.3. The circular on the seminars by the post-graduate students shall be sent to other Departments to enable those interested to attend the same.
- 10.4. The Chairman will monitor the progress of the preparation of the seminar paper and correct the manuscript containing not less than 25 typed/printed pages with a minimum number of 50 references covering the recent 10 years time. The student will submit 2 copies of the corrected manuscript to the Head of the Department concerned through the Chairman before presentation.
The student will incorporate suggestions and carry out corrections made during the presentation and resubmit three fair copies to the Head of the Department concerned through the Chairman (one copy each to Dept. Library, Chairman and the student) within 10 days after presentation.
- 10.5 The performance of the student has to be evaluated for 100 marks and Grade Point will be awarded by the Head of the Department concerned along with Advisory Committee. The Grade Point may be given based on the following norms.

Coverage of Literature	40
Presentation	30
Use of Audio-Visual Aids	10
Capacity to Participate in the discussion and answer the Questions	20
Total	100

11. Term paper / Special assignment

This has to be assigned to the student by the teacher in subject with theory and practical. Term papers should cover a wide range of topics within the subject limits. The topic should be different from that of the credit seminar. Term papers / special assignments will be evaluated during practical examination.

12. Qualifying Examination

Only those students who successfully completed the qualifying examination will be admitted to candidacy of the degree. The qualifying examination consists of written and oral examination.

12.1. Minimum requirement for Qualifying Examination

The students who have **passed** major courses will be permitted to appear for the qualifying examination. The qualifying examination will be conducted during IIIrd semester after midsemester examination and before the end of the IIIrd semester.

12.2. Selection of Examiner

A panel of five external examiners for qualifying examinations shall be given by the HOD at the end of II semester to the Controller of Examinations, who will nominate as per need from the panel of the examiner.

12.3. Written Examination

The written examination consists of one paper covering major subjects only. The Controller of Examination will conduct the examination by getting the question paper from external. The external examiner will evaluate the answer papers during his visit to conduct the viva-voce examination.

The question paper for the written examination will be of 3 hours duration and each question (Essay type) need not be restricted to any particular topic in a course but it should be comprehensive, The written examination will be conducted at the same time in all discipline. Qualifying marks for passing the written examination will be 60.

12.4. Qualifying viva-voce Examination

The advisory committee shall conduct the qualifying viva-voce examination with the external member, who shall be a specialist in the subject from outside the university

12.5. The Heads of departments will monitor and coordinate the conduct of the qualifying viva. The performance of the candidate will be Graded as Satisfactory / Unsatisfactory.

12.6. Communication of results of qualifying examination

The chairman of the advisory committee shall act as chairman for the examination committee and shall be responsible for communicating the results of the examination to the Controller of Examination through HOD in the prescribed format.

12.7. Failure /Absence in Qualifying Examination

When a student fails or absents for the qualifying examination, he/she may apply again for permission to appear for re-examination to the Controller of Examination with the recommendation of the chairman of the advisory committee and Head of the Department. A student, who apply for re-examination should attend written examination and viva-voce. Re-examination shall not take place earlier than three months after the first examination and it will be conducted by the advisory committee as previously indicated. If a student fails in the re-examination, further re-examination will be considered on the recommendation of the Advisory Committee, HOD and Dean, Faculty of Agriculture. If the students fail in the qualifying examination, the research credits registered in the III semester should not be evaluated unless he / she successfully completes the qualifying examination.

12.8 Absence of advisory committee member during qualifying/final viva-voce examination:

1. Conducting qualifying and final viva voce examination in the absence of advisory committee members is not allowed.
2. Under extra-ordinary circumstances if the qualifying/final viva-voce examination to postgraduate student has to be conducted in the absence of one or two advisory committee members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Dean in advance through the Head of the Department. The Chairman of the advisory committee in consultation with the concerned member and Head of the Department will co-opt another member.

3. The co-opted member should be from the same department of the member who is not attending the examinations.
4. In the absence of the Chairman of advisory committee, respective Heads of Departments should act as Co-chairman with prior permission of Dean.

13. Research Work

13.1. The topic of thesis research to be carried out by the student will be assigned by the Chairman of the Advisory Committee in consultation with the Head of the Department concerned. After assigning the topic, each student may be instructed to submit a detailed programme of work to be carried out by him/her during the semester in the prescribed proforma. After scrutiny and approval, a copy of the programme may be given to the student for carrying out the work during the semester in the prescribed proforma. The evaluation of research work done by the student should be based on the approved programme.

13.2. The distribution of research credits will be as follows:

I Semester	0+ 1
II Semester	0+ 2
III Semester	0+ 8
IV Semester	0+ 9
Total	0 + 20

14. Evaluation of Thesis Research

- 14.1. Attendance register must be maintained in the department by HOD /chairman for all the students to monitor whether the student has 80% of attendance in research.
- 14.2. The student has to submit his/her research observation note book to the major Adviser. The major Adviser will scrutinize the progress and sign the note book with remarks as frequently as possible. This note book will form the basis for evaluation of research progress.
- 14.3. After completion of 80% attendance for research and on or before the last day of the semester, the advisory committee should evaluate the progress of research work as per the approved programme and monitoring register and award SATISFACTORY OR UNSATISFACTORY depending upon quantity and quality of work done by the student during the semester.
- 14.4. The procedure of evaluating research credits under different situations are explained hereunder.

Situation - I

The students has completed the research credits as per the approved program and awarded 'SATISFACTORY' by the advisory committee. Under the said situation the student can be permitted to register fresh credits in the subsequent semester. If the student is awarded 'UNSATISFACTORY' he/she has to register afresh the same block of the research credits in the subsequent semester.

Situation - II

The student who does not satisfy the required 80 per cent attendance shall be awarded grade 'E'.

Situation-III

The student who could not complete the research work as per the approved programme of work for reasons beyond his/her control such as

- Failure of crop
- Non-Incidence of pests or diseases or lack of such experimental conditions
- Non-availability of treatment materials like planting materials chemicals etc.
- Any other impeding/ unfavourable situation for satisfying the advisory committee
- Under the situations (II&III) grade 'E' should be awarded. The student has to re-register the same block of research credits for which 'E' grade was awarded in the following semester. The student should not be allowed to register for fresh (first time) research credits.
- In the mark sheet, it should be mentioned that 'E' grade was awarded due to lack of attendance or want for favourable conditions.

Situation – IV

The student who fails to complete the research work after repeating the registration for the second time will be awarded 'Unsatisfactory' and in the the mark sheet the 'second time' should be mentioned.

- For the registration of research credits for the third time permission has to be obtained from the Dean of the Faculty and permission for further registration for the fourth time has to be obtained from the University.
- Re-registration of further research credits shall be decided by the University based on the recommendation of the Advisory Committee, Head of the Department concerned and the Dean, Faculty of Agriculture.

Situation -V

- If a student could not complete qualifying examination till the end of the final semester/grace period, 'E' grade should be awarded for the final block of the research credits registered in the final semester. He/She has to re-register the same block of research credits in the next semester and attend the qualifying examination when conducted by the Controller of Examinations.

15. Submission of Thesis

- 15.1. The thesis for his/her Master's degree should be of such a nature as to indicate a student's potentialities for conduct of independent research. The thesis shall be on topic falling within the field of the major subject and shall be the result of the student's own work. A certificate to this effect duly endorsed by the Major Adviser (Chairman) shall accompany the thesis.
- 15.2 The research credits registered in the last semester of post graduate programmes should be evaluated only at the time of the submission of thesis, by the advisory committee. Students can submit the thesis at the end of the final semester. If a post graduate student has completed the thesis before the closure of the final semester, the chairman can convene the advisory committee meeting and take decision on the submission of thesis provided the student satisfies 80 per cent attendance requirement. Two copies of the thesis should be submitted in paper pack for evaluation to the HOD.

16. Grace period

- 16.1 Students can avail a grace period up to a month for submission of thesis/project report after the closure of final semester by paying necessary fine as prescribed by the University. If a student is not able to submit the thesis within a month grace period, the student has to re-register the credits in the forth coming semester. The student (s) who re-register the credits after availing the grace period will not be permitted to avail grace period.
- 16.2 Based on the recommendation of advisory committee and the Head of the Department, the Dean, can sanction the grace period. A copy of the permission letter along with the receipt for payment of fine as prescribed by the University should accompany the thesis while submission.

17. Submission of thesis after re-registration

The minimum of 80 per cent attendance requirement for submitting the thesis after, re-registration need not be insisted for those students who have fulfilled the minimum academic and residential requirement i.e. 2 years (4 semesters) and completed the minimum credit requirements for getting Degree.

18. Publication of articles

Part of the thesis may also be published in advance with the permission of the HOD. If any part is published the fact should be indicated in the certificate given by the chairman that the work has been published in part/full in the scientific or popular journals, proceedings, etc. The copies are to be enclosed in the thesis at the time of submission.

19. Evaluation of Thesis

- 19.1 The thesis submitted in partial fulfillment of a Master's degree shall be evaluated by an external examiner. The external examiner shall be a specialist in the student's major field of study from outside Annamalai University and shall be appointed by the University as per the recommendation of the Head of the Department.
- 19.2 The external examiner will send the evaluation report in duplicate one marked to the Controller of Examination and another to the Head of the Department along with the corrected copy of the thesis. If the report is favourable, Viva-Voce will be arranged by the Head of the Department concerned and conducted by the Advisory Committee. The chairman of the advisory committee shall send the recommendations of the examining committee to the Controller of Examinations through Head of the Department after the student duly carries out the corrections/ suggestions mentioned by the external examiner (a certificate to be enclosed along with the recommendation). On the unanimous recommendation of the committee and with the approval of the University, the degree shall be awarded to the candidate.
- 19.3 In case of rejection of the thesis by the external examiner, the Controller of Examinations may on the recommendation of the Head of the Department concerned and Advisory Committee refer the thesis for valuation by a second external examiner chosen by the University. If the second external examiner recommends the thesis for acceptance, Viva-Voce will be conducted.
- 19.4 If the revision of the thesis is recommended for repeating experiments, field trial etc., resubmission must be done by the candidate concerned after a

minimum of six months. The revised version should be sent to the examiner who recommended revision.

- 19.5 After incorporating the suggestions of the examiners and those received at the time of viva-voce, two hard bound copies of thesis should be submitted to the Department (one to the scholar and one to the chairperson) and two soft copies in CDs to the University. At the time of final submission, the advisory committee members should certify the corrections and suggestions carried out as indicated by the examiners. However, fellowship holder has to submit a hard bound copy also as per the need, 3 copies of abstract of thesis (in 10-15 lines), 2 copies of the summary of the findings both in Tamil and English and also in C.D. form.

20. Revision of thesis

If an examiner recommends for revision of thesis the following norms will be adopted.

- 20.1 For revision of draft, the thesis should be resubmitted after a minimum of one month from the date of communication from the controller of examination
- 20.2 At the time of submission, the advisory committee should give certificate for carrying out the corrections/recommendations. The resubmitted copies of thesis should be got corrected carrying out the necessary corrections indicated by the external examiner and necessary certificates obtained from the chairman and HOD before the conduct of the final viva-voce.
- 20.3 A fine prescribed by the University to be collected from the students at the time of resubmission of thesis.

21. Failure to appear for final Viva-voce/ Non submission of thesis after viva-voce.

- 21.1 If a candidate fails to appear before the examining committee for final viva-voce, on the date fixed by the HOD the following are the time frame and penalty.
- 21.2 The re-viva-voce must be completed within two years. An amount of fine prescribed by the University must be charged to the candidate.
- 21.3 After successful completion of thesis final viva-voce if a student fails to submit the corrected version of the thesis within 15 days he/she will be levied a fine prescribed by the University at the time of sending the proposal for result declaration

22. Result notification

- 22.1 After the completion of each semester, the student will be given the statement of marks by the Controller of Examinations
- 22.2 The transcript will be prepared by controller of examinations. The various subjects taken by a student along with the credits and the grade obtained shall be shown on his transcript. Based on the total credits admitted, the final Grade Point Average shall be calculated and given.

23. Award of Medals

Medal should be awarded only if the student secures at least 8.0 OGPA, clears all courses in first attempt and in the programme having a batch of at least three students.

**M.Sc. (AG.) / (HORT.) DEGREE PROGRAMME
DISTRIBUTION OF COURSES**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	611	Concerned department	2+1
2.	612	Concerned department	2+1
3.	613	Concerned department	2+1
4.	621	Concerned department	2+1
5.	622	Concerned department	2+1
6.	623	Concerned department	2+1
7.	624	Concerned department 1+1/2+0	1+1
		Total	13+7=20
Minor- 9 credits			
1.	OPC- XXX 621	Compulsory minor	2+1
2.	OPC- XXX 711	Minor-related field outside Dept –Each Department	2+1
3.	OPC XXX 712	Minor-related field outside Dept—Each Department	2+1
		Total	6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistics – Statistics Department	2+1
2.	COM-611	Computer Applications for Agrl. Research- Computer science	1+1
		Total	3+2=5
Seminar + Research - 21 credits			
1.	032	Seminar	0+1
2.	011;021;031 041	Research 011- 0+1 ; , 021- 0+2 ; , 031- 0+8 ; , 041- 0+9	0+20
		Grand Total	22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
		Research ethics (Agricultural extension)	
		Research data analysis** (Agricultural economics)	
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0+1
		Laboratory techniques for audio and video production (Agricultural extension)	
		Forecasting techniques**- (Agricultural economics)	
4	PGS 624	Library and information services (Library science)	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture (Agri. Economics)	1+0
6	PGS 716 e-course	Disaster management (Agronomy)	1+0
			2 + 4=6

**M.Sc. (AG.) AGRONOMY
COURSE - WISE DISTRIBUTION**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	AGR 611	Modern concepts in crop production	2+0
2.	AGR 612	Principles and practices of weed management	2+1
3.	AGR 613	Agro meteorology and crop weather forecasting	2+1
4.	AGR 614	Agronomy of cereals, pulses, fodders and green manure crops	1+1
5.	AGR 621	Principles and practices of water management	2+1
6.	AGR 622	Principles and practices of soil fertility and nutrient management	2+1
7.	AGR 623	Agronomy of oilseed, fibre, sugar, tuber and narcotic crops	1+1
8.	AGR 624	Farming system for Sustainable Agriculture	1+1
		Total	13+7=20
Minor- 9 credits			
1.	OPC- GPB 621	Concepts of crop physiology	2+1
2.	OPC-AGR 711	Organic farming and precision Agriculture	2+1
3.	OPC-AGR 712	Dry farming and watershed management	2+1
		Total	6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistical Methods and Design of Experiments	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
		Total	3+2=5
Seminar + Research - 21 credits			
1.	AGR -032	Seminar	0+1
2.	AGR -011; 021;031; 041	Research 011-0+1; , 021-0+2; , 031- 0+8; , 041- 0+9	0+20
		Grand Total	22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0+1
4	PGS 624	Library and information services	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture	1+0
6	PGS 716 e-course	Disaster management	1+0
			2 + 4=6

M.Sc. (AG.) AGRONOMY
SEMESTER – WISE DISTRIBUTION

S.No.	Course No.	Courses	Credit Hours
FIRST SEMESTER			
1.	AGR 611	Modern concepts in crop production	2+0
2.	AGR 612	Principles and practices of weed management	2+1
3.	AGR 613	Agro meteorology and crop weather forecasting	2+1
4.	AGR 614	Agronomy of cereals, pulses, fodders and green manure crops	1+1
5.	STA 611	Statistical Methods and Design of Experiments	2+1
6.	COM 611	Computer Applications for Agricultural Research	1+1
7.	AGR 011	Research	0+1
8.	PGS 611	Agriculture research ethics and methodology (0+1)	-
9.	PGS 612	Technical writing and communication skills (0+1)	-
		Total	10+6=16
SECOND SEMESTER			
1.	AGR 621	Principles and practices of water management	2+1
2.	AGR 622	Principles and practices of soil fertility and nutrient management	2+1
3.	AGR 623	Agronomy of oilseed, fibre, sugar, tuber and narcotic crops	1+1
4.	AGR 624	Farming system for Sustainable Agriculture	1+1
4.	OPC- GPB 621	Concepts of crop physiology	2 +1
5.	AGR 021	Research	0+2
6.	PGS 623	Basic concepts in laboratory techniques (0+1)	-
7.	PGS 624	Library and information services (0+1)	-
		Total	8+7=15
THIRD SEMESTER			
1.	OPC-XXX 711	Minor Course - Related discipline	2+1
2.	OPC-XXX712	Minor Course - Related discipline	2+1
3.	AGR 031	Research	0+8
4.	AGR 032	Seminar	0+1
5.	PGS 715 e-course	Intellectual property and its management in agriculture (1+0)	-
6.	PGS 716 e-course	Disaster management (1+0)	-
		Total	4+11 =15
FOURTH SEMESTER			
1.	AGR 041	Research	0 + 9
		Total	0 + 9
		Grand Total	22+33 = 55

AGR 611 - MODERN CONCEPTS IN CROP PRODUCTION (2+0)

Objective

This course is scheduled to study the advanced concepts of crop growth and productivity.

Unit I - Climate change and crop production

Agronomic aspects in food security - Basic concepts in growth and growth analysis-Crop growth and production in relation to climate change- Climate resilient farming- climate ready crops - Physiological basis for crop yield differences - Mechanism for carbon assimilation - Respiration and photo respiration- Agro biodiversity. Stress physiology - crop response to abiotic and biotic stresses - ecological risk assessment for innovations in crop production.

Unit II - Importance of tillage, plant population and farm mechanization

Modern concepts in tillage - zero, minimum and conservation tillage - Seed priming - Plant population and crop geometry in relation to soil fertility, solar radiation and available moisture regimes -Farm mechanization - Indigenous technological knowledge (ITK).

Unit III - Recent trends in Crop production

Biotechnology in Agriculture - GM crops and Eco restoration- Integrated Natural Resource Management (INRM) - Balanced nutrition - Integrated Nutrient Supply System (IPNS) - Improved crop nutrition practices - Soil Health Care (SHC) - Efficient Post Harvest Management (EPHM) - organic farming - principles and components of organic farming -Ever green revolution - Sustainable agriculture - Vermi-technology - resource conservation technology - Agroforestry enrichment - Nano-technology.

Unit IV – Plant ideotypes and yield maximization

Plant ideotypes – Concept of potential yield - High Yielding Varieties (HYV) - Stability in yield – Yield maximization - Interaction of inputs on growth and yield attributes of crops - plant growth regulators.

Unit V - Remote sensing and precision agriculture

Precision agriculture - concepts and approach - remote sensing- GIS, GPS, VAT based precision farming - Yield mapping with remote sensing for precision agriculture - Use of hyperspectral data and GI based nutrient delivery systems in precision agriculture - Information technology - GPS and Drone technology.

Theory Lecture schedule

1. Population, food requirement and agronomic techniques for food security, basic concepts in growth and growth analysis, growth curves.
2. Analysis of crop growth: LAI, CGR, RGR, NAR and LAD. Effect of climate change on crop production and climate resilient crops.
3. Physiological basis for crop yield differences.
4. Assimilation - respiration and photorespiration.
5. Agro biodiversity.
6. Stress physiology-crop response to abiotic and biotic stresses.
7. Ecological risk assessment for innovations in crop production.
8. Modern concepts in tillage - zero, minimum and conservation tillage.

9. Seed priming- concept, importance and use in crop production. Plant population and crop geometry in relation to soil fertility.
10. Solar radiation and available moisture regimes.
11. Farm mechanization.
12. Biotechnology in Agriculture -GM crops- Eco restoration.
13. Role of Indigenous Technological Knowledge (ITK) in sustainable agriculture.
14. Integrated Natural Resource Management (INRM).
15. Balanced nutrition-Integrated nutrient supply system (IPNS).
16. Improved crop nutrition practices- Soil Health Care (SHC).
17. Efficient Post Harvest Management (EPHM).
18. Mid semester examination
19. Organic Farming - principles and components of organic farming.
20. Ever green revolution-sustainable agriculture-vermi-technology.
21. Resource conservation technology- Agro-forestry enrichment.
22. Nano-technology and its applications in agriculture.
23. Concept of potential yield- High Yield Varieties (HYV).
24. Yield maximization- stability and high yielding varieties.
25. Concept of ideal plant type and crop modeling for desired crop yield.
26. Interaction of inputs on growth and yield attributes of crops.
27. Plant growth regulators and growth retardants.
28. Precision agriculture- definition, basic concepts, scope and approaches.
29. Remote sensing in precision farming.
30. GIS, GPS, VAT based precision farming.
31. Yield mapping with remote sensing for precision agriculture.
32. Use of hyperspectral data and mapping techniques for precision farming.
33. GI based nutrient delivery systems in precision agriculture.
34. Information technology- GPS and Drone technology.

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<ftp://ftp.fa>
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AGR 612 - PRINCIPLES AND PRACTICES OF WEED MANAGEMENT (2 + 1)**Objectives**

To offer an exposure with the concepts and principles of weed management and to equip the students with scientific advancements in the field of weed science.

Unit I - Weed Biology and Ecology

Weeds – definition and concepts – characteristics - classification – economic uses of weeds and losses caused by weeds. Weed seed dissemination – dormancy and germination. Perennation of weeds. Crop – weed interactions – competition – allelopathy.

Unit II - Weed Control Principles

Methods of weed control – preventive and curative. Mechanical, cultural, biological and chemical control of weeds. Integrated Weed Management - Control of aquatic, parasitic and problematic weeds. Control of weeds in field crops, cropping systems and non-cropped areas - Efficiency indices of weed management techniques. Cost benefit analysis of weed management.

Unit III - Herbicide physiology

Herbicides - Introduction and history of their development; Classification of herbicides based on application, chemical and physiological - Herbicide structure - activity relationship - factors affecting the efficiency of herbicide - Herbicide formulation - components and adjuvants. Herbicide mixtures - herbicide rotation - herbicide interaction with other inputs. Mode of action of herbicides – absorption, translocation and mechanism of action of herbicides. Herbicide persistence in soil and plant – Herbicide application techniques – equipments.

Unit IV - Selectivity, safety and compatibility of herbicides

Basis for herbicide selectivity – metabolism of herbicide – carry over effect – Herbicide residue management. Herbicide toxicology and regulatory aspects. Compatibility of herbicide with other agrochemicals. Decision Support System for weed management.

Unit V - Biotechnology in weed management

Herbicide resistance in weeds and crops – Herbicide resistance management. Weed shift and invasive alien species – Weed Risk Assessment (WRA). Bio control of weeds using plant products, insects and fungi.

Practical

Collection and identification of weeds associated in different ecological situations – Weed survey in crops and cropping systems – Preparation of weed herbarium – Weed seed characters – implements used for weed control – Classification, identification and study of characteristics of important herbicides – Herbicide spraying equipments – formulation of herbicides - Economics of

herbicides application – Herbicides residue determination – Bio-assay – Weed control indices – complimentary weed control – Bioagents and natural products for weed control – Weed research methodology- Phytotoxic injury of herbicides.

Theory Lecture Schedule

1. Definition – characteristics and classification of weeds.
2. Losses caused by weeds on crops, aquatic ecosystem and non cropped field and economic values of weeds.
3. Survival mechanism of weeds – Biology of weeds, Weed migration, Weed seed distribution in different ecosystems.
4. Weed seed dormancy, germination, establishment and perennation of weeds in different ecosystems.
5. Crop - weed competition.
6. Allelopathy – concepts, allochemicals, ways of releasing, types, stimulatory effects and use of allelopathy in agriculture.
7. Principles of weed management- preventive measures.
8. Cultural methods of weed management.
9. Mechanical methods of weed management.
10. Biological method of weed control, bio-herbicides, mycoherbicides and allelo chemicals.
11. Integrated weed management in major field crops.
12. Management of perennial, noxious and problematic weeds.
13. Management parasitic and aquatic weeds.
14. Weed management in different cropping systems.
15. Weed management in non-cropped areas
16. Evaluation of efficiency indices of weed management
17. Cost-benefit analysis of integrated weed management in different ecosystems.
18. Mid semester examination
19. History and development of herbicides.
20. Classification and characteristics of herbicides.
21. Herbicide formulations and its suitability.
22. Herbicides and herbicide mixtures and their compatibility and efficiency.
23. Adjuvants, herbicide protectants and antidotes.
24. Low dose herbicides and nano herbicides.
25. Mode of action of herbicides and their selectivity.
26. Herbicide persistence and degradation in plants and soils. Herbicide residues and their management.
27. Herbicide rotation and its significance on weed management.
28. Herbicide application techniques and equipments.
29. Herbicide selectivity and compatibility.
30. Herbicide toxicology. Herbicide registration and regulation - Decision support system.
31. Herbicide resistant weeds and their impact on weed management.
32. Development of transgenic herbicide resistant crops.

33. Weed shift and Invasive alien species.
34. WRA, natural products and biotechnology in weed management.

Practical Schedule

1. Identification, characterization and classification of terrestrial weeds.
2. Identification, characterization and classification of aquatic weeds.
3. Phytosociological survey of weeds.
4. Assessment of weed seed bank and seed production potential of weeds.
5. Working out herbicides and spray fluid requirements.
6. Herbicide application techniques and equipments.
7. Use of herbicides with different formulations in the field to various crops.
8. Working out economics of herbicide application.
9. Working out weed control efficiencies of different weed management practices.
10. Study on the influence of herbicides on soil microflora.
11. Study on complimentary weed control through cultural practices like mulching and intercropping.
12. Identification and use of bioagents for weed control.
13. Identification and use of natural products for weed control.
14. Methodology for weed research – competition studies and control.
15. Scoring for phyto-toxic injury of herbicides and bio-assay of herbicide residues.
16. Studies and analysis of herbicide residue with Gas chromatography, HPLC etc.
17. Weed management for different farming systems and crops.

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4. <https://www.ipm.iastate.edu/files>>
5. www.dwr.org.in > Downloads>weed identification

AGR 613 - AGRO METEOROLOGY AND CROP WEATHER FORECASTING (2+1)

Objective

To impart knowledge about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

Theory

Unit I - Introduction to agro meteorology

Agro meteorology - aim, scope and development in relation to crop environment. Branches of meteorology, Status of meteorology and agricultural meteorology in India- Composition of atmosphere, distribution of atmospheric pressure and wind.

Unit II - Solar radiation and rainfall

Characteristics of solar radiation - energy balance of atmosphere system - radiation distribution in plant canopies, energy budget of plant canopies - photosynthesis and radiation utilization efficiency by field crops - Rainfall, rainfall variation and its effect on crop production.

Unit III - Temperature and relative humidity

Temperature profile in air, soil, crop canopies – Influence of soil and air temperature on plant processes - atmospheric moisture and relative humidity, vapor pressure and their relationships for better crop production - evaporation and evapo-transpiration and meteorological factors determining evapo-transpiration.

Unit IV - Monsoons

Modification of plant environment in open and controlled conditions - artificial rain making: heat transfer, controlling heat load, heat trapping and shading - protection from cold, sensible and latent heat flux, controlling soil moisture - monsoon and their origin, characteristics of monsoon - onset, progress and withdrawal of monsoon. Weather hazards, drought monitoring and planning for mitigation. Principles and systems of climatic classification, different types of clouds and micro-climatology.

Unit V - Weather forecasting

Weather forecasting in India - short, medium and long range; meteorological service organizations - benefits of weather services to agriculture. Remote sensing application in agro-meteorology and its present status in India. Forecasting of destructive frost, soil moisture forecast, phenological stages and crop yield. Crop yield forecasting and its implications in policy decision. Atmospheric pollution and its effect on climate and crop production; climate change, climate variability and its impact on agriculture - green house effect, carbon sequestration and carbon trading. Crop weather modeling , weather in relation to pest and disease management. Crop weather calendar.

Practical

Visit to agro-meteorological observatory and to record sun-shine hours, wind velocity, wind direction, relative humidity, soil and air temperature, evaporation, precipitation and atmospheric pressure. Measurement of solar radiation outside and within plant canopy. Measurement/estimation of evapo-transpiration by various methods. Measurement/estimation of soil water balance. Rainfall variability analysis. Determination of heat - unit requirement for different crops. Measurement of crop canopy temperature. Measurement of soil temperatures at different depths.

Remote sensing and familiarization with agro-advisory service bulletins. Study of synoptic charts and weather reports, working principle of Automatic Weather Station (AWS). Verification of forecast products.

Theory Lecture Schedule

1. Agro meteorology- aim, scope and development in relation to crop environment.
2. Composition of atmosphere.
3. Distribution of atmospheric pressure and wind.
4. Solar radiation – characteristics.
5. Energy balance of atmospheric system.
6. Radiation distribution in plant canopies, radiation utilization by field crops.
7. Photosynthesis and efficiency of radiation utilization by crops.
8. Energy budget of plant canopies.
9. Environmental temperature – soil, air, canopy temperature.
10. Environmental temperature - Temperature profile in air, soil, crop canopies.
11. Soil and air temperature effects on plant processes.
12. Regulation of air, soil temperature for protection against frost and hot winds
13. Environmental moisture and evaporation – measures of atmospheric moisture, temperature.
14. Environmental moisture and evaporation - measures of relative humidity, vapour pressure and their relationship.
15. Evapotranspiration and meteorological factors deciding evapotranspiration.
16. Modification of plant environment.
17. Artificial rain making.
18. Mid-semester examination
19. Controlling heat load, heat trapping and shading.
20. Protection from cold , reduction in sensible and latent heat flux.
21. Monsoon and their origin, characteristics of monsoon.
22. Onset, progress and withdrawal of monsoon.
23. Weather forecasting in India: short, medium and long range forecasting.
24. Benefits of weather services to agriculture.
25. Forecasting of destructive frost and soil moisture.
26. Phonological forecast, crop yield forecast etc.
27. Aero space science and remote sensing – application in agriculture, present status of remote sensing in India.
28. Atmospheric pollution and its effects on climate and crop production.
29. Climate change, climate variability and its impact on agriculture.
30. Green house effect.
31. Carbon sequestration and carbon trading.
32. Crop weather modeling.

33. Weather in relation to pest and diseases.
34. Crop weather calendar.

Practical Schedule

1. Visit to agro-meteorological observatory
2. Measurement of air, soil temperature and grass minimum temperature and drawing isoline for weather interpretation
3. Measurement of sunshine hours and solar radiation outside and within plant canopy
4. Humidity measurements – use of wet and dry bulb, Assmann psychrometer
5. Measurement of wind direction and wind speed
6. Measurement of rainfall - Ordinary and self-recording rain gauges and Dew - dew gauge
7. Measurement of atmospheric pressure - barograph
8. Measurement of Evaporation - Open pan evaporimeter- application of evaporation data
9. Measurement/estimation of evapo-transpiration by various methods
10. Measurement/estimation of soil water balance
11. Rainfall variability analysis
12. Determination of heat-unit requirement for different crops
13. Measurement of crop canopy temperature and soil temperatures at different depths
14. Remote sensing and familiarization with agro-advisory service bulletins
15. Study of synoptic charts and weather reports and preparation of crop weather calendar. Working principle of Automatic Weather Station (AWS)
16. Visit to nearby IMD station.
17. Weather forecasting

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2. <http://www.fao.org/docrep/x5672e/x5672e09.htm>
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AGR 614 - AGRONOMY OF CEREALS, PULSES, FODDERS AND GREEN MANURE CROPS (1+1)

Objective

To impart knowledge on agronomy of crops *viz.*, cereals millets, pulses and fodder crops

Theory

Unit - I

Cereals – Rice, Maize, Wheat, Barley, Oats, Rye and Triticale

Unit - II

Millets - Sorghum, Cumbu, Finger Millet and Minor millets

Unit - III

Pulses – Pigeon pea, Green gram, Black gram, Chick pea, Cowpea, Soybean, Peas and Horse gram

Unit - IV

Fodders – Cereal, legume and tree fodder – Green manures : Daincha, Sunhemp, Sesbania, Glyricidia, Pillipesara and Cluster bean

Unit - V

Value addition - low cost technologies. Problems and prospects of cereals and pulse production-future thrust - physiological aspects of yield formation, approaches for breaking yield barrier and the role of agronomic practices.

Practical

Laying out observation plots with popular varieties of cereals, millets and pulses - observation on - phenological studies, intercultural operations at different crop growth stages in cereals - millets - pulses - working out growth indices (LAI, CGR, RGR, NAR, LAD). Estimation of quality parameters in cereals and pulse - Assessing of physiological maturity in cereals, millets and pulses - visit to field experiments on cultural, fertilizer, weed control and water management aspects in cereals and pulses - working out harvest index of major crops in cereals, millets and pulses - determination of cost of cultivation of major crops in cereals and pulses - study of seed production techniques in cereals, millets and pulse crops - Estimation of crop yield on the basis of yield attributes for major cereals and pulses - Observation of growth and yield parameters of green manures/ green leaf manures, area, production and its productivity - Silage and hay making – quality and preservation of fodder. Visit to crop research stations and farmer fields.

Theory Lecture Schedule

Origin, history, area and production, classification, prominent and latest varieties, climate, soil, water and cultural requirements, cropping systems, nutrition and quality component, post harvest handling and processing , by-products, value addition and scope for mechanized cultivation. Recent advances in research on cereals, millets, pulses and fodder crops as follows

1. Rice.
2. Rice.
3. Maize.
4. Wheat.
5. Barley and Oats, Rye, Triticale.
6. Sorghum and Cumbu.
7. Finger millet and Minor millets.
8. Chick pea and Peas.
9. Mid semester examination
10. Horse gram and Pigeonpea.
11. Green gram and Blackgram .
12. Cowpea and Soybean.
13. Green manure and green leaf manures: Production technologies for Daincha, Sesbania, Sunnhemp, Tephrosia and Cluster bean and seed production techniques.
14. Forage crops : Scope and importance – definition of fodders and forages – classification – constraints in forage production – production technologies for forage cereals – Sorghum, Maize, Oats and Pearl millet – Forage grasses Perennial grass - Cumbu Napier hybrid grass, Guinea grass, Para grass and Cenchrus – annual grasses – Deenanath, Marvel, Anjan and Setaria grass.
15. Legume forages – production technologies for Alfalfa, Cluster beans, Sweet clover, Desmanthus, Stylosanthus, Berseem, Cowpea and Minor legumes – Pillipesara and Siratro - Cutting management, nutritive and quality management – cropping system.
16. Tree – fodders – Agroforestry – Ley farming - quality characters of tree fodder - silvipastures - nutritive value and quality aspects of forage crops.
17. Present trends and future thrust in cereal and pulse production - Low cost and cost effective technique in cereal production

Practical Schedule

1. Planning and layout of field experiments in cereals, millets and pulses.
2. Sowing of certain crops for observations on growth and yield parameters in sole and intercrop situations.
3. Practicing nursery field preparation for different crops.
4. Phenological studies, intercultural operations at different crop growth stages in cereals.
5. Phenological studies, intercultural operations at different crop growth stages in millets and pulses.

6. Working out growth indices (LAI, CGR, RGR, NAR, LAD).
7. Assessing of physiological maturity in cereals, millets and pulses.
8. Working out harvest index of major crops in cereals, millets and pulses through estimation of yield parameters.
9. Working out cost of cultivation of major cereal, millet and pulse crops.
10. Study of seed production techniques in cereal, millet and pulse crops.
11. Study of seed production techniques in green manure and fodder crops
12. Estimation of crop yield on the basis of yield attributes for major cereals and pulses
13. Estimation of biomass and seed yield of green manures/ green leaf manures.
14. Practicing of silage and hay making.
15. Estimation of quality parameters in cereals, millets and pulses.
16. Insitu incorporation techniques for green manure crops in different farming systems.
17. Visit to nearby crop research stations and farmers field.

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AGR 621 - PRINCIPLES AND PRACTICES OF WATER MANAGEMENT (2+1)

Objective

To impart water management principles and practices to increase water use efficiency and enhance crop productivity.

Theory

Unit I - Water resources and irrigation development

History of irrigation in India - water resources of India and Tamil Nadu - Major and minor irrigation projects of India and Tamil Nadu - Scope for water conservation and storage in India and Tamil Nadu.

Unit II - Soil-water-plant relationship

Water and its properties - soil water concepts - classification of soil water - water movement in soils and plants - absorption and conductance by plants - soil moisture depth concepts.

Unit III - Crop water requirement and irrigation scheduling

Water Requirement (WR) of crops - factors affecting WR - methods of estimation of WR of crops - Gross and Net irrigation requirement concepts - scheduling irrigation based on different approaches - frequency of irrigation.

Unit IV - Methods of irrigation and water use efficiency

Irrigation methods - surface, sub-surface and pressurized systems - suitability of crops - Design and layout of irrigation systems - WUE - methods to improve WUE - units of expression.

Unit V - Integrated water management

Water management for different crops under excess water and deficit conditions - understanding quality parameters of irrigation water and its management by agronomic practices, management of problems soils - drainage methods.

Practical

Analysis of quality of irrigation water for important salts, determination of soil water constants, estimation of basic and cumulative infiltration rate of different soils, determination of hydraulic conductivity, soil moisture estimation by gravimetric and improved devices, working out irrigation efficiency parameters, calculations on fertigation, working out economics of different method of irrigation and visit to important institutes of irrigation.

Lecture schedule

1. History of irrigation - water resources of India and Tamil Nadu - occurrence of ground water – aquifers.
2. Major and minor irrigation projects of India and Tamil Nadu
3. Scope for water conservation and storage in Indian and Tamil Nadu.
4. Water, its properties and role in plants.
5. Soil water potential concepts.
6. Relationship between different potentials-units of expression.
7. Factors influencing Soil water potential.
8. Physical classification of water.
9. Soil moisture constants - ASM - RAW and MAD concepts - response of various soil types.

10. Soil water movement - mechanisms of absorption and conductance in plants - factors responsible.
11. Effective root zone depth - Moisture extraction pattern.
12. Loss of water from soil and plant - evaporation – transpiration.
13. Evapotranspiration - factors affecting ET.
14. Water needs of crops - NIR, GIR, NWIR, GWIR concepts.
15. Factors affecting WR of crops.
16. Methods of estimating WR of crops.
17. Scheduling of irrigation by various approaches - ET_0 - ET_C - K_C factors.
18. Mid semester examination
19. Methods of irrigation - surface - sub surface - advantages and shortcomings - suitable crops.
20. Pressurized systems - advantages and shortcomings - suitable crops.
21. Fertigation - concepts - suitable fertilizers and crops - advantages and limitations.
22. WUE - factors affecting.
23. Agronomic management practices to increase WUE.
24. Water management for crops and cropping systems.
25. Soil moisture stress - symptoms - plant response to water stress.
26. Crop adaptation mechanisms - and practices to overcome soil moisture stress.
27. Management of water under constraint situation.
28. Command area development and on farm water management practices.
29. Quality of irrigation water - criteria for determination.
30. Influence of quality irrigation water on plant growth - tolerant crops.
31. Management of saline and brackish water.
32. Water management of problem soils.
33. Excess soil water - factors responsible for water stagnation - remedial measures.
34. Drainage methods - concepts, design, layout and spacing.

Practical schedule

1. Determination of soluble salts and Ca^{2+} , Mg^{2+} in irrigation water.
2. Determination of CO_3^- and HCO_3^- and Na in irrigation water.
3. Estimation of soil moisture constants for light soils.
4. Estimation of soil moisture constants for heavy soils.
5. Standardizing soil moisture curves using different devices *viz*, tensiometer, pressure plate apparatus.
6. Water flow measurement using different devices at field level.
7. Determination of infiltration rate of soil.
8. Determination of hydraulic conductivity of soil.
9. Determination of soil moisture depletion.
10. Assessment of plant water status - RWC by direct method.
11. Determination of irrigation requirement of crops.

12. Computation of water requirement of important crops using modified Penman method.
13. Working out various irrigation efficiencies using formulae.
14. Calculation on fertigation for important crops based on its water requirement.
15. Economics of various irrigation systems.
16. Field drainage.
17. Visit to important irrigation institutions.

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AGR 622 - PRINCIPLES AND PRACTICES OF SOIL FERTILITY AND NUTRIENT MANAGEMENT (2+1)

Objective

To impart knowledge of fertilizers and manures as sources of plant nutrients and appraise about the integrated approach of plant nutrition and sustainability of soil fertility.

Theory

Unit I - Soil fertility and productivity

Soil - origin, formation, dispersion – retundant – features of good soil management. Soil health- Problem of supply and availability of nutrients - relationship between nutrient supply and crop growth. Soils of India - soil fertility and productivity – definition and importance.

Unit II – Essentiality of plant nutrients

Mineral nutrition of plants – criteria of essentiality of nutrients - essential plant nutrients – their functions, nutrient deficiency symptoms, nutrient movement and uptake - major plant nutrients in soil and plant. Soil pH and CEC – importance of plant nutrients and its availability - IPNS - importance and essentiality - Problem soils and their management.

Unit III – Nutrient budgeting

Methodologies for soil fertility assessment - approaches for fertilizer scheduling – significance - CNC, CNR, DRIS, inverse yield nitrogen law - Mitscherlich yield equation, its interpretation and applicability – Baule Unit and crop logging - Maintenance of soil fertility - Determining the nutrient needs for yield potentiality of crops – Concept of balanced nutrition – INM. IPNSS - Recycling of organic wastes and residue management.

Unit IV – Fertilizer and fertilization

Commercial fertilizers - solid and liquid composition– fertilizer mixture and grades –crop response to different nutrients - residual effects and fertilizer use efficiency - different methods of estimating and increasing FUE - nutrient availability– soil moisture and nutrient interaction.

Unit V – Methods of fertilization

Time and methods of manures and fertilizers application; foliar application and its concept - fertigation - soluble nutrients - chelated nutrients- fertilizer related environmental and ground water pollution - carbon sequestration.

Practical

Determination of soil pH, EC, organic C, total N, available N, P, K and S in soils. Determination of total N, P, K and S in plants. Interpretation of interaction effects and computation of economic and yield optima. Nutrient budgeting. Diagnosis of nutrient deficiencies and remedial measures.

Theory Lecture Schedule

1. Soil: orgin, formation, dispersion- factors influencing soil formation.
2. Physico- chemical properties of the soil.
3. Problems of supply and availability of nutrients and features of good soil management.
4. Factors influencing nutrient supply and crop growth.

5. Different soils of India- characteristics and functions
6. Soil fertility and crop productivity- definition and concepts-Agronomic significance for sustainable crop production.
7. Availability of plant nutrients in soil - micro and macro nutrients - criteria of essentiality of nutrients.
8. Essential plant nutrients – their functions- macronutrients – N, P, K.
9. Essential plant nutrients – their functions – secondary and micronutrients.
10. Identification of nutrient deficiency and its symptoms – critical levels.
11. Transformation and dynamics of plant nutrients – nitrogen.
12. Transformation and dynamics of phosphorus and potassium.
13. Soil pH and CEC – Importance in availability of plant nutrients.
14. IPNS- importance and essentiality - crops and cropping system.
15. Soil health and its importance.
16. Problem soils and their management.
17. Methodologies for soil fertility assessment - approaches for fertilizer scheduling.
18. Mid semester examination
19. CNC, CNR, DRIS - significance - crop logging.
20. Composting techniques-composition, C: N ratio-availability and crop response.
21. Recycling of organic wastes and residue management.
22. Organic farming - basic concepts and definitions - organic farming in crops and cropping system.
23. Commercial fertilizers - solid and liquid composition – relative fertilizer value and cost.
24. Crop response to different nutrients.
25. Residual effects and fertilizer use efficiency
26. FUE-Agronomic, chemical and physiological methods of estimating FUE.
27. FUE-Techniques for increasing FUE.
28. Fertilizer mixtures and grades – their composition- uses.
29. Nutrient availability – soil moisture and nutrient interaction.
30. Time and methods of manures and fertilizer application - Foliar nutrition- application and its concept - uses.
31. Fertigation - soluble and chelated nutrients - application, concept - uses.
32. Fertilizer related environmental and ground water pollution.
33. Nutrient budgeting-imbalance - concepts – crops and cropping system.
34. Carbon sequestration - concepts – essentiality - different methods.

Practical Schedule

1. Collection of soil and plant samples for analysis.
2. Estimation of pH, EC in soils.
3. Determination of organic carbon of soil.
4. Determination of total N of soil.
5. Determination of available N in soil.
6. Determination of available P_2O_5 in soil.
7. Determination of available K_2O in soil.

8. Determination of available sulphur in soil.
9. Working out C: N ratio and fertilizer schedule for different cropping systems.
10. Determination of total N in plants.
11. Determination of total P plants.
12. Determination of total K plants
13. Interpretation of interaction effects.
14. Computation of economic and yield optima.
15. Nutrient budgeting.
16. Diagnosis of nutrient deficiencies for major nutrients and remedial measures.
17. Diagnosis of nutrient deficiencies for minor nutrients and remedial measures.

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AGR 623 - AGRONOMY OF OILSEED, FIBRE, SUGAR, TUBER AND NARCOTIC CROPS (1+1)

Objective

To impart knowledge on agronomy of crops viz., oilseed, fibre, sugar, narcotics and tuber crops.

Theory

Origin, history, area and production, classification, prominent and latest varieties, climate, soil, water and cultural requirements, nutrition and quality component, post harvest handling and processing , by-products, value addition and scope for mechanized cultivation - recent advances in research on commercial crops.

Unit - I

Major Oilseeds: Groundnut, Sesame, Coconut, Rapeseed and Mustard

Unit - II

Minor Oilseeds : Sunflower, Safflower, Linseed, Niger, Castor, and Jatropha

Unit - III

Fibre crops : Cotton, Jute, Sunhemp, Mesta and Agave

Unit - IV

Sugar crops: Sugarcane, Sugar beet and Sweet sorghum

Unit - V

Tuber and narcotic crops : Tapioca, Sweet potato, Potato and Tobacco

Practical

Identification of latest crop varieties - Establishing crop cafeteria plots - phenological study of different crops- seed and sett treatment methods - Nursery management for crops - input application to different crops - Determination of oil content in oilseeds and computation of oil yield – practice on sugarcane cultivation from nursery to harvest – quality parameters of sugarcane juice – Assessing maturity of crops - Harvest index - Intercultural operations in different crops - Working out canopy measurement and growth indices (LAI, CGR, RGR, NAR, LAD) - Working out cost of cultivation of different crops - Estimation of crop yield on the basis of yield attributes – Studies on value addition of different oilseeds, fibres, sugars and tuber crops - Study of seed production techniques in various crops - Visit to field experiments, Farmer's fields/ Research institutes.

Theory Lecture Schedule

Origin, history, area and production, classification, prominent and latest varieties, climate, soil, water and cultural requirements, cropping systems, nutrition and quality component, post harvest handling and processing , by-products, value addition and scope for mechanized cultivation. Recent advances in research on commercial crops for the following crops:

1. Oilseeds : Introduction -constraints in oil seed production and measures to improve productivity
2. Groundnut
3. Sesamum
4. Rapeseed and mustard
5. Coconut
6. Sunflower and safflower
7. Linseed, Niger, castor and Jatropha
8. Introduction and economic importance and role of fibre crops -Area, production, productivity, - classification - Demand, supply and marketability of fibre crops
9. Mid semester examination
10. Cotton
11. Jute, Mesta, Sunnhemp and Agave
12. Sugarcane: Ruling varieties – nursery techniques – SSI – methods of planting – after cultivation practices- weed management and irrigation.
13. Sugarcane, crop logging, cane ripeners, Sugarcane based cropping system, Harvesting and scope for mechanized cultivation and ratoon management techniques

14. Sugar beet and Sweet sorghum.
15. Tapioca
16. Potato and Sweet potato
17. Tobacco

Practical schedule

1. Planning and layout of field experiments.
2. Sowing of certain crops for observation on growth and yield parameters.
3. Study of seed treatment and nursery management for different crops.
4. Study of phenology and growth characters in groundnut, sesame and sunflower.
5. Study of phenology and growth characters in sugarcane and cotton.
6. Cutting of sugarcane setts, its treatment, methods of planting .
7. On plant inter-cultivation technologies in sugarcane.
8. Determination of cane maturity, calculation on purity percentage, recovery percentage and sucrose content in cane juice, at different growth stages of crop
9. Working out growth indices (LAI, CGR, RGR, NAR, LAD).
10. Judging of physiological maturity in different crops and working out harvest index.
11. Working out cost of cultivation of different crops with intercropping situations.
12. Estimation of crop yield on the basis of yield attributes and Harvest index (HI).
13. Determination of oil content in oilseeds and computation of oil yield.
14. Estimation of quality of fibre for different fibre crops.
15. Study of seed production techniques in various crops.
16. Studies on value addition of different oilseeds, fibres, sugars and tuber crops
17. Visit to field experiments/Research stations/farmers field to acquire practical knowledge on cultural, fertilizer, weed control and water management aspects.

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AGR 624 - FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE (1 +1)

Objective

To offer an understanding on cropping and farming system as a tool for enhancing farm productivity and to incorporate scientific principles of sustainability in low input farming.

Unit I - Farming system

Farming system - integrated farming system, alternate farming system - meaning and scope - recycling and crop residue management - natural farming - concept and components - Organic farming - Crop diversification – principles, types and needs - sustainable agriculture - definition, scope and objectives - Socio-economic constraints in adoption of systems approach - location specific IFS models - Crop diversification for sustainability.

Unit II - Cropping system

Cropping system – Definition – scope and importance – intensive agriculture – principles – ecological interactions among crop communities – competition, annidation and allelopathy – resource competition and management in cropping systems. Types of multiple cropping – sequential, relay, inter, mixed and multi-storied - evaluation indices for farming and cropping systems

Unit III - Dryland farming

Definition, concept, significance and dimensions of dryland farming in Indian agriculture, characteristics and classification of dryland farming - delineation of dry farming areas on the basis of moisture deficit index and their characteristics - constraints limiting crop production in dry land areas; drought management strategies – contingency crop planning for aberrant weather conditions - dry land crop production technologies for sustainable agriculture.

Unit IV - Sustainability through systems Approach

Sustainability concepts in cropping and farming systems – Development, management and allocation of resources – low input sustainable agriculture –

Water harvesting- its concepts, techniques and practices - Watershed management- definition, objectives, concepts, problems, approach for sustainable farming - Natural resources - characterization and management for crop planning - Sustainable cropping and farming systems in agriculture in relation to environmental degradation - alternate land use pattern.

Unit V - Farming for environmental conservation

Impact of agro inputs – biotechnology – GMO’s and invasive alien species on farm productivity. Environmental pollutants abatement and farming – Restoration of degraded and wastelands – WTO - Farming systems and agro industries, value addition in farm products - Bioremediation and Bio-scavenging.

Practical

Preparation of cropping scheme for different agroclimatic zones – Designing of cropping system based on rainfall analysis – working out input requirement for crops, cropping systems – preparation of calendar of operation for wetland, irrigated upland and dry land cropping system – working out indices for evaluation of cropping system – study on evaluation indicators on farming system – preparation of integrated farming system models for different eco – systems – on farm field visit – analysis of farming system models.

Theory Lecture Schedule

1. Scope of Farming systems and factors influencing the choice of component elements.
2. Integrated Farming Systems – prospects, constraints, resource recycling and crop residue management.
3. Alternate farming system - natural farming - organic farming - definition, scope, objectives, concept and components.
4. Multiple cropping and crop diversification – scope and importance of cropping system and intensive agriculture.
5. Plant interactions – Competition, annidation and allelopathy / teletoxicity.
6. Evaluation of farming and cropping systems based on various indices .
7. Socio- economic constraints for adoption of cropping systems.
8. Resource management and crop planning - Alternate land use systems.
9. Mid semester examination
10. Dry land farming - definition, concept, significance and dimensions of dryland farming in Indian agriculture, and characteristics and classification of dryland farming.
11. Delineation of dry farming areas on the basis of drought indices and their characteristics and constraints limiting crop production in dry land areas.
12. Drought management strategies, contingency crop planning and preparation of crop plans for dry land areas.
13. Dry land crop production technologies for sustainable agriculture.
14. Inputs management and cost reduction strategies for sustainable agriculture.
15. Watershed management and water harvesting- its concepts, techniques.
16. Biotechnology – GMO’s and invasive alien species on farm productivity.
17. Restoration of degraded and wastelands and bioremediation and Bio-scavenging

Practical Schedule

1. Preparation of cropping scheme for different agro climatic zones.
2. Review of cropping system experiments in India and Tamilnadu.
3. Study on Indices for biological and economic evaluation of cropping system.
4. Assessing risks and opportunities with component elements dairy, fishery, poultry, goat rearing, piggery etc.
5. Formulation of Integrated Farming Systems for wetlands.
6. Formulation of Integrated Farming Systems for garden land and dry lands.
7. Assessment of Organic recycling in Integrated Farming Systems.
8. Tracing the role of farming elements in reducing inputs and agrochemical use.
9. Preparation of cropping scheme for different farming systems and working out input requirement.
10. Calendar of operations for wet land and irrigated upland cropping system.
11. Working out indices for evaluating the farming and cropping system - land use, yield advantage, Economics, sustainability.
12. Analysis and interpretation of weather data – initial and conditional probabilities.
13. Working out moisture availability index based on rainfall and ET.
14. Determination of Agricultural drought.
15. Designing of cropping system based on rainfall analysis.
16. Visit to watershed and study of various technologies.
17. Visit to dry land agricultural research stations.

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MINOR COURSES OFFERED BY DEPARTMENT OF AGRONOMY

OPC - AGR 711 - ORGANIC FARMING AND PRECISION AGRICULTURE (2+1)

Objectives

To impart knowledge on the concepts and importance of organic agriculture, precision agriculture and to equip the students with geostatistical techniques and variable crop yield mapping.

Theory

Unit I - Importance of Organic farming

Organic farming – current status of organic farming in India and Tamil Nadu – Potential resources for nutrient supply in organic farming – Prospects and

limitations of organic farming in field and horticultural crops - ITK in organic agriculture

Unit II - Soil health and organic certification

Organic farming in relation to soil health and quality organic farming in relation to insect and disease management – organic manures, bio-fertilizers, blue green algae and vermicompost in organic farming - Trade, industry and certification in organic farming – certification standards - Procedures and regulatory mechanisms in organic agriculture – Government policies towards research and development of organic farming in India.

Unit III - Precision farming

Precision farming – concept and approach – Application of precision concept in INM of field crops – Land information for precision agriculture – Remote sensing – GIS and GPS – VAT based precision farming. Scope of precision farming in agriculture, horticulture and plantation crops.

Unit IV - Yield mapping techniques

Potential and limitation of satellite remote sensing in precision agriculture – yield mapping with remote sensing for precision agriculture – precise water management in agriculture using spatial hydrological methods and remote sensing – use of hyperspectral data for precision farming – soil survey and mapping techniques for precision farming.

Unit V - Application of GIS and decision support system tool

GIS based nutrient delivery systems – Development of sensors and their evaluation – remote sensing and GIS applications for management of land and water resources on watershed framework – Decision support system tool for impact assessment of saline and sodic environment – geo-statistical techniques for precision farming – Spatial and temporal variability of soil physical parameters – DSSAT for variable crop yield mapping – Farm machinery for precise input application.

Practical

Aerobic and anaerobic methods of making compost, making vermicompost – Efficient use of biofertilizers – techniques of treating legume seeds with Rhizobium cultures, use of Azotobacter, Azospirillum, and PSB cultures in field - Visit to an organic farm – bio – dynamic farm – Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms. Visual image interpretation, Spectral Indices, Thermal indices derived from remote sensing data, Spectroradiometer data analysis, IR thermometer principles and working, Map projection system. Digital image processing, ERDAS imaging, ARC view, Satellites, Sensors and platforms, Satellite data acquisition and dissemination, Principles of crop modeling.

Theory lecture Schedule

1. Organic Farming – definition, concepts, prospects, opportunities and priorities.
2. Current status of Organic Farming in India and Tamil Nadu.
3. Resources for nutrient supply in organic farming – Bio and industrial wastes.

4. Role of Indigenous technological knowledge (ITK) in organic agriculture.
5. Prospects and limitations of organic farming in field crops – Cereals, millets, and pulses.
6. Prospects and limitations of organic farming in field crops – Oilseeds and commercial crops.
7. Prospects of organic farming in agriculture and horticultural crops – Vegetables, fruits, spices and plantation crops.
8. Organic farming in relation to soil health and quality.
9. Organic farming in relation to insect and disease management.
10. Organic manures, bio-fertilizers, blue green algae and vermicompost for organic farming.
11. Government policies towards development of organic farming in India.
12. Trade, industry and certification in organic farming – Certification standards, procedures and regulatory mechanisms.
13. Precision farming – concept, approach and relevance to Indian Agriculture.
14. Application of precision concept in INM of field crops.
15. Precision agriculture and cropping system.
16. Soil and land information of precision agriculture.
17. Remote sensing – GIS and GPS – VAT based precision farming.
18. Mid Semester Examination.
19. Scope of precision farming in horticulture / plantation crops.
20. Potential and limitation of satellite remote sensing for precision farming.
21. Yield mapping with remote sensing for precision agriculture.
22. Precise water management in agriculture using spatial hydrological models and remote sensing.
23. Use of hyperspectral data for precision farming.
24. Soil survey and mapping techniques for precision farming.
25. GIS based nutrient delivery systems.
26. Development of sensors and their evaluation.
27. Remote sensing and GIS applications for management of land and water resources on watershed framework.
28. Decision support system tool for impact assessment of saline/sodic environment.
29. Geostatistical techniques for precision farming.
30. Spatial and temporal variability of soil physical parameters.
31. DSSAT for variable crop yield mapping.
32. Farm machinery for precise input application.
33. Precision farming in agroforestry.
34. Weather forecast – A decision tool for precision farming.

Practical Schedule

1. Practicing aerobic methods of making compost.
2. Practicing anaerobic methods of making compost.
3. Practicing vermicomposting methods.

4. Techniques of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum* and PSB cultures in field.
5. Role of Indigenous Technological Knowledge (ITK) in weed, insect and disease management.
6. Visit to sugar industry to study the by-products composting.
7. Visit to an organic farm.
8. Visit to biodynamic farm.
9. Quality standards, inspection, certification and labelling and accreditation procedures for farm produce from organic farms.
10. Visual image interpretation, spectral indices, thermal indices derived from remote sensing data.
11. Spectro radiometer data analysis.
12. Study of IR thermometer principles and working.
13. Practicing map projection system.
14. Practicing digital image processing.
15. ERDAS imaging, ARC view, satellites.
16. Study of sensors and platforms.
17. Satellite data acquisition and dissemination and crop modeling studies.

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14. Woomer, P.L., and Swif, M.J. 1994. *The Biological Management of Tropical Soil Fertility*, T.S.B.F. and Wiley.

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1. http://ncof.dacnet.nic.in/Training_manuals/Training_manuals_in_English/Organic_Agriculture_in_India.pdf
2. http://orgprints.org/2768/1/eyhorn-2004-Organic_Agriculture_in_India.pdf
3. <http://www.fao.org/organicag/oa-home/en/>
4. <https://www.fibl.org/fileadmin/documents/shop/1636-organic-world-2014.pdf>

OPC - AGR 712 - DRY FARMING AND WATERSHED MANAGEMENT (2+1)

Objective

To impart scientific knowledge on concepts and practices of dry farming, soil moisture conservation and watershed management.

Theory

Unit I - Principles of dry land agriculture

Dry farming - Definition, concept, characteristics and classification - Significance and dimensions of dry farming in Indian agriculture - Production constraints in dry farming areas - Rainfall characterization in dry lands.

Unit II - Drought and mitigation strategies

Drought and its classification - Drought resistance in crops - Mechanism for drought tolerance and crop adaptability to drought situations - Drought tolerant crops and their varieties, plant ideotypes for dry land areas - ephemerals - shoot and root growth characteristics - preparation of appropriate crop plans for dry land areas - midseason correction for aberrant weather situation - contingent crop planning .

Unit III - Soil moisture conservation techniques in drylands

Soil moisture conservation techniques - Agronomic, Engineering and Biological methods - Moisture retention and availability concepts - Length of Growing Period (LGP) - Water absorption by crop plants under stress conditions - Water loss through evaporation and transpiration and its management under stress conditions - effectiveness and economics - Management of soil constraints.

Unit IV - Approaches for Integrated dry farming technology

Agricultural implements and machineries for dry farming - Tillage - Soil and crop management techniques: seed hardening and efficient fertilizer use - Integrated dry farming technology - Cropping systems, integrated farming systems, organic farming and alternative land use systems.

Unit V - Watershed management

Watershed management - concepts, approaches and components - Water harvesting techniques - Scope and application - Rain water management in watershed - pre and post sowing conservation technologies - Role of organization in promoting watershed - Selection of crops and cropping systems based on rainfall

and socio - economic factors – Land capability classification - Rehabilitation of degraded lands in watershed .

Practical

Mapping of arid and semiarid zones of India and agro - climatic zones of India and Tamil Nadu - study of moisture profiles of soils - Rainfall analysis and interpretation – Use of mulches and antitranspirants - seed hardening techniques - germination and crop establishment in relation to moisture stress – Estimation of moisture index, aridity index and Water-Use Efficiency - Plant root growth studies with reference to stress management - farm mechanization in dry farming - Collection and interpretation of data for water balance equations - Estimation of run-off and soil moisture loss - Crop planning for different drought conditions – Preparation of model watershed programme - Visit to dry farming research experiments / exposure visits to research institutes/ stations and watersheds.

Theory lecture schedule

1. Dry farming- Definition, concept, characteristics.
2. Dimensions of dry land farming in Indian agriculture.
3. Dry farming- classification - significance and dimensions of dry farming in India.
4. Production constraints in dry farming areas.
5. Rainfall characterization and behaviours.
6. Delineation of dry farming areas on the basis of drought indices and their characteristics.
7. Drought and its classification.
8. Drought management strategies and preparation of crop plans for dry land areas.
9. Dry land crop production technologies for sustainable agriculture.
10. Methods of controlling runoff and its significance.
11. Evaporation, evapo-transpiration, mulching, antitranspirants and antievaporants.
12. Drought resistance in crops - Mechanism for drought tolerance and crop adaptability to drought situations.
13. Drought tolerant crops and their varieties.
14. Plant ideotypes for dryland areas - shoot and root growth characteristics.
15. Preparation of appropriate crop plans for dryland areas.
16. Midseason correction for aberrant weather situation.
17. Contingent crop planning to mitigate drought.
18. Mid-semester examination
19. Soil moisture conservation techniques - Agronomic, Engineering and Biological.
20. Moisture retention and availability concepts - Length of Growing Period (LGP) - Water absorption by crop plants under stress conditions.
21. Water loss through evaporation and transpiration and its management under stress conditions - effectiveness and economics- management of soil constraints.

22. Agricultural implements and machineries for dry farming.
23. Tillage - Soil and crop management techniques - seed hardening and efficient fertilizer use.
24. Integrated dry farming technology - Cropping systems.
25. Integrated farming systems – significance - location specific IFS – models for wetlands, garden lands and drylands.
26. Organic farming and alternative land use systems.
27. Watershed management: Definition, concepts, problems, approaches and components of watershed.
28. Problems, approach components, development of cropping systems for watershed areas.
29. Resource management and crop planning – alternate land use pattern
30. Water harvesting techniques - Scope and application - Rain water management in watershed.
31. Pre and post sowing conservation technologies.
32. Role of organization in promoting watershed.
33. Selection of crops and cropping systems based on rainfall and socio economic factors.
34. Classification of land based on LCC and rehabilitation of degraded lands in watershed

Practical schedule

1. Mapping of arid and semiarid zones of Tamilnadu and India.
2. Study of moisture profiles of soils.
3. Rainfall analysis and interpretation.
4. Designing cropping systems based on rainfall analysis
5. Use of mulches and antitranspirants.
6. Seed treatment techniques –hardening, seed priming.
7. Estimation of moisture index, aridity index and water-use efficiency.
8. Plant root growth studies with reference to stress management.
9. Study of farm implements in dry farming.
10. Estimation of run-off and soil moisture loss.
11. Collection and interpretation of data for water balance equations.
12. Preparation and methodology for implementation of watershed projects.
13. Preparation of model watershed programme.
14. Visit to nearby watershed.
15. Visit to dry land agricultural and horticultural research stations.
16. Crop planning for different drought conditions.
17. Assessment of biomass production under watershed area.

References

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2. Das, NR. 2007. Tillage and crop production. Scientific Publishers, Jodhpur, India

3. Dhopte, A.M. 2002. Agro-technology for dryland farming. Scientific Publishers, Jodhpur, India
4. Dhruv Narayan, VV. 2002. Soil and water conservation research in India. ICAR publications, New Delhi.
5. Gupta, U.S. 1990. Physiological aspects of dry farming. Oxford and IBH Publication, New Delhi.
6. Jeevananda Reddy S. 2002. Dryland agriculture. B.S.Publications, Hyderabad.
7. Kerkar, R.R . 2010. Climate change – A holistic view. B.S publications, Hyderabad
8. Khan, M.A.2002.Watershed management for sustainable agriculture. Agrobios (India) Jodhpur
9. Panda, S.C..2008. Dryland agriculture, Agribios,India, Jodhapur.
10. Rao, SC and Ryan, J. 2007. Challenges and strategies of dryland agriculture. Scientific Publishers, Jodhpur, India.
11. Rao, G.G.S.N.2015. Drought in agricultural production, New India publishing Agency, New Delhi.
12. Singh, P and Maliwal, PL. 2005. Technologies for food security and sustainable agriculture. Agrotech Publishing Company.
13. Singh, RP. 2005. Sustainable development of dryland agriculture in India. Scientific Publishers, Jodhpur, India
14. Venkateshwarlu, J. 2004. Rainfed agriculture in India. Research and Development Scenario. ICAR.

e-Resources

1. www.fao.org/docrep/w7314e/w7314e0q.htm
2. www.ias.ac.in
3. www.wcainfonet.org/.../soilmoistureconservtion_en_1303_all_1.html
4. www.world-agriculture.com

DEPARTMENT OF ENTOMOLOGY
M.SC. (AG.) AGRICULTURAL ENTOMOLOGY
DISTRIBUTION OF COURSES

Major courses – 20 credits

Sl. No.	Course code	Course Title	Credit Hours
1.	ENT 611	Insect Morphology and Classification	2+1
2.	ENT 612	Insect Anatomy, Physiology and Nutrition	2+1
3.	ENT 613	Insect Ecology, Pest Management, Storage and Quarantine Entomology	2+1
4.	ENT 621	Toxicology of Insecticides	2+1
5.	ENT 622	Biological Insect Pest Suppression	2+1
6.	ENT 623	Pests of Crops and their Management	2+1
7.	ENT 624	Plant Resistance To Pests	1+1
Total			13+7=20

Minor -9 Credits

1.	OPC GPB 621	Concepts of Crop Physiology	2+1
2.	OPC ENT 711	Productive Insects and Weed Killers	2+1
3.	OPC ENT 712	Pest Management in Organic Farming	2+1
Total			6+3=09

Supporting Courses – 5 Credits

1.	STA 611	Statistical Methods And Design Of Experiments	2+1
2.	COM 611	Computer Application For Agricultural Research	1+1
Total			3+2=05

Seminar +Research – 21 Credits

1.	ENT 032	Seminar	0+1
2.	ENT 011, 021, 031, 041	Research 011- 0+1; 021 -0+2; 031 - 0+8; 041- 0+9	0+20
Total			0 + 21
Grand Total			22+33=55

Non credit compulsory course 2+4=6

1.	PGS 611	Agricultural Research Ethics and Methodology	0+1
2.	PGS 612	Technical Writing And Communication Skills	0+1
3.	PGS 623	Basic Concepts In Laboratory Techniques	0+1
4.	PGS 624	Library and Information Services	0+1
5.	PGS 715 (e-course)	Intellectual Property and Its Management In Agriculture	1+0
6.	PGS 716 (e-course)	Disaster Management	1+0
Total			2+4=6

SEMESTER WISE DISTRIBUTION OF COURSES

I Semester			
Sl. No.	Course code	Course Title	Credit hours
1.	ENT 611	Insect Morphology and Classification	2+1
2.	ENT 612	Insect Anatomy, Physiology and Nutrition	2+1
3.	ENT 613	Insect Ecology, Pest Management, Storage and Quarantine Entomology	2+1
4.	STA 611	Statistical Methods And Design Of Experiments	2+1
5.	COM 611	Computer Application For Agricultural Research	1+1
6.	ENT 011	Research	0+1
7	PGS 611	Agricultural Research Ethics and Methodology (0+1)	-
8	PGS 612	Technical Writing And Communication Skill (0+1)	-
Total			9 + 6=15
II Semester			
1.	ENT 621	Toxicology of Insecticides	2+1
2.	ENT 622	Biological Insect Pest Suppression	2+1
3.	ENT 623	Pests of Crops and their Management	2+1
4.	ENT 624	Plant Resistance To Pests	1+1
5.	OPC GPB 621	Concepts in crop physiology	2+1
6.	ENT 021	Research	0+2
7.	PGS 623*	Basic Concepts In Laboratory Techniques (0+1)	-
8.	PGS 624*	Library and Information Services (0+1)	-
Total			9+7=16
III Semester			
1	OPC-XXX 711	Minor Course - Related discipline	2+1
2	OPC-XXX712	Minor Course - Related discipline	2+1
3.	ENT 031	Research	0+8
4	ENT 032	Seminar	0+1
5	PGS 715* (e-course)	Intellectual Property And Its Management In Agriculture (1+0)	-
6	PGS 716 * (e-course)	Disaster Management (1+0)	-
Total			4+11=15
IV Semester			
1.	ENT 041	Research	0+9
Total			0+9
Grand Total			22 + 33 = 55

ENT 611 - INSECT MORPHOLOGY AND CLASSIFICATION (2+1)**Objective**

- To understand the external morphology of insects
- To study the principles and concepts of insect classification
- To gain hands-on experience in diagnosing insect orders

Unit I - Insect head and thorax

Tagmosis in insects – General body wall – its structure, cuticular outgrowths, special integumentary processes. Insect colouration. Body regions, sclerites, sutures and sulci. Insect head and its orientation; appendages of head and their modification- antenna and its modifications. Mouth parts in insects – mandibulate and haustellate types - their modifications - special types. Insect thorax and its appendages - Legs – modifications and types. Insect wings – development – venation – modifications and types - articulation with thoracic muscles.

Unit II - Insect abdomen and metamorphosis

Insect abdomen – segmentation – modifications – appendages in different life stages – genitalia, their modification. Structure of sense organs. Insect metamorphosis – types of insect egg, larva and pupa.

Unit III - Basics and advances in insect taxonomy

Insect taxonomy and systematics - definition and principles. Taxonomic publications, recent advances in insect taxonomy - micro and macro morphological, embryological, ecological, behavioural, cytological, biochemical and numerical taxonomy. Typological, nominalistic, biological and evolutionary species concepts. Taxonomic keys, International Code of Zoological Nomenclature (ICZN) – preamble - bi and trinomial nomenclature - major group names - validity of names - principle of priority, synonymy and homonymy, type concept.

Unit IV - Classification of non-insect orders, apterygotes and exopterygotes

Recent classification of insects – Diagnosis of non-insect orders – Collembola, Protura and Diplura, Apterygotes –Archaeognatha and Zygentoma. Diagnosis of Palaeoptera and Neoptera. Diagnostic characters of orders and important families of Palaeoptera (Ephemeroptera and Odonata) and Neoptera – Plecoptera, Dermaptera, Embioptera, Zoraptera, Orthoptera, Phasmatodea, Grylloblattodea, Mantophasmatodea, Mantodea, Blattodea (roaches and termites), Psocodea (free-living and parasitic), Thysanoptera and Hemiptera.

Unit V - Classification of endopterygotes

Diagnostic characters of various holometabolous insect orders and important families of Neuroptera, Megaloptera, Raphidioptera, Coleoptera, Strepsiptera, Diptera, Mecoptera, Siphonaptera, Trichoptera, Lepidoptera and Hymenoptera.

Practical

Methods of collection and preservation of insects - External morphology of insects – detailed observation and naming of parts. Structure and modification of head, antennae and mouth parts. Thoracic sclerites, structure and modification of legs, wings and their venation. Abdomen and its appendages. Genitalia of insects of representative orders and families. Morphological features of insect eggs, larvae, pupae and adults. Chaetotaxy in insects. Micrometry in insects, insect imaging and microphotography. Preparation of permanent slides. Study of insect orders and their identification using taxonomic keys. Observing and keying out orders and

families of insects - Collembola, Protura, Diplura, Archaeognatha, Zygentoma, Ephemeroptera, Odonata, Plecoptera, Dermaptera, Embioptera, Orthoptera, Phasmatodea, Mantodea, Blattodea (roaches and termites), Psocodea (free-living and parasitic), Thysanoptera, Hemiptera, Neuroptera, Megaloptera, Raphidioptera, Coleoptera, Strepsiptera, Diptera, Mecoptera, Siphonaptera, Trichoptera, Lepidoptera and Hymenoptera. Field visit to agricultural, horticultural, forest and hill ecosystems to collect insects of different orders.

Assignment

10 permanent slides of appendages in insects – 5 immature stages (wet preservation) – Submission of fifty insects representing major families and orders.

Lecture Schedule

Theory

1. Introduction to morphology – Importance of insect morphology. Tagmosis in insects.
2. General body wall – its structure, cuticular outgrowths, special integumentary processes.
3. Insect colouration. Body regions, sclerites, sutures and sulci.
4. Insect head and its orientation; appendages of head and their modifications.
5. Mouth parts in insects – external structure - mandibulate types.
6. Mouth parts in insects – external structure - haustellate types.
7. Insect thorax and its appendages - Legs – modifications and types.
8. Insect wings – development – venation – modifications and types - articulation with thoracic muscles.
9. Insect abdomen – segmentation – modifications – appendages in different life stages.
10. Insect genitalia and their modification.
11. Structure of sense organs.
12. Insect metamorphosis – types of insect egg, larva and pupa – Sexual dimorphism polymorphism and polyphenism in insects.
13. Insect taxonomy and systematics - definition and principles.
14. Taxonomic publications, recent advances in insect taxonomy - micro and macro morphological, embryological, ecological, behavioural, cytological, biochemical and numerical taxonomy.
15. Typological, nominalistic, biological and evolutionary species concepts.
16. Taxonomic keys.
17. Mid Semester examination
18. International Code of Zoological Nomenclature (ICZN) – preamble- bi and trinomial nomenclature.
19. Nomenclature - major group names- validity of names- principle of priority, synonymy and homonymy, type concept.
20. Recent classification of insects.
21. Diagnosis of non-insect orders – Collembola, Protura and Diplura.

22. Apterygotes –Archaeognatha and Zygentoma. Diagnosis of Palaeoptera and Neoptera.
23. Diagnostic characters of orders and important families of Palaeoptera (Ephemeroptera and Odonata).
24. Diagnostic characters of orders and important families of Neoptera – Plecoptera, Dermaptera, Embioptera and Zoraptera.
25. Diagnostic characters of orders and important families of Neoptera – Orthoptera.
26. Diagnostic characters of orders and important families of Neoptera - Phasmatodea, Grylloblattodea and Mantophasmatodea
27. Diagnostic characters of orders and important families of Neoptera - Mantodea, Blattodea (roaches and termites) and Psocodea (free-living and parasitic).
28. Diagnostic characters of orders and important families of Neoptera- Thysanoptera and Hemiptera.
29. Diagnostic characters and important families of orders Neuroptera, Megaloptera and Raphidioptera.
30. Diagnostic characters and important families of order Coleoptera.
31. Diagnostic characters and important families of orders Strepsiptera and Diptera.
32. Diagnostic characters and important families of orders Mecoptera, Siphonaptera and Trichoptera.
33. Diagnostic characters and important families of order Lepidoptera.
34. Diagnostic characters and important families of order Hymenoptera.

Practical schedule

1. External features of grasshopper and beetle - detailed observation of tagma in insects - Insect head orientation – Types of insect mouth parts and study of mandibulate and haustellate mouth parts – Types of insect antennae.
2. Observing insect thoracic sclerites – Types of insect legs and modifications – Wing venation, types of wings and wing coupling mechanism in insects.
3. Observing insect abdomen – modifications and appendages. Dissection and observation of genitalia of Orthoptera, Coleoptera, Lepidoptera and Hymenoptera.
4. Examining types of insect eggs, larvae and pupae. Chaetotaxy in insects.
5. Practicing micrometry in insects, insect imaging and microphotography.
6. Preparation of permanent slides of insects and insect parts.
7. Practicing methods of collection and preservation of insects including immature stages.
8. Hands on experience in diagnosing insect orders and their identification using taxonomic keys. Observing and keying out orders - Collembola, Protura, Diplura, Archaeognatha, Zygentoma, Ephemeroptera and Odonata.
9. Observing and keying out orders and families of insects - Plecoptera, Dermaptera, Embioptera, Orthoptera, Phasmatodea and Mantodea.

10. Observing and keying out orders and families of insects - Blattodea (roaches and termites) and Psocodea (free-living and parasitic).
11. Observing and keying out orders and families of insects – Thysanoptera and Hemiptera.
12. Observing and keying out orders and families of insects - Neuroptera, Megaloptera, Raphidioptera, Strepsiptera, Diptera, Mecoptera, Siphonaptera and Trichoptera.
13. Observing and keying out families of insect order Coleoptera.
14. Observing and keying out families of insect order Lepidoptera.
15. Observing and keying out families of insect order Hymenoptera.
16. Field visit to agricultural and horticultural, ecosystems to collect insects of different orders.
17. Field visit to forest and hill ecosystems to collect insects of different orders.

Reference books

1. Beutel, R.G., F. Friedrich, S.Q. Ge and X.K. Yang. 2014. Insect Morphology and Phylogeny: A textbook for students of Entomology. De Gruyter, Berlin. 516 p.
2. Chapman, R.F. 2013. The Insects: Structure and function. Cambridge University Press, Edinburgh, Cambridge, UK, 961 p.
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4. ICZN. 1999. International Code of Zoological Nomenclature. UK. 106 p.
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E-Resources

1. http://extension.oregonstate.edu/umatilla/sites/default/files/external_morphology.pdf
2. http://www.zoology.ubc.ca/bclepetal/Order%20Lepidoptera%20et%20al%20Text%20Files/order_lepidoptera.htm
3. <http://www.faculty.ucr.edu/~legneref/entomol/exorthop.htm>
4. <http://www.waterbugkey.vcsu.edu/php/familylist.php?idnum=1&o=coleoptera>
5. <http://www.knowyourinsects.org/Key%20to%20Insect%20Orders.pdf>

ENT 612 - INSECT ANATOMY, PHYSIOLOGY AND NUTRITION (2 + 1)**Objective-**

- To gain knowledge about the anatomy and physiology of various systems in insects.
- Role of nutrition in growth and development of insects.

Unit I - Digestive and excretory physiology

History, importance and scope of insect physiology – Structure, modification and physiology of digestive system. Energy/ cellular metabolism – Carbohydrate metabolism – Glycolysis, Krebs's cycle, Oxidative phosphorylation. Metabolism of proteins and lipids – Role of fat bodies in metabolism. Structure, modification and physiology of excretory system. Homeostasis – Osmoregulation of water and salts – Excretion in aquatic and endo parasitic insects.

Unit II - Circulatory and respiratory physiology

Structure, modifications and physiology of circulatory system – Haemocytes – Immunity. Structure, modification and physiology of respiratory system – Physiology of gaseous exchange – Respiration in aquatic and parasitic insects – Role of respiration and haemolymph in thermoregulation.

Unit III - Neuro physiology, sense organs and muscles

Structure, modification and physiology of nervous system – Brief overview about ion channels – Neuro transmitters – Bio-chemical mechanism of nerve transmission. Sense organs – Structure and physiology of Photo - Chemo - and Mechano receptors. Sound & light production in insects. Basic structure and physiology of muscles.

Unit IV - Insect endocrinology and reproductive physiology

Endocrine glands – Structure, secretions – Brief overview about synthesis and functions of Prothoracicotropic hormone(PTTH), ecdysteroids, juvenile hormones, eclosion hormones and other minor hormones. Structure and modification of reproductive system – Physiology of vitellogenesis, oogenesis and spermatogenesis – Different types of reproduction.

Unit V - Insect embryology and nutritional physiology

Embryonic development in insects – Formation of different systems. Insect nutrition – Role of carbohydrates, proteins, lipids, vitamins, minerals, sterols in growth and development of insects. Role of extra and intra cellular microorganisms in nutrition Role of artificial diet.

Practicals

Study of anatomy of different systems of grasshopper, cockroach and blister beetle. Estimation of reducing sugar, proteins and lipids in insect tissue homogenates. Chromatographic analysis of free AAs in haemolymph. Estimation of acetyl choline and cholinesterase activity in insects. Determination of respiratory quotient. Studying endo symbionts in insects. Assessment of feeding efficiency and utilization of food by insects. Identification and estimation of haemocytes – Microtomy.

Lecture Schedule

1. History, importance and scope of insect physiology.
2. Basic structure of digestive system.
3. Modifications and physiology of digestive system.

4. Energy/ cellular metabolism. Carbohydrate metabolism - Glycolysis, Kreb's cycle, Oxidative phosphorylation.
5. Metabolism of proteins and lipids – Role of fat bodies in metabolism.
6. Structure, modification and physiology of excretory system.
7. Homeostasis – Osmoregulation of water and salts – Excretion in aquatic and endoparasitic insects.
8. Structure, modifications and physiology of circulatory system.
9. Haemolymph and types of haemocytes.
10. Physiological role of haemocytes and immunity.
11. Structure, modification and physiology of respiratory system.
12. Physiology of gaseous exchange.
13. Respiration in aquatic and parasitic insects.
14. Role of respiration and haemolymph in thermoregulation.
15. Structure of nervous system.
16. Physiology and modifications of nervous system - Brief overview about Ion channels and axonic conduction. Neuro transmitters, Bio-chemical mechanism of nerve transmission – Synaptic conduction.
17. Mid semester examination
18. Sense organs – Structure and physiology of Photoreceptors.
19. Structure and physiology of Chemoreceptors.
20. Structure and physiology of Mechanoreceptors.
21. Sound & light production in insects. Basic structure and physiology of muscles.
22. Endocrine glands – Structure and secretions.
23. Brief overview about synthesis and functions of Prothoracicotropic hormone (PTTH), ecdysteroids, juvenile hormones, eclosion hormones
24. Brief overview about synthesis and functions of other minor hormones – PBANS, diuretic hormones etc.,
25. Structure and modification of reproductive system.
26. Physiology of vitellogenesis and oogenesis.
27. Physiology of spermatogenesis.
28. Different types of reproduction.
29. Embryonic development in insects.
30. Formation of different systems.
31. Insect nutrition – Role of carbohydrates, proteins and lipids in growth and development of insects.
32. Role of vitamins and minerals in growth and development of insects.
33. Role of sterols in growth and development of insects.
34. Role of extra and intra cellular microorganisms in nutrition.

Practical Schedule

1. Dissection of cockroach / grasshopper / blister beetle to study anatomy of digestive system.
2. Dissection of silk cotton bug to study filter chamber.
3. Dissection of cockroach / grasshopper / blister beetle to study anatomy of reproductive system

4. Dissection of cockroach / grasshopper / blister beetle to study anatomy of nervous system. Observing ventral nerve cord and ganglia.
5. Dissection of cockroach / grasshopper / blister beetle to study anatomy of circulatory system. Studying heart beat in lepidopteran caterpillar.
6. Dissection of cockroach / grasshopper / blister beetle to study anatomy of respiratory system. Observing trachea, tracheoles and taenidial lining.
7. Estimation of reducing sugars in insect homogenates by DNS method.
8. Estimation of protein in insect homogenates by Lowry's method.
9. Estimation of lipids in insect homogenates by Bligh – Dyer method.
10. Paper chromatographic analysis of free AAs in haemolymph.
11. Thin layer chromatographic analysis of free AAs in haemolymph.
12. Estimation of acetyl choline and cholinesterase activity in insects.
13. Determination of respiratory quotient.
14. Studying endosymbionts in insects.
15. Comparison of feeding efficiency and utilization of artificial and natural diet by insects.
16. Identification and estimation of haemocytes
17. Practicing microtomy.

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ENT 613 - INSECT ECOLOGY, PEST MANAGEMENT, STORAGE AND QUARANTINE ENTOMOLOGY (2+1)

Objectives

- To impart knowledge on the basic principles of insect ecology and Integrated pest management.
- To address various pests infesting stored produce and their management.
- To focus on threat due to invasive pests and the importance of quarantine regulations.

Theory

Unit I - Insect Ecology

History and Definition. Basic Concepts - Abundance and diversity of insects and relation between the two - Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology - Population growth - basic models - Exponential vs Logistic models (r and k strategists) Discrete vs Continuous growth models (J and S shaped growth) - Life Tables and their application - Case studies of insect life tables. Population dynamics - dispersal and migration, Seasonality in insects- Diapause (Quiescence) - aestivation, hibernation. Food as a limiting factor for distribution and abundance - Food chain - web and ecological succession. Biotic and abiotic factors influencing the insect abundance - Interspecific and intraspecific interactions - Defense mechanisms against predators/parasitoids. Community ecology.

Unit II - Concepts of IPM

Pest - definition, categories, biotypes, losses and causes for outbreaks - Ecological principles in pest management - economic threshold concepts (EIL and ETL) - tools of pest management and their integration; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys – Agro Ecosystem Survey Analysis.

Unit III - Components and implications of IPM

Legislative, cultural, physical, mechanical, host plant resistance, biological, botanical, chemical and other biorational methods – sterile male technique, chemosterilants, insect growth regulators, moult inhibitors, juvenile hormone mimics, antifeedants and repellants. Biotechnology in pest management – transgenic crops. Political, social and legal implications of IPM, pest and pesticide risk analysis, benefit cost ratio and partial budgeting. FFS and Plant clinic centres, IPM village - case studies of successful IPM programmes.

Unit IV - Stored produce pests and their management

Post-harvest losses of food grains in India due to insects, mites, rodents and birds. Factors responsible for grain losses. Sources of infestation. Identification, host range and biology of major stored grain pests and non-insect pests. Field and cross infestations - Ecology of insect pests of stored commodities / grains - moisture, temperature and humidity in safe storage of food grains. Stored grain deterioration process - physical and biochemical changes and consequences. Principles of safe grain storage, types of storage structures. Traditional grain storage practices. IPM for stored grain insect pests - prophylactic and curative measures using chemical and non-chemical methods. Safe use of pesticides with

special emphasis on fumigants. Natural enemies of storage pests. Management of important mite, rodent and bird pests of storage.

Unit V - Quarantine principles and invasive pests

Quarantine principles and applications – Legislations adopted in India – Quarantine regulations of agricultural produce, seeds, plants and domestic material in international sea and air ports. Quarantine laws – seed and seed health laws. Quarantine regulation for import and export of bio control agents – Case studies on successful import of biocontrol agents - Environmental Act, Insecticide act and registration procedure related to Quarantine. Invasive pests in India.

Practical

Characterization of ecosystem, AESA, sampling methods- population estimation methods, symptoms and nature of damage. Crop loss assessment. Computation of EIL/ETL. Pest and pesticide risk analysis, BCR, FFS, Plant clinic centres. IPM for rice, cotton and tomato. Collection and identification of stored grains / seed insect pests and nature of damage caused by them; detection and estimation of insect infestation in stored food grains, stored grain insect detection gadgets; determination of moisture content in stored grains; familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality. Identification of Rodents and their management. Field visits to save grain campaign, central warehouse and FCI and institutions engaged in research or practice of grain storage. Visit to quarantine stations/NIPHM, Hyderabad to impart knowledge on different quarantine principles.

Assignment

Each student has to collect and submit 5 number of stored product pests along with infested materials.

Theory lecture schedule

1. Introduction and history of insect ecology - Concept, definition, importance.
2. Abundance and diversity of insects and their implications - Law of the Minimum, Law of Tolerance and biocoenosis.
3. Population growth – basic models - Exponential vs Logistic models (r and k strategists), Discrete Vs Continuous growth models (J and S shaped growth)
4. Life Tables and their application - Case studies of insect life tables.
5. Population dynamics - dispersal and migration, Seasonality in insects- Diapause (Quiescence) - aestivation, hibernation.
6. Food as a limiting factor for distribution and abundance, nutritional ecology, Food chain, web and ecological succession.
7. Abiotic factors influencing insect abundance - day degree concept.
8. Biotic factors influencing insect abundance - Interspecific and intraspecific interactions – Lotka – Volterra Model. Defense mechanism in insects – mimicry, colouration, concept of predator satiation.
9. Pest - definition, categories, biotypes, losses and causes for pest outbreaks.

10. History, origin and concepts of IPM - Ecological principles and economic threshold concepts.
11. Tools of pest management and their integration.
12. Pest survey and surveillance, forecasting, remote sensing methods and factors affecting surveys - Agro Ecosystem Survey Analysis.
13. Legislative, cultural, physical and mechanical methods of pest management.
14. Host plant resistance and biological methods in pest management.
15. Botanical methods of pest management.
16. Chemical methods of pest management.
17. Mid semester examination.
18. Sterile male technique, chemosterilants and insect growth regulators in pest management - Moulting inhibitors, juvenile hormone mimics, antifeedants and repellants in pest management.
19. Biotechnology in pest management – transgenic crops.
20. Political, social and legal implications of IPM.
21. Pest risk analysis and pesticide risk analysis, Benefit cost –ratios and partial budgeting.
22. Farmers' Field School, Plant clinic centers and IPM Village.
23. Post-harvest losses of food grains in India due to insects, mites, rodents and birds - Factors responsible for grain losses. Sources of infestation.
24. Identification, host range and biology of major stored grain insect and non-insect pests.
25. Field and cross infestations - Ecology of insect pests of stored commodities / grains - moisture, temperature and humidity in safe storage of food grains.
26. Stored grain deterioration process - physical and biochemical changes and consequences.
27. Principles of safe grain storage, types of storage structures and traditional grain storage practices.
28. IPM for stored grain insect pests - prophylactic and curative measures by employing chemical and non-chemical methods.
29. Natural enemies of storage pests and Safe use of pesticides with special emphasis on fumigants.
30. Management of important mite, rodent and bird pests of stored commodities.
31. Quarantine principles and applications.
32. Legislations adopted in India – Quarantine regulations of agricultural produce, seeds, plants and domestic material in international sea and air ports.
33. Quarantine laws – seed and seed health laws. Quarantine regulations for import and export of bio control agents.
34. Environmental Act and registration procedure related to Quarantine. Invasive pests of India.

Practical schedule

1. Characterization of pond ecosystem and identification of food chain and web.
2. Agro ecosystem survey analysis in rice.
3. Practicing of sampling methods and population estimation.
4. Studying symptoms and nature of damage in crops.
5. Practicing of crop loss assessment and Computation of EIL and ETL.
6. Practicing pest surveillance – light traps/pheromone traps.
7. Pest risk analysis, pesticide risk analysis and benefit cost – ratios.
8. Procedure for organizing Farmers' Field School and concepts of IPM village and plant clinic center.
9. Practicing IPM in rice and coconut.
10. Collection and identification of stored grains / seed insect pests and their nature of damage. Identification of Rodents and their management.
11. Detection and estimation of insect infestation in stored food grains.
12. Studying stored grain insect detection gadgets.
13. Determination of moisture content in stored grains.
14. Observing various storage structures – Traditional, improved and modern.
15. Demonstration of preventive and curative measures and fumigation techniques.
16. Field visits to 'Save Grain' campaign, central warehouse and FCI warehouses.
17. Visit to quarantine station to impart knowledge on different quarantine principles.

Reference books

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ENT 621 - TOXICOLOGY OF INSECTICIDES (2 + 1)**Objectives**

- To understand basic concepts of toxicology and to study about chemistry and mode of action of insecticides.
- To gain knowledge on consequences of insecticide usage.

Unit I - Principles of toxicology

Toxicology – definition – branches - Insect toxicology – History. Toxicity evaluation – dose – response relationship – NOEL, LOEL – Median lethality concept – Toxicity parameters.

Unit II - Classification and chemistry of insecticides

Classification of insecticides based on mode of entry – mode of action - IRAC – toxicity range – chemical classification. Chemistry and important characteristics of major groups of insecticides viz., inorganic, organic and synthetic organics. Bio rationals – antifeedants, repellants, chemosterilants, IGRs, pheromones and neuropeptides. Rodenticides, acaricides and nematocides.

Unit III - Mode of action of insecticides and rodenticides

Mode of action of major groups of insecticides viz., inorganic, organic and synthetic organics. Brief overview on structure – activity relationship. Synergism, antagonism and potentiation. Compatibility, phytotoxicity and shelf life. Mode of action of acute and chronic rodenticides.

Unit IV - Insecticide metabolism and consequences of insecticide usage

Metabolism of insecticides - Phase I and II reactions in mammals. Consequences of insecticides usage – Insecticide resistance – Types – Molecular mechanisms– Insecticide resistance management. Pest resurgence. Insecticide residues – Hazards to human, animals, pollinators and wildlife – Concepts in relation to residues – ADI, MRL, waiting period – Principles and methods of residue analysis.

Unit V - Insecticide industry and development of insecticides

Potential molecular targets. Pipeline compounds. Pesticide use and insecticide industry in India. Insecticide development. Insecticide Act 1968 and Rules 1971 and amendments – Registration of insecticides – Procedure and data requirement. Basic toxicological assessment procedures – acute oral, dermal, inhalation toxicities – Ethics in animal use.

Practicals

Rearing of test insects – various bioassay techniques – determination of LC₅₀ and LD₅₀ of insecticides – bracketing – Probit analysis – graphical method and

Finney's method – Green house evaluation of insecticides – principles of field evaluation of insecticides – Physical properties of various formulations of insecticides. Carriers and adjuvants in insecticide formulations. Determination of synergistic activity – determination of resistance ratio, susceptibility index – determination of diagnostic dose – studies on compatibility and phytotoxicity of insecticides – safety evaluation of insecticides towards natural enemies and pollinators – pesticide residue analysis. Visit to pesticide residue analysis lab or toxicological evaluation centres.

Lecture Schedule

1. Toxicology - definition and branches. Insect toxicology- Definition and History.
2. Toxicity evaluation – Dose – response relationship – NOEL, LOEL – Median lethality concept.
3. Toxicity parameters.
4. Classification of insecticides based on mode of entry and toxicity ranges.
5. Classification of insecticides based on mode of action - IRAC.
6. Classification based on chemical nature.
7. Chemistry and important characteristics of inorganic insecticides.
8. Chemistry and important characteristics of organic insecticides
9. Chemistry and important characteristics of synthetic organic insecticides - I.
10. Chemistry and important characteristics of synthetic organics - II.
11. Brief chemistry and important characters of antifeedants, repellants and chemosterilants.
12. Brief chemistry and important characters of IGRs.
13. Brief chemistry and important characters of pheromones and neuropeptides.
14. Rodenticides, acaricides, nematocides–chemistry, mode of action, characteristics.
15. Mode of action of insecticides – Metabolic inhibitors.
16. Mode of action of insecticides – Insect growth regulators.
17. Mid semester examination
18. Mode of action of insecticides – Axonic poisons
19. Mode of action of insecticides – Synaptic poisons
20. Mode of action of insecticides – Neuro muscular joints and other types.
21. Brief overview on structure – activity relationship.
22. Synergism, antagonism and potentiation.
23. Compatibility, phytotoxicity and shelf life.
24. Mode of action of acute and chronic rodenticides.
25. Metabolism of insecticides - Phase I and II reactions in mammals.
26. Insecticide resistance – Types – Molecular mechanisms. Insecticide resistance management.
27. Pest resurgence. Insecticide residues–Hazards to human, animals, pollinators and wildlife – Concepts in relation to residues – ADI, MRL, waiting period.
28. Principles and methods of pesticide residue analysis.
29. Pesticide use and insecticide industry in India.
30. Insecticides development.

31. Potential molecular targets. Pipeline compounds.
32. Insecticide Act 1968 and Rules 1971 and amendments.
33. Registration of insecticides – Procedure and data requirement.
34. Basic toxicological assessment procedures – acute oral, dermal, inhalation toxicities – Ethics in animal use.

Practical Schedule

1. Mass culturing of test insects – Pulse beetle, *Spodoptera* and Aphids.
2. Practicing various bioassay techniques.
3. Preparation of test solutions for bio assays. Determination of LC₅₀ and LD₅₀ of insecticides and bracketing.
4. Probit analysis – graphical method and Finney's method.
5. Practicing greenhouse evaluation of insecticide.
6. Learning principles of field evaluation of insecticides.
7. Studying the properties of various formulations of insecticides.
8. Carriers and adjuvants in insecticide formulations.
9. Determination of synergistic activity.
10. Determination of resistance ratio, susceptibility index.
11. Determination of diagnostic dose.
12. Studies on compatibility assessment of insecticides with other agrochemicals.
13. Phytotoxicity assessment of insecticides.
14. Safety evaluation of insecticides towards natural enemies and pollinators.
15. Pesticide residue analysis in various matrices (plant, soil and water).
16. Learning basic toxicological assessment procedures such as acute, oral and dermal toxicities.
17. Visit to pesticide residue analysis lab and toxicological evaluation centers.

Reference books

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5. Kranthi, K.R. 2005. *Insecticide Resistance -Monitoring, Mechanisms and Management Manual*. CICR, Nagpur, 153 p.
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ENT 622- BIOLOGICAL INSECT PEST SUPPRESSION (2+1)

Objectives

- To study the basics and role of bio control agents in insect pest management.
- To study the mass production and field evaluation techniques of important biological control agents.

Unit I - Basics of biological control

Biological control - definition, history, scope, principles, successful case histories of biocontrol agents and concepts. Natural, applied and classical biological control. Scope of biological insect pest suppression –use of living organisms and their products, parasitoids, predators, entomopathogens, entomophilic nematodes, predatory mites, spiders, botanicals and semiochemicals.

Unit II - Insect parasitoids and predators

Insect Parasitoids – types, desirable attributes, important groups, biology, adaptation, host selection behavior, mass production and field release. Insect predators - types, desirable attributes, important groups, biology, adaptation, host seeking behavior, mass production and field release. Tritrophic interaction of parasitoids and predators.

Unit III - Entomopathogens and entomophilic nematodes

Entomopathogens – important groups – Bacteria, viruses, fungi, protozoans and rickettsiae - host range, symptoms of infections and desirable attributes. Nematodes – important groups, host range, symptoms of attack, mass production and field release.

Unit IV - Non insect predators and weed killers

Predatory mites – important species, host range, biology and host seeking behavior. Spiders – important species, host range, biology and host seeking behavior. Predatory birds of agricultural importance. Weed killers-desirable attributes of weed killers – major weeds and their biocontrol agents.

Unit V - Implications of bio-control

Factors affecting efficacy of biocontrol agents conservation and augmentation, integration with IPM components, role of weeds and mixed/trap cropping and dirty field technique in enhancing natural enemy activity, future possibilities of biological

control, importations of natural enemies – quarantine regulations in utilization of exotic biocontrol agents, role of biotechnology and semiochemicals in biological control.

Practical

Field survey for collection of parasitoids using various methods, host rearing, net sweep and traps in agricultural and horticultural ecosystems. Diagnosis and sketching of parasitoids, predators and entomopathogens. Establishing tritrophic relationship of parasitoids and predators. Identification of predatory mites and spiders. Mass production techniques of parasitoids – *Trichogramma*, *Goniozus* and *Brachymeria*; Predators- *Chrysopa* and coccinellids. Pathogenicity and mass production of entomopathogens – NPV, *Metarrhizium* and *Bt*. Mass production of entomophilic nematodes. Field release and evaluation of parasitoids and predators.

Assignment

Each student has to submit 50 numbers of bio control agents comprising parasitoids, predators and non insect predators (at least 10 should be from host rearing).

Theory Lecture Schedule

1. Biological insect pest suppression – definition and scope - use of living organisms and their products.
2. History and development of biological control in India and abroad.
3. Principles and successful examples of biocontrol.
4. Natural, applied and classical biological control – definition and difference.
5. Classification of bio control agents – parasitoids, predators, entomopathogens, entomophilic nematodes, predatory mites, spiders, botanicals, semiochemicals and weed killers.
6. Insect parasitoids – types, desirable attributes and important groups.
7. Biology of important parasitoids.
8. Host selection behaviour of parasitoids.
9. Biological characteristics of adult parasitoids.
10. Mass production, economics and field release of parasitoids.
11. Insect predators – types, desirable attributes and important groups including vertebrate predators.
12. Biology, adaptation and host seeking behaviour of predators.
13. Mass production, economics and field release of predators.
14. Entomopathogens – Bacteria – important groups, examples, host range, symptoms of infections and desirable attributes.
15. Entomopathogens – Viruses – important groups, examples, host range, symptoms of infections and desirable attributes.
16. Entomopathogens – Fungi – important groups, examples, host range, symptoms of infections and desirable attributes.
17. Mid semester examination
18. Entomopathogens – Protozoans and Rickettsiae – important groups, examples, host range, symptoms of infections and desirable attributes.

19. Mass production, formulation, economics and field application of entomopathogens.
20. Tritrophic interaction – host plant - host insect - parasitoid/predator
21. Entomophilic nematodes – important groups, host range and symptoms of attack.
22. Mass production, formulation and field application of entomophilic nematodes.
23. Predatory mites – important species, host range, biology and host seeking behaviour.
24. Predatory Spiders - important species and host range.
25. Predatory Spiders - biology and host seeking behaviour.
26. Weed killers – desirable attributes and important species.
27. Weed killers – host range and biology.
28. Factors affecting efficacy of bio control agents.
29. Conservation techniques in improving efficiency of NE.
30. Augmentation of bio control agents.
31. Integration of IPM components, role of weeds/refugia mixed / trap crop and dirty field technique in enhancing natural enemy activity.
32. Future possibilities of biological control, importation of natural enemies - Quarantine regulation in utilisation of exotic bio-control agents.
33. Role of biotechnology in biological control.
34. Role of semiochemicals in biological control.

Practical schedule

1. Identification and sketching of important Chalcidoidea parasitoid families of agricultural importance.
2. Identification and sketching of other parasitoid families of agricultural importance.
3. Identification and sketching of important insects predators of agricultural importance.
4. Identification and sketching of other invertebrate and vertebrate insect predators.
5. Identification and sketching of important entomopathogens and entomophilic nematodes of agricultural importance.
6. Identification and sketching of important predatory mites, spiders and weed killers of agricultural importance.
7. Mass production techniques of *Trichogramma* and *Brachymeria*.
8. Mass production techniques of *Chrysopa* and Coccinellids.
9. Practicing tritrophic interaction.
10. Mass production techniques of NPV.
11. Pathogenicity of NPV to *Helicoverpa* / *Spodoptera* and *Metarrhizium* to Rhinoceros beetle grub.
12. Mass production techniques of *Metarrhizium* and *Beauveria*.
13. Mass production techniques of *Bacillus thuringiensis* and Spore staining.
14. Pathogenicity of *Bt* to *Helicoverpa* / *Plutella*.

15. Experimentation of semiochemicals in host selection.
16. Experiment on compatibility of biocontrol agents with botanicals and agrochemicals.
17. Visit to NBAIR / production unit of biocontrol agents.

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ENT 623- PESTS OF CROPS AND THEIR MANAGEMENT (2+1)

Objective

- To study the damage, symptoms, bionomics and Integrated pest management strategies of major insect and non-insect pests of field and horticultural crops.

Unit I - Pests of cereals, millets and pulses

Cereals: Rice, Wheat and Maize; Millets; Pulses: Red gram, Black gram, Green gram, Bengal gram, Cowpea, Pea, Lab lab and Soybean.

Unit II - Pests of oilseeds, fibre and sugar crops, masticatories, green manures and forage crops

Oil seeds: Groundnut, Sesame, Sunflower, Safflower, Castor and Mustard;
Fibre Crops: Cotton and Jute; Sugar Crops: Sugarcane and Sugarbeet;
Masticatories: Tobacco, Arecanut and Betelvine; Green manures and Forage crops.

Unit III - Pests of vegetables, tubers, spices and condiments, plantation and beverage crops

Vegetables: Brinjal, Bhendi, Tomato, Crucifers, Cucurbits, Moringa and Amaranthus; Tuber crops: Potato, Sweet potato, Tapioca and Yam; Spices and condiments: Pepper, Cardamom, Cinnamon, Chillies, Onion, Garlic, Ginger, Turmeric, Coriander, Curry leaf, Tamarind and Mint; Plantation crops: Coconut, Oil palm; Beverage crops: Coffee, Tea and Cocoa.

Unit IV - Pests of fruits and flowers

Tropical fruits: Mango, Sapota, Citrus, Banana, Grapevine, Guava, Cashew, Jack, Pomegranate, Pineapple, Papaya, Ber; Temperate fruits: Apple, Plum, Peach and others; Flower crops: Rose, Jasmine, Chrysanthemum, Crossandra, Tube rose, Marigold and Nerium.

Unit V - Pests of tree, lawn, ornamental and medicinal plants, mushroom, green house crops, locusts, non-insect pests and insect vectors of plant diseases

Tree Crops: Neem, Teak, Sandalwood, Eucalyptus, Casuarina; Pests of Lawn; Ornamental crops: Crotons, Gladiolus, Gerbera, Lily and Carnation; Medicinal plants: Ocimum, Senna, Periwinkle, Glory lily, Ashwagandha, Aloe and Noni; Mushroom pests; Green house pests; Non-insect pests: Rodents, mites, nematodes and birds; Locusts; Insect vectors of plant diseases – Major groups and major diseases transmitted by them.

Practical

Identification of symptoms of damage and life stages of important pests of different field and horticultural crops - Cereals, Millets, Pulses, Oilseeds, Fibre, Sugarcane, Masticatories, Green Manures, Forage Crops, Vegetables, Tubers, Spices and Condiments, Plantations, Beverages, Fruits, Flowers, Ornamental, Medicinal Plants, Tree, Lawn, Mushroom, Green house crops, Non-insect pests, Locusts, Insect Vectors of Plant diseases.

Assignment

Each student has to submit 25 major insect pests as rearings and 50 insect pests as preserved/mounted/carded specimens from field and horticultural crops.

Lecture Schedule

Economic importance, distribution, seasonal incidence, host range, bionomics and Integrated pest management strategies of major insect and non-insect pests of following crops:-

1. Rice – borers and leaf feeders.
2. Rice – sucking pests and non-insect pests.
3. Wheat and maize.
4. Minor millets.
5. Pulses.
6. Groundnut, sesame.
7. Sunflower, safflower, castor and mustard.

8. Sugarcane and sugarbeet.
9. Cotton and jute.
10. Tobacco, arecanut and betelvine.
11. Green manures and forage crops.
12. Brinjal, bhendi, tomato.
13. Cucurbits.
14. Crucifers.
15. Moringa and amaranthus.
16. Tuber crops - Potato, sweet potato, tapioca and yam.
17. Mid Semester Examination
18. Pepper, cardamom, cinnamon.
19. Chillies, onion, garlic.
20. Ginger, turmeric and coriander, curry leaf, tamarind and mint.
21. Coconut and oil palm.
22. Coffee.
23. Tea and cocoa.
24. Mango, sapota and citrus.
25. Banana, grapevine, guava, cashew.
26. Jack, pomegranate, pineapple, papaya and ber.
27. Apple, plum, peach and others.
28. Rose, jasmine, chrysanthemum, crossandra, tuberose, marigold and nerium.
29. Neem, teak, sandalwood, eucalyptus and casuarina.
30. Lawn; Ornamental crops: Crotons, gladiolus, gerbera, lily and carnation.
31. Ocimum, senna, periwinkle, glory lily, ashwagandha, aloe and noni.
32. Mushroom pests; Green house pests; Non insect pests.
33. Rodents, mites, nematodes and birds.
34. Locusts; insect vectors of plant diseases – Major groups and major diseases transmitted by them.

Practical Schedule

Identification of symptoms of damage and life stages of important pests of following field and horticultural crops

1. Cereals: Rice maize.
2. Wheat and millets.
3. Pulses.
4. Oilseeds: Groundnut, sesame, sunflower, safflower, castor and mustard.
5. Sugar crops: Sugarcane and sugarbeet.
6. Fibre crops: Cotton and jute.
7. Masticatories: Tobacco, arecanut and betelvine, green manures and forage crops.
8. Pests of Vegetables: brinjal, bhendi, tomato, cucurbits, crucifers, moringa and amaranthus.
9. Tuber crops: Potato, sweet potato, tapioca and yam.
10. Spices and condiments - Pepper, cardamom, clove, nutmeg, chillies, onion, garlic, ginger, turmeric, coriander, curry leaf, tamarind and mint.

11. Plantation and beverage crops: Coconut, oil palm, rubber, coffee, tea and cocoa.
12. Tropical fruits: Mango, sapota and citrus, banana, grapevine and guava.
13. Tropical fruits: Cashew, jack, pomegranate, pineapple, papaya, ber, date palm, jamun; temperate fruits: Apple, plum, peach and others.
14. Flower crops: Rose, jasmine, chrysanthemum, crossandra, tuberose, marigold and nerium. Tree crops: Neem, teak, sandalwood, eucalyptus and casuarina.
15. Pests of Lawn; Ornamental crops: Crotons, gladiolus, gerbera, lily and carnation. Medicinal plants: Ocimum, senna, periwinkle, glory lily, ashwagandha, aloe and noni.
16. Mushroom pests; Green house pests; Non-insect pests: Rodents, mites, nematodes and birds.
17. Locusts; Insect vectors of plant diseases – Major groups.

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ENT 624 – PLANT RESISTANCE TO PESTS (1+1)

Objectives

- To study the types, bases, mechanisms and genetics of resistance in plants to insect pests and mites.
- To acquire knowledge on the status of resistance in crop plants and biotechnological approaches in development of resistance in crop plants.

Theory

Unit I - Basics of host plant resistance

Host plant resistance – History, importance, definitions – advantages and disadvantages – Insect-host plant relationship – Host selection process by insects- role of allelochemicals in host selection.

Unit II - Mechanisms and factors of resistance

Classification of resistance – ecological/pseudo resistance – host evasion, escape and induced resistance. Genetic resistance. Mechanisms of resistance – antixenosis, antibiosis and tolerance. Biophysical factors – Trichomes – Glandular, non-glandular and other morphological characters. Biochemical factors – volatiles and secondary plant substances, chemical ecology, tritrophic relations.

Unit III - Genetic and induced resistance

Genetics of crop resistance to insects, factors influencing resistance, breeding for resistance – methods – problems and prospects. Stability of resistance – biotype development and measures to combat biotypes. Induced resistance – Elicitors – Forms of IR – ISR, SAR – Mechanisms; Plant defense – Phytohormones – JA, SA Pathways- Role of endophytes.

Unit IV - Insect resistance in major crops

Successful examples of resistant crop varieties in India and world – resistance to key pests in rice, maize, sorghum, sugarcane, cotton, pulses, oilseeds, vegetable and fruit crops – achievements and future thrusts – Methods of evaluation of resistance.

Unit V - Biotechnological approaches in plant resistance

Biotechnological tools in host plant resistance –utilization of wild species – identification of genes responsible for resistance. Marker aided selection – Incorporation of genes for resistance into crop varieties – transgenic crops, their status, scope and limitations. Molecular techniques – cloning.

Practical

Mass culturing of homopteran and lepidopteran insects for screening. Screening methodologies and evaluation techniques for resistance to key pests in rice, sorghum, pulses, cotton, sugarcane and vegetables. Antixenosis and antibiosis mechanisms of resistance to major pests in rice, cotton, and vegetables. Estimation of biophysical and biochemical factors of resistance. Important nutritional factors imparting resistance – carbohydrates, phenols etc.

Theory Lecture Schedule

1. History, importance and definition, status, scope, and limitations of plant resistance to pests.
2. Insect – host plant relationship – host selection by phytophagous insects.
3. Classification of host plant resistance.

4. Mechanisms of resistance – antixenosis.
5. Mechanisms of resistance – antibiosis and tolerance.
6. Biophysical factors of resistance – Trichomes and other morphological characters.
7. Bio chemical factors of resistance- volatile and secondary plant substances; Chemical ecology – tritrophic relations.
8. Genetic basis of resistance, abiotic and biotic factors influencing resistance in plants
9. Mid semester examination
10. Breeding for resistance – methods, problems and prospects.
11. Stability of resistance – insect biotypes – development and their management.
12. Induced resistance – Elicitors – Forms of IR – ISR, SAR – Mechanisms; JA, SA Pathways- Role of endophytes, Exogenous application of elicitors.
13. Successful examples, future thrusts of insect resistance in crop varieties in India and world – cereals, millets, insect resistance in sugarcane, cotton and pulses.
14. Successful examples, future thrusts of insect resistance in crop varieties in India and world – oilseeds, fruits and vegetables.
15. Biotechnological tools in host plant resistance.
16. Utilization of wild species – identification and incorporation of genes of interest and marker aided selection.
17. Genetic engineering and plant resistance – status, scope and limitations of transgenic crop varieties.

Practical schedule

1. Mass culturing of rice brown planthopper / aphids / whiteflies
2. Mass culturing of diamond back moth / *Spodoptera* / *Helicoverpa* / rice leaf folder
3. Green house methodology for screening of rice varieties against brown planthopper; standard seed box test and modified seed box for grading and grouping.
4. Methodology and evaluation of resistance in rice to stem borer and leaf folder.
5. Methodology and evaluation of resistance in sorghum to key insect pests.
6. Methodology and evaluation of resistance in cotton to key insect pests.
7. Methodology and evaluation of resistance in sugarcane to key insect pests.
8. Methodology and evaluation of resistance in vegetables to key insect pests.
9. No- choice test for studying preference / non- preference of rice / cotton / tomato / bhendi varieties against major insect pests.
10. Locating feeding punctures of green leaf hopper on resistant and susceptible rice varieties using safranin dye technique.
11. Growth and development of brown plant hopper / leaf folder on resistant and susceptible rice varieties – no choice test for studying antibiosis.

12. Studying feeding preference of brown plant hopper in resistant and susceptible rice varieties.
13. Estimation of biophysical factors of resistance in the foliage of rice / cotton / bhendi / tomato varieties.
14. Estimation of biophysical factors of resistance in the fruits of tomato / bhendi, cotton bolls and bracts and sesame capsules.
15. Estimation of total and O.D. phenols in tomato / cotton varieties and silica in rice varieties.
16. Estimation of reducing and non – reducing sugars in tomato / bhendi varieties.
17. Estimation of secondary substances in crop varieties – gossypol in cotton, tomatine/lycopene in tomato and solanin in brinjal.

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OPC- ENT 711 – PRODUCTIVE INSECTS AND WEED KILLERS (2+1)

Objectives

- To impart knowledge on the basic and commercial aspects of productive insects such as honeybee, silkworm and minor productive insects.
- To know the importance of weed killers.

Unit I - Basics of Apiculture

History of bee keeping in India – Honey bee species – Colony organization of honey bees – Bee behavior. Apiary establishment – Bee pasturage. Floral calendar – Colony management. Bee keeping appliances. Artificial queen rearing. Pests and Diseases of honey bee and their management. Modern techniques of bee keeping – Collapsible hives or flow hives, hex hives, etc.– impact of pesticides on honey bees.

Unit II - Specialized beekeeping methods and bee products

Specialized bee keeping methods –Organic or natural bee keeping, Migratory bee keeping, Urban bee keeping. Bee hive products – Bee wax – Extraction techniques – Bee venom and its products – Apitherapy – Propolis, Royal jelly – Collection, Uses and marketing of bee products. Bee keeping and ancillary industries. SWOT analysis. Quality standards of honey – Skill development in apiculture.

Unit III - Morigulture

Importance of mulberry cultivation in sericulture – Characteristics of mulberry varieties/ hybrids – Mulberry cultivation – Propagation –Asexual and sexual – Methods of planting – Nursery and field preparation – soil, water and nutrient management – Pruning methods – Pests and diseases of mulberry and their management. Preservation of leaves – Nutrient value of mulberry and its uses. Value added products of mulberry. Cultivation of host plants of non- mulberry silkworm.

Unit IV - Sericulture and minor productive insects

History of sericulture in India – Types of silkworm – Races of silkworm – Grainage technology – rearing house maintenance — rearing equipments, disinfectants – Chawki and Late age rearing. Pests and diseases of silkworm and their management. Mountages – harvesting of cocoons. Non –mulberry silkworms. Silk processing and marketing. Diversification of seriproductions – Uses – e-commerce – Entrepreneurial development. Seri biotechnology – prospects and progress. SWOT analysis of sericulture – Skill development in sericulture – Minor productive insects.

Unit V - Biological control of weeds using insects

Weed – definition –Noxious and invasive weeds – Importance – basic classification – Biological control of weeds – Role of insects – Definitions – Principles of biological control of weeds using insects –Conservation and augmentation techniques for weed killers – examples in India and other parts of the world – Benefits and risks – Damage to non-target plants – Future prospects.

Practicals

Identification of different species of honey bees, castes of bees. Bee keeping appliances. Handling of bees, practicing inspection of bee hives and Queen rearing techniques. Identification of pests and non-insect pests of bees and diagnosis of bacterial, viral, fungal and protozoan diseases. Apiary management techniques during on-season and dearth period. Identification of different value added bee products. Honey testing kits, testing the quality of honey using standard protocols – Economics of bee keeping.

Identification of different types of silkworms – Identification of different varieties and hybrids of mulberry – Practicing different propagation techniques and

planting methods- Mulberry production techniques –Nursery management – Practicing different pruning methods - Silkworm egg production – Chawki and late age rearing – Silkworm rearing equipments - Identification of insect, non insect pests and diseases of silkworms – Prevention – Management techniques – Sericlinic – Utilization of sericulture waste – Diversification of mulberry and sericulture products – Economics of Moriculture and Sericulture – non mulberry silkworms – Minor productive insects.

Identification of important weed killers – Evaluation of feeding potential of weed killers – Mass production techniques of potential weed killer insects.

Lecture Schedule

1. History of bee keeping in India – Honey bee species.
2. Colony organization of Honey bees and Bee behavior.
3. Apiary establishment – Bee Pasturage. – Floral Calendar.
4. Colony management – Bee keeping appliances.
5. Artificial queen rearing – Pests and Diseases of honey bee and their management.
6. Modern techniques of bee keeping –Collapsible hives or Flow hives, Hex hives etc.,
7. Scope of biotechnology in Apiculture and impact of pesticides on honey bees.
8. Organic or Natural bee keeping, Migratory bee keeping and Urban bee keeping.
9. Bee wax – Extraction techniques – Bee venom and its products – Apitherapy.
10. Propolis, Royal jelly – Collection – Uses and Marketing of bee products.
11. Bee keeping and ancillary industries.
12. SWOT analysis of bee keeping.
13. Quality standard of honey.
14. Skill development in apiculture.
15. Importance of mulberry cultivation in sericulture and characteristics of mulberry varieties/ hybrids.
16. Asexual and sexual propagation of Mulberry.
17. Mid semester examination
18. Methods of planting. Nursery and field preparation – soil, water and nutrient management.
19. Pruning methods – Pests and Diseases of mulberry and their management.
20. Preservation of leaves – Nutrient value of mulberry and its uses. Value added products of mulberry.
21. Cultivation of host plants of non- mulberry silkworm.
22. History of sericulture in India – Types of silkworm – Races of silkworm and Grainage technology.
23. Rearing house maintenance and rearing equipments, disinfectants.
24. Chawki and Late age rearing. Mountages –harvesting of cocoons.
25. Pests and Diseases of silkworm and their management.
26. Non –mulberry silkworms.

27. Silk processing and Marketing. Seri biotechnology – prospects and progress.
28. Diversification of seriproducts – Uses – e- commerce – Entrepreneurial development – SWOT analysis of sericulture.
29. Skill development in sericulture.
30. Minor productive insects.
31. Weed – definition –Noxious and invasive weeds – Importance – basic classification – Biological control of weeds – Role of insects.
32. Principles of biological control of weeds using insects.
33. Conservation and augmentation techniques for weed killers – Examples in India and other parts of the world.
34. Benefits and Risks involved – Damage to Non-Target plants – Future prospects.

Practical Schedule

1. Identification of different species of honey bees, castes of bees.
2. Handling of bee keeping appliances.
3. Handling of bees, practicing of hive inspection, apiary management and Queen bee rearing techniques.
4. Identification of pests and non insect pests of bees and diagnosis of bacterial, viral, fungal and protozoan diseases.
5. Identification of different value added bee products. Testing the quality of honey using standard protocols. Economics of bee keeping.
6. Identification of different types of silkworms – Identification of different varieties and hybrids of mulberry – Practicing different propagation techniques and planting methods.
7. Nursery management – Practicing different pruning methods.
8. Silkworm egg production – Chawki and late age rearing.
9. Silkworm rearing equipments.
10. Identification of insect and non insect pests and diseases of silkworms – Prevention – Management techniques.
11. Sericlinic – Utilization of sericulture waste. Diversification of mulberry and sericulture products.
12. Economics of Moriculture and Sericulture.
13. Non mulberry silkworms.
14. Minor productive insects.
15. Identification of important weed killers.
16. Evaluation of feeding potential of weed killers.
17. Mass production techniques for potential weed killer insects.

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OPC ENT 712- PEST MANAGEMENT IN ORGANIC FARMING (2 + 1)

Objectives-

- To understand the importance and scope of pest management in organic farming.
- To acquaint with various strategies in organic pest management and input certification standards.

Unit I - Importance of organic farming

Organic farming – Definition – Current status, scope and importance. History of organic farming – Agencies and schemes in relation to organic farming. Importance of pest management in organic farming – Components of pest management strategies in organic farming – Cultural, biological, botanical, behavioural and ecological engineering strategies – Definition.

Unit II - Cultural and traditional strategies

Cultural practices – Importance – Principles - Role of crop rotation, crop isolation, soil management, crop residue management, weed management, field localization, tillage. Host plant resistance – Traditional varieties of major crops. Pest evasion through temporal isolation of crops. Successful examples – limitations.

Traditional methods of pest management – Traditional storage structures – Rodent management.

Unit III - Ecological engineering strategies

Ecological engineering - Importance. Role of conservation of natural enemies in pest management – Beetle bank -Weed strips – Pollen producing ground cover - Cropping systems – Trap and intercropping – Push – Pull strategy – successful examples – limitations. Importance of community approach in implementation of ecological engineering.

Unit IV - Biological, botanical and behavioural strategies

Entomophages and entomopathogens in organic pest control –Different types. General principles of mass production. Application of bacterial, viral, myco insecticides and entomophages – Role of insectivorous birds in pest management - Importance of insecticides of plant origin – Plant extracts and their preparation– application – Shelf life and storage - Use of pheromones and other traps in pest management – Importance.

Unit V - Permitted pest management inputs

Organic certification Standards – NPOP, NOP, JAS, and European standards - Permitted inputs for pest management under various standards with emphasis on NPOP – APEDA - Certification agencies – Input approval criteria - Current status of organic pest management inputs in the market – Marketing and scope of certified organic inputs.

Practicals

Introduction to pests and basic principles of pest management excluding chemicals – Various cultural practices for pest management – Studying characters of resistant varieties of important crops – Agro ecosystem survey analysis – Study of various inter cropping and trap cropping systems – Identification of refugia crops in important crop ecosystems and traditional pest management methods - Practicing conservation techniques of natural enemies – Identification of important entomopathogens, predators, parasitoids and insectivorous birds by their common names – Brief mass production procedure for green lace wings, Coccinellids, *Trichogramma* – Brief mass production procedure for NPV, mycoinsecticides and Bt – Identification of plants used as insecticides- Preparation of popular botanical insecticides, their application – Traps and pheromones in organic pest management – Studying organic certification standards – Market analysis of certified organic inputs – visit to organic farms practicing pest management.

Lecture Schedule

1. Organic farming – Definition – Current status, scope and importance.
2. History of organic farming.
3. Agencies and schemes in relation to organic farming.
4. Importance of pest management in organic farming.
5. Components of pest management strategies for organic crops – Cultural, biological, botanical, behavioural and ecological engineering strategies – Definition.
6. Cultural practices – Importance – Principles.
7. Role of crop rotation, crop isolation and soil management.

8. Role of crop residue management, weed management, field localization, tillage.
9. Host plant resistance – Traditional varieties of major crops.
10. Pest evasion through temporal isolation of crops. Successful examples – limitations.
11. Advantages and disadvantages of cultural practices.
12. Traditional methods of pest management – traditional storage structures
13. Rodent management.
14. Ecological engineering - Definition and importance.
15. Role of conservation of natural enemies in pest management – Beetle bank -Weed strips – Pollen producing ground cover.
16. Cropping systems – Trap and intercropping.
17. Mid semester examination.
18. Push – Pull strategy – successful examples – limitations.
19. Importance of community approach in implementation of ecological engineering.
20. Entomophages and entomopathogens in organic pest control –Different types.
21. General principles of mass production.
22. Application of bacterial, viral and myco insecticides.
23. Application of entomophages.
24. Role of insectivorous birds in pest management.
25. Importance of insecticides of plant origin – Examples.
26. Plant extracts and their preparation.
27. Plant extracts application, Shelf life and storage.
28. Use of pheromones and other traps in pest management – Importance.
29. Organic certification Standards – NPOP, NOP, JAS, and European standards.
30. Permitted inputs for pest management under various standards with emphasis on NPOP.
31. APEDA - Certification agencies.
32. Organic input approval criteria.
33. Current status of organic pest management inputs in the market.
34. Marketing and scope of certified organic inputs.

Practical Schedule

1. Introduction to pests and basic principles of pest management excluding chemicals.
2. Practicing various cultural practices for pest management.
3. Studying characters of resistant varieties of important crops.
4. Agro ecosystem survey analysis.
5. Study of various inter cropping and trap cropping systems.
6. Identification of refugia crops in important crop ecosystems.
7. Studying traditional pest management methods.
8. Practicing conservation techniques of natural enemies.

9. Identification of important entomopathogens, predators, parasitoids and insectivorous birds by their common names.
10. Brief mass production procedure for green lace wings, Coccinellids and *Trichogramma*.
11. Brief mass production procedure for NPV and mycoinsecticides.
12. Brief mass production procedure of *Bt*.
13. Identification of plants used as insecticides.
14. Preparation of popular botanical insecticides, their application.
15. Traps and pheromones in organic pest management.
16. Studying organic certification standards and Market analysis of certified organic inputs.
17. Visit to organic farms.

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**M.Sc.(AG.) GENETICS AND PLANT BREEDING
COURSE - WISE DISTRIBUTION**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	GPB 611	Principles of Genetics	2 + 1
2.	GPB 612	Principles of Plant Breeding	2 + 1
3.	GPB 613	Breeding Field Crops - I	2 + 1
4.	GPB 621	Principles of Quantitative Genetics	2 + 1
5.	GPB 622	Principles of Cytogenetics	2 + 1
6.	GPB 623	Breeding Field Crops - II	2 + 1
7.	GPB 624	Biotechnology For Crop Improvement	1 + 1
Total			13+7=20
Minor- 9 credits			
1.	OPC- GPB 611	Concepts of crop physiology	2+1
2.	OPC-GPB 711	Germplasm collection, exchange and quarantine	2+1
3.	OPC-GPB 712	Fundamentals of genetics	2+1
Total			6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistical Methods and Design of Experiments	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
Total			3+2=5
Seminar + Research - 21 credits			
1.	GPB -032	Seminar	0+1
2.	GPB -011;021;031 041	Research 011-0+1; , 021-0+2; , 031- 0+8; , 041- 0+9	0+20
Grand Total			22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0+1
4	PGS 624	Library and information services	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture	1+0
6	PGS 716 e-course	Disaster management	1+0
Total			2 + 4=6

**M.SC.(AG.) GENETICS AND PLANT BREEDING
SEMESTER WISE DISTRIBUTION**

Semester I

S. No	Course No.	Title	Total
1	GPB 611	Principles of Genetics	2 + 1
2	GPB 612	Principles of Plant Breeding	2 + 1
3	GPB 613	Breeding Field Crops - I	2 + 1
4	STA 611	Statistical methods and Designs of experiments	2 + 1
5	COM 611	Computer Application for Agricultural Research	1 + 1

6	GPB 011	Research	0 + 1
7	PGS 611	Agricultural Research Ethics and Methodology (0 + 1)	-
8	PGS 612	Technical writing and communication skills (0 + 1)	-
Total			9 + 6 = 15

Semester II

1	GPB 621	Principles of Quantitative Genetics	2 + 1
2	GPB 622	Principles of Cytogenetics	2 + 1
3	GPB 623	Breeding Field Crops - II	2 + 1
4	GPB 624	Biotechnology For Crop Improvement	1 + 1
5	OPC-GPB 621	Concepts of Crop Physiology	2 + 1
6	GPB 021	Research	0 + 2
7	PGS 623	Basic concepts in laboratory techniques (0 + 1)	
8	PGS 624	Library and Information services (0 + 1)	
Total			9 + 7 = 16

Semester III

1	OPC-XXX 711	Minor course- Related discipline	2 + 1
2	OPC-XXX 712	Minor course- Related discipline	2 + 1
3	GPB 031	Research	0 + 8
4	GPB 032	Seminar	0 + 1
5	PGS 715 e-course	Intellectual property and its management in agriculture (1 + 1)	
6	PGS 716 e-course	Disaster management (1 + 1)	
Total			4 + 11 = 15

Semester IV

1	GPB 041	Research	0 + 9
Total			0 + 9 = 9
Grand Total			22 + 33 = 55

GPB 611 PRINCIPLES OF GENETICS (2+1)

Objectives

- To impart knowledge on various concepts of genetics
- To make the students to understand the basic principles and recent development in genetics
- To motivate the students to develop their analytical, quantitative and problem solving skills from classical to molecular genetics.

Theory

Unit I - Mendelian genetics & chromosomal theory of inheritance

Mendelian genetics, allosomes, linkage and extra chromosomal inheritance
 Introduction to genetics -Earlier concepts of inheritance – cell and cell organelles-
 Cell division, Mendel's laws; Discussion on Mendel's paper- Chromosomal theory of inheritance; Multiple alleles, gene interactions, sex determination, differentiation and sex-linkage, sex influenced and sex limited inheritance; Linkage-detection, estimation; recombination and genetic mapping in eukaryotes, somatic cell genetics, Extra chromosomal inheritance.

Unit II - Population genetics, chromosomal aberrations & protein synthesis

Population genetics, variation in chromosomes and protein synthesis
 Population - Mendelian population – Random mating population -Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium; Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis.

Unit III - Concepts of genes

Concepts of gene, gene repair and gene regulation
 Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters. Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression; Gene regulation in eukaryotes, RNA editing.

Unit IV - Genetic hybridization

Gene cloning, gene amplification and functional genomics
 Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, anti-sense RNA and ribozymes; Micro-RNAs (miRNAs). Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.

Unit V - Behavioural genetics & biochemical synthesis

Metagenomics, role of environment in genetic characters, Polymorphism, bioethics and Behavioural genetics, Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts; Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural Genetics.

Practical

Laboratory exercises in probability and chi-square; problems on various genetic principles; Demonstration of genetic principles using laboratory organisms;

Chromosome mapping using three point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification -Electrophoresis – basic principles and running of amplified DNA

Theory schedule

1. Beginning of genetics, heredity, inheritance, Brief history and earlier concepts of genetics.
2. Structure and function of cell and cell organelles – Differences between Prokaryotes and Eukaryotes.
3. Cell division – mitosis, meiosis and their significance, cell cycle.
4. Work of Mendel – Characters studied reasons for Mendel's success, Laws of Mendel, Discussion on Mendel's paper- Rediscovery of Mendel's work.
5. Chromosomal theory of inheritance; Multiple alleles with examples.
6. Gene interactions-i.) Dominant epistasis (12:3:1) ii.) Recessive epistasis (9:3:4) iii.) Duplicate and additive epistasis((9:6:1) iv.) Duplicate dominant epistasis(15:1) v) Duplicate recessive epistasis (9:7) vi.) Dominant and recessive epistasis(13:3); Summary of epistatic ratios (i)to (vi).
7. Sex determination: Autosomes and sex chromosomes - chromosomal theory- Genic balance theory of sex determination - different types.Sex linked inheritance – Criss cross inheritance – reciprocal difference; holandric genes; sex influenced and sex limited inheritance.
8. Linkage – detection and estimation-Strength of linkage and recombination; Two point and three point test cross. Double cross over, recombination and genetic map in eukaryotes.
9. Somatic cell genetics-extra chromosomal inheritance.
10. Population-Hardy-Weinberg law-equilibrium –Random mating population-gene and genotypic frequencies.
11. Chromosomal aberration: Variation in chromosome structure – deletion, duplication, inversion and translocation – genetic and cytological implications.
12. Chromosomal aberration: Variation in chromosome number – euploid, aneuploid, types of aneuploids and their origin-Polyploid - auto and allopolyploids, their characters; meaning of genome; evolution of wheat, Triticale, cotton, tobacco, Brassicas.
13. DNA, the genetic material – Griffith's experiment, experiment of Avery, McCleod and McCarthy – confirmation by Hershey and Chase; RNA as genetic material – Frankel, Conrat and Singer experiment.
14. Structure of DNA – Watson and Crick model – Central dogma of life-Proof for semi conservative method of DNA replication; Models of DNA replication; steps involved in DNA replication.
15. Organization of DNA in chromosomes; Genetic code; Protein biosynthesis – Transcription –translation gene expression.
16. Protein synthesis; Regulation of gene expression – operon model of Jacob and Monad; Structural genes and regulator genes.
17. Mid-Semester Examination

18. Fine structure of the gene- Cistron, muton and recon; Complementation test; exons, introns – split genes – plant genome structure; Transposable genetic elements; Overlapping genes, Pseudogenes – Oncogenes.
19. Gene families-origin-actin- Divergence in multigene families-Evolution of members- clusters-Globin-Histone; Regulation of gene expression in prokaryotes – Operon model of Jacob and Monad; Structural genes and regulator genes.
20. Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and Transposable (Tn) elements.
21. Gene regulation in eukaryotes; RNA editing.
22. Gene isolation, synthesis –chemical synthesis-Phosphodiester approach-phosphotriester approach-Enzymatic synthesis of DNA-synthesis of complete gene-
23. Gene cloning-.recombinant DNA-cloning and expression- plasmids-cosmids-integration of DNA into vectors-introduction of vector into host-selection of recombinant clones-multiplication-expression-integration of DNA inserts in host genome.
24. cDNA libraries-preparation of cDNA –problems in c DNA preparation-Isolation of m RNA;Genomic library-construction of Genomic library.
25. PCRbased cloning; positional cloning
26. Nucleic acid hybridization and immunochemical detection-DNA sequencing.
27. DNA restriction- restriction enzymes-types-nomenclature-recognition sequences-cleavage patterns-modification of cut ends.
28. Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).
29. Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.
30. Polymorphism-Methods of studying polymorphism at biochemical and DNA level .
31. Transgenic bacteria and bioethics
32. Gene silencing-Transcriptional silencing-post transcriptional silencing-
33. Genetics of mitochondria-CMS-mt DNA-Yeast mitochondrial genome-chloroplasts-features of organellar genome.
34. Concepts of Eugenics, Epigenetics.
35. Genetic disorders and Behavioural Genetics.

Practical schedule

1. Problems and exercises in probability and chi-square test.
2. Demonstration of genetic principles using laboratory organisms.
3. Problems on two point test cross and three point test cross; Working out interference, coincidence and drawing genetic maps.
4. Chromosome mapping using three point test cross.
5. Tetrad analysis-detection of linkages.
6. Analysis of ordered and unordered tetrads
7. Induction and detection of mutations through genetic tests.
8. Problems on various genetics disorders

9. Problems on autosomal inheritance
10. Problems on allosomal inheritance
11. DNA extraction from crops through various methods-detection of quality and quantity.
12. Basic principles of PCR
13. Amplification and running of PCR
14. Developing marker systems.
15. Detection of transgenes in the exposed plant material.
16. Visit to transgenic glasshouse and learning the practical considerations.
17. Practical examination

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2. Gardner, E.J. & Snustad, D.P. 1991. Principles of Genetics. John Wiley & Sons, USA.
3. Russell, P.J. 1998. Genetics. The Benzamin Cummings Publishers, USA.
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GPB 612 PRINCIPLES OF PLANT BREEDING (2+1)

Objectives

- To impart knowledge on application of various genetics principles in crop improvement
- To impart knowledge on emasculation and pollination techniques of various crops

Theory

Unit I - Reproductive systems in plant breeding

Objectives and role of plant breeding - historical perspective – activities in Plant Breeding. Centres of origin – contribution of Vavilov- law of homologous series. Plant genetic resources – importance – germplasm – types – activities Modes of reproduction – sexual – asexual - self and cross fertilization – significance of pollination. Self incompatibility – classifications – mechanisms – application Sterility – male sterility – introduction – classification – CMS, GMS, CGMS-inheritance and applications. TGMS, PGMS, Gametocides, Transgenic Male sterility and applications. Apomixis – introduction - classification-applications; Parthenocarpy and its types.

Unit II - Breeding methods of self pollinated crops

Basic biometrics-nature and significance of qualitative and quantitative variation-phenotypic, genotypic and environmental-heritability and genetic advance. Plant introduction as a breeding method – types of introduction – objectives – quarantine - acclimatization – achievements - merits and demerits. Genetic basis of self pollinated crops – Vilmorin principle of progeny selection - Breeding methods for self pollinated crops without involving artificial hybridization:

- Breeding methods of self pollinated crops involving artificial hybridization: Creating variability in self pollinated crops - steps in hybridization - kinds of emasculation. Pedigree breeding – procedure – mass pedigree – merits – demerits – achievements; Bulk breeding , Single Seed Descent (SSD) method. Backcross breeding– multi lines and multi blends - population improvement approach in self-pollinated crops.

Unit III - Breeding methods of cross pollinated crops and clonally propagated crops

Genetic structure of a population in cross pollinated crop – Hardy Weinberg law – gene frequencies in random mating population – principles in population improvement. Breeding methods of cross pollinated crops without involving artificial hybridization: Mass selection Breeding methods of cross pollinated crops involving artificial hybridization: Recurrent selection ; Heterosis breeding – genetic basis – hybrid vigour – estimation of heterosis – inbreeding depression – development of inbreds; Heterosis breeding – procedure – use of male-sterility systems and manual emasculation in hybrid seed production – maintenance of parental lines -types of hybrids – achievements – merits and demerits; Synthetics and composites - steps in development of synthetics and composites – achievements – merits and demerits. Genetic characters of asexual reproduction – breeding methods – clonal selection – hybridization and clonal selection.

Unit IV - Special breeding methods

Mutation breeding: mutation – types – mutagens – breeding procedure – applications – achievements – limitations. Breeding for biotic and abiotic stresses; Breeding for pest resistance - mechanisms of resistance; Breeding for disease resistance - mechanisms of resistance; Breeding for Abiotic stress – drought and cold. – mechanisms of resistance; Breeding for Abiotic stress – salinity and alkalinity - mechanisms of resistance; Breeding for quality produce; Ideotype breeding,

Unit V - Maintenance breeding

Types of cultivars – procedure for release of new varieties – stages in seed multiplication – seed certification and TC plants certification. Maintenance Breeding: General seed production techniques – steps in nucleus and breeder seed production – varietal rundown and renovation. Current trends in Plant Breeding- Marker assisted breeding -Transgenic crops - Varietal protection and geographical indications –DNA fingerprinting. PPV & FR act, 2001- Plant breeders’ right, Farmers right, Biodiversity act, 2002; Germplasm registration.

Practical

Floral biology in self and cross pollinated species, selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male sterility in field crops.

Theory schedule

1. Objectives and role of plant breeding - historical perspective
2. Activities in Plant Breeding-Centres of origin – contribution of Vavilov- law of homologous series.

3. Plant genetic resources – importance – germplasm – types
4. Modes of reproduction – sexual – asexual - self and cross fertilization – significance of pollination- Self incompatibility – classifications – mechanisms – application
5. Sterility – male sterility CMS,GMS,CGMS-inheritance and applications
6. TGMS,PGMS, Gametocides, Transgenic Male sterility and applications.
7. Apomixis – introduction - classification-applications; Parthenocarpy and its types
8. Basic biometrics-nature and significance of qualitative and quantitative variation - phenotypic, genotypic and environmental-heritability and genetic advance.
9. Plant introduction as a breeding method – types of introduction – objectives – quarantine - acclimatization – achievements - merits and demerits
10. Genetic basis of self pollinated crops – Vilmorin principle of progeny selection
11. Breeding methods for self pollinated crops without involving artificial hybridization - Breeding methods of self pollinated crops involving artificial hybridization
12. Creating variability in self pollinated crops
13. Steps in hybridization - kinds of emasculation. Pedigree breeding – procedure – mass pedigree – merits – demerits – achievements – Bulk breeding , Single Seed Descent (SSD) method
14. Backcross breeding– multi lines and multi blends - population improvement approach in self-pollinated crops.
15. Genetic structure of a population in cross pollinated crop – Hardy Weinberg law – gene frequencies in random mating population
16. Principles in population improvement.
17. Mid-semester examination
18. Breeding methods of cross pollinated crops without involving artificial hybridization: Mass selection
19. Breeding methods of cross pollinated crops involving artificial hybridization: Recurrent selection
20. Heterosis breeding – genetic basis – hybrid vigour – estimation of heterosis – inbreeding depression – development of inbreds
21. Heterosis breeding – procedure – use of male-sterility systems and manual emasculation in hybrid seed production
22. Maintenance of parental lines -types of hybrids – achievements – merits and demerits - Bulk breeding, Single Seed Descent (SSD) method
23. Backcross breeding– multi lines and multi blends - population improvement approach in self-pollinated crops.
24. Mutation breeding: mutation – types – mutagens – breeding procedure – applications – achievements – limitations
25. Breeding for biotic and abiotic stresses; Breeding for pest resistance – mechanisms of resistance
26. Breeding for disease resistance - mechanisms of resistance - Breeding for Abiotic stress – drought and cold

27. Mechanisms of resistance - Breeding for Abiotic stress – salinity and alkalinity - mechanisms of resistance
28. Breeding for quality produce; Ideotype breeding - Types of cultivars – procedure for release of new varieties
29. Stages in seed multiplication – seed certification and TC plants certification
30. Maintenance Breeding: General seed production techniques – steps in nucleus and breeder seed production - varietal rundown and renovation. Current trends in Plant Breeding
31. Marker assisted breeding -Transgenic crops
32. Varietal protection and geographical indications– DUS, PPV &FR act, 2001
33. Plant breeders' right, Farmers right
34. Biodiversity act, 2002; Germplasm registration.

Practical schedule

1. Pollination and reproduction in plants
2. Alternation of generation and life cycle, preparation of herbarium
3. Description and drawing different pollination systems - Mechanisms enforcing Self and cross pollination in crops; Pollen morphology - Exine structure of different crops
4. Breeder kit and its components – uses; Basic steps of selfing and crossing techniques.
5. Emasculation and pollination techniques in field crops.
6. Emasculation and pollination techniques in horticultural crops.
7. Studies on segregating generations and maintenance of records.
8. Fertility and sterility in A, B, R and TGMS lines - Maintenance of A, B and R line and TGMS lines
9. Hybrid seed production techniques
10. Estimation of heterosis.
11. Studies on different wild species in crop plants and wide hybridization.
12. Irradiation - dosimetry - half life period - procedure for irradiation of seeds and planting materials. Chemical mutagenesis - molar solution preparation - procedure for chemical mutagenesis of seeds and planting materials.
13. Calculation of PCV, GCV, heritability, genetic advance, genetic divergence
14. Layout of different yield trials - Observing the experimental plots; Visit to nucleus and breeder seed production plots.
15. Screening methods – laboratory and field – for biotic and abiotic stresses.
16. Procedure for marker assisted selection.
17. Final Practical Examination.

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2. Chopra, V.L. 2001. Breeding Field Crops. Oxford & IBH, New Delhi.
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4. Singh, B.D. 2006. Plant Breeding. Kalyani Publishers, New Delhi.
5. Singh, P. 2002. Objective Genetics and Plant Breeding. Kalyani Publishers, New Delhi.
6. Singh, P. 2006. Essentials of Plant Breeding, Kalyani Publishers, New Delhi.

GPB 613 BREEDING FIELD CROPS - I (2+1)**Objectives**

- To impart knowledge about the genetical ways of taming, training and improving crop plants
- To provide insight into recent advances in improvement of cereals, pulses, and oil seeds using conventional and modern biotechnological approaches.

Unit I - Major Cereals

Origin, Evolution, and distribution of cultivated species – wild relatives and germplasm: Genetics and cytogenetics and genome relationship – breeding objectives – yield, quality characters, biotic and abiotic stress resistance etc – variety release – seed production in the following crops. Rice, Wheat, Maize, Sorghum, Pearl Millet

Unit II - Minor Cereals

Ragi, Varagu, Samai, Thinai, Panivaragu

Unit III - Pulses

Redgram, Greengram, Blackgram, Cowpea, Bengalgram, Horsegram, Field and garden beans

Unit IV - Oil Seeds

Groundnut, Soybean, Sesame, Sunflower, Safflower,

Unit V - Oil Seeds

Mustard, Castor, linseed, Coconut, Oil palm,

Practical

Floral morphology – Emasculation techniques – crossing techniques in the following crops. Rice, Maize, Sorghum, Pearl millet, Redgram, Greengram, Blackgram, Cowpea, Bengalgram, Field and garden beans, Groundnut, Soybean, Sesame, Sunflower, Castor and coconut.

Theory schedule

1. Breeding of Rice
2. Breeding of Rice
3. Breeding of Rice
4. Breeding of Wheat
5. Breeding of Wheat
6. Breeding of Maize
7. Breeding of Maize
8. Breeding of Sorghum
9. Breeding of Sorghum
10. Breeding of Pearl Millet
11. Breeding of Pearl Millet
12. Breeding of Ragi
13. Breeding of Varagu,
14. Breeding of Samai,
15. Breeding of Thinai,
16. Breeding of Panivaragu
17. Mid –semester examination
18. Breeding of Redgram

19. Breeding of Greengram,
20. Breeding of Blackgram
21. Breeding of Cowpea
22. Breeding of Bengal gram
23. Breeding of Horsegram
24. Breeding of Beans
25. Breeding of Groundnut,
26. Breeding of Soybean
27. Breeding of Sesame
28. Breeding of Sunflower
29. Breeding of Safflower
30. Breeding of Mustard
31. Breeding of Castor
32. Breeding of linseed,
33. Breeding of Coconut
34. Breeding of Oil palm

Practical schedule

1. Emasculation and crossing techniques of Rice
2. Emasculation and crossing techniques of Maize
3. Emasculation and crossing techniques of Sorghum
4. Emasculation and crossing techniques of Pearl Millet
5. Emasculation and crossing techniques of Redgram
6. Emasculation and crossing techniques of Greengram and Blackgram
7. Emasculation and crossing techniques of Cowpea and Bengalgram
8. Emasculation and crossing techniques of Field and garden beans
9. Emasculation and crossing techniques of Groundnut
10. Emasculation and crossing techniques of Soybean
11. Emasculation and crossing techniques of Sesame
12. Emasculation and crossing techniques of Sunflower
13. Emasculation and crossing techniques of Castor
14. Emasculation and crossing techniques of Mustard and linseed
15. Emasculation and crossing techniques of Coconut
16. Emasculation and crossing techniques of Oil palm
17. Final Practical examination

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2. Chopra, V.L. 1994 Plant breeding – Theory and Practices. Oxford and IBH Publishers, New Delhi.
3. Hari Har Ram and Hari Govind Singh. 2006. Crop breeding and genetics, Kalyani Publishers, New Delhi.
4. Singh, D.P. 1991. Genetics and Breeding of pulse crops. Kalyani Publishers, New Delhi.

GPB 621 PRINCIPLES OF QUANTITATIVE GENETICS (2 + 1)

Objective

- To impart theoretical knowledge and computation skills regarding component of variation and variances, scales, mating designs and gene effects

Theory

Unit I - Continuous variation

Introduction – Degree of Statistics : First degree, Second degree, third degree statistics – Mendelian traits and polygenic traits – nature of quantitative traits and its inheritance – multiple factor hypothesis – analysis of continuous variation; Variations associated with polygenic traits – phenotypic, genotypic and environmental – non-allelic interactions; Nature of gene action – additive, dominance, epistatic and linkage effects.

Unit II - Analysis of variance

Principles of analysis of Variance (ANOVA) – Expected variance of components - random and fixed models; MANOVA - biplot analysis; comparison of means and variances for significance.

Unit III - Plant Breeding Experiments

Designs of plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and D^2 analysis – Association analysis – phenotypic and genotypic correlations ; Path analysis and Parent – progeny regression analysis – Selection indices – selection of parents – Concepts of selection – selection intensity, selection differential and types of selection – selection responses for additive and non-additive traits, heritability and genetic advance.

Unit IV - Gene Action

Heterosis and inbreeding depression – Mating designs – Diallel, partial diallel, line x tester analysis, NCD's and Triple Test Cross analysis (TTC) - Generation mean analysis: scaling techniques

Unit V - GxE and QTL

Models for GxE analysis and stability parameters; AMMI analysis – GGE bi plot technique principles and interpretation – QTL mapping ; Strategies for QTL mapping – desired populations for QTL mapping – statistical methods in QTL mapping – QTL mapping in genetic analysis; Marker assisted selection (MAS) – selection based on marker and phenotype – factors influencing MAS.

Practical

Problems on multiple factor inheritance – Partitioning of variance – Estimation of heritability and genetic advance – Covariance analysis – D^2 analysis – Cluster analysis – Construction of cluster diagrams and dendrograms – interpretation – Correlation analysis – Path analysis – parent progeny regression analysis – diallel analysis Griffing's methods I and II – diallel analysis ; Hayman's graphical approach – Diallel analysis ; interpretation of results – NCD's and their interpretations – Line x tester analysis and interpretation of results – Estimation of heterosis – estimation of inbreeding depression – Scaling test - Generation mean analysis; analytical part and interpretation – Estimation of different types of gene actions. Partitioning of phenotypic variance – GxE analysis – Construction of saturated linkage maps and

QTL mapping – strategies for QTL mapping ; statistical methods in QTL mapping ;
Phenotype and Marker linkage studies – Use of software's in statistical analysis

Theory schedule

1. Introduction for biometric Genetics
2. First degree, Second degree, third degree statistics
3. Mendelian traits and polygenic traits
4. Multiple factor hypothesis
5. Analysis of continuous variation
6. Variance and covariance analysis
7. Nature of gene action – additive, dominance, epistatic and linkage effects.
8. Principles of analysis of Variance (ANOVA) –
9. Expected variance of components - random and fixed models;
10. MANOVA - biplot analysis
11. Comparison of means and variances for significance.
12. Designs of plant breeding experiments - principles and applications
13. Genetic diversity analysis – metroglyph, cluster
14. D2 analysis
15. Association analysis – phenotypic and genotypic correlations
16. Path analysis and Parent – progeny regression analysis
17. Mid semester examination
18. Selection indices – selection of parents – Concepts of selection – selection intensity, selection differential and types of selection
19. Selection responses for additive and non-additive traits,
20. Heritability and genetic advance.
21. Heterosis and inbreeding depression
22. Mating designs – Diallel, partial diallel,
23. Line x tester analysis
24. NCDs and Triple Test Cross (TTC)
25. Generation mean analysis
26. Scaling techniques
27. Models for GxE analysis
28. Stability parameters
29. AMMI analysis – principles and interpretation
30. QTL mapping ; Strategies for QTL mapping
31. Desired populations for QTL mapping
32. Statistical methods in QTL mapping – QTL mapping in genetic analysis
33. Marker assisted selection (MAS) – selection based on marker and phenotype
34. Factors influencing MAS.

Practical schedule

1. Problems on multiple factor inheritance
2. Estimation of heritability and genetic advance
3. D2 analysis
4. Correlation analysis

5. Path analysis
6. Parent progeny regression analysis
7. Diallel analysis - Griffing's methods I and II
8. Diallel analysis - Hayman's graphical approach
9. NCD and their interpretations
10. Line x tester analysis
11. Estimation of heterosis and inbreeding depression
12. Scaling test
13. Generation mean analysis Introducing, deriving data for various generations
14. G x E analysis : Stability parameters
15. Construction of saturated linkage maps and QTL mapping – strategies for QTL mapping ; statistical methods in QTL mapping
16. Phenotype and Marker linkage studies
17. Use of software's in statistical analysis

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GPB 622 PRINCIPLES OF CYTOGENETICS (2+1)

Objective

- To provide insight into structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution.

Theory

Unit I - Chromosome architecture

Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of

chromosomes, Chromosomal theory of inheritance; Cell Cycle and cell division – mitosis and meiosis; Differences, significance and deviations – Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over-recombination models, cytological basis- chemical composition of chromosomes and staining properties

Unit II - Chromosomal aberrations

Variation in chromosome structure: Evolutionary significance -Introduction to techniques for karyotyping; Chromosome banding and painting - *in situ* hybridization and various applications; Structural and Numerical variations of chromosomes and their implications - Symbols and terminologies for chromosome numbers - euploidy -haploids, diploids and polyploids ; Utilization of aneuploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations - balanced lethals and chromosome complexes.

Unit III - Polyploidy

Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids Vs allopolyploids – Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis –meiotic behavior in apomicts- Evolutionary and genetic problems in crops with apomixis.

Unit IV - Interspecific hybridization

Reversion of autopolyploids to diploids; Genome mapping in polyploids - Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) – Hybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids - Bridge species.

Unit V - Wide hybridization

Fertilization barriers in crop plants at pre-and post fertilization levels- *In vitro* techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization ; case studies – Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical

Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. - Microscopy: various types of microscopes, - Observing sections of specimen using Electron microscope; Preparing specimen for observation - Fixative preparation and fixing specimen for light microscopy studies in cereals - Studies on the course of mitosis in Rice, pearl millet - Studies on the course of mitosis in onion and *Aloe vera* -Studies on the course of meiosis in cereals, millets and pulses - Studies on the course of meiosis in oilseeds and forage crops - Using micrometers and studying the pollen grain size in various crops -Various methods of staining and preparation of temporary and permanent slides - Pollen germination *in vivo* and *in vitro*; Microtomy and steps in microtomy; Agents employed for the induction of various ploidy levels; Solution

preparation and application at seed, seedling level - Identification of polyploids in different crops - Induction and identification of haploids; Anther culture and Ovule culture - Morphological observations on synthesized autopolyploids - Observations on C-mitosis, learning on the dynamics of spindle fibre assembly - Morphological observations on allopolyploids - Morphological observations on aneuploids - Cytogenetic analysis of interspecific and intergeneric crosses -Maintenance of Cytogenetic stocks and their importance in crop breeding - Various ploidy levels due to somaclonal variation ; Polyploidy in ornamental crops. -Fluorescent *in situ* hybridization (FISH)- Genome *in situ* hybridization GISH.

Theory Schedule

Architecture of chromosome in prokaryotes and eukaryotes

1. Artificial chromosome construction and its uses
2. Special types of chromosomes - Chromosomal theory of inheritance.
3. Cell Cycle and cell division – mitosis and meiosis;
4. Recombination models, cytological basis- differences, significance and deviations
5. Cytological basis- chemical composition of chromosomes. Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over.
6. Mechanisms and theories of crossing over- recombination models, cytological basis.
7. Variation in chromosome structure- numerical aberration.
8. Evolutionary significance of chromosomal aberration.
9. Introduction to techniques for karyotyping and dye binding properties of chromosomes.
10. Chromosome banding and painting
11. *In situ* hybridization and various applications.
12. Euploidy -haploids, diploids and polyploids.
13. Utilization of aneuploids in gene location.
14. Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction. Evolutionary advantages of autopolyploids vs allopolyploids.
15. Balanced lethals and chromosome complexes. Role of aneuploids in basic and applied aspects of crop breeding.
16. Mid-semester examination
17. Inter-varietal chromosome substitutions - Polyploidy and role of polyploids in crop breeding. Maintenance and utilization of polyploids in gene mapping.
18. Alien addition and substitution lines – creation and utilization.
19. Apomixis - Evolutionary and genetic problems in crops with apomixes .
20. Reversion of autopolyploids to diploids;
21. Genome mapping in polyploids.
22. Interspecific hybridization and allopolyploids .
23. Synthesis of new crops - wheat, triticale and brassica .

24. Hybrids between species with same chromosome number, alien translocations.
25. Hybrids between species with different chromosome number.
26. Gene transfer using amphidiploids - Bridge species
27. Fertilization barriers in crop plants at pre-and post fertilization levels.
28. *In vitro* techniques to overcome the fertilization barriers in crops.
29. Chromosome manipulations in wide hybridization.
30. Production of doubled haploids.
31. Maintenance of cytogenetics stock.
32. Somaclonal variation.
33. FISH and GISH, Anther culture and ovule culture.

Practical Schedule

1. Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc.
2. Microscopy: various types of microscopes
3. Observing sections of specimen using Electron microscope; Preparing specimen for observation
4. Fixative preparation and fixing specimen for light microscopy studies in cereals
5. Studies on the course of mitosis in wheat, pearl millet - Studies on the course of mitosis in onion and *Aloe vera*
6. Studies on the course of meiosis in cereals, millets and pulses - Studies on the course of meiosis in oilseeds and forage crops
7. Using micrometers and studying the pollen grain size in various crops
8. Various methods of staining and preparation of temporary and permanent slides
9. Pollen germination *in vivo* and *in vitro*; Microtomy and steps in microtomy
10. Agents employed for the induction of various ploidy levels
11. Solution preparation and application at seed, seedling level - Identification of polyploids in different crops - Induction and identification of haploids
12. Anther culture and Ovule culture - Morphological observations on synthesized autopolyploids
13. Observations on C-mitosis, learning on the dynamics of spindle fibre assembly - Morphological observations on allopolyploids
14. Morphological observations on aneuploids - Cytogenetic analysis of interspecific and intergeneric crosses
15. Maintenance of Cytogenetic stocks and their importance in crop breeding - Various ploidy levels due to somaclonal variation
16. Polyploidy in ornamental crops. -Fluorescent *in situ* hybridization (FISH)- Genome *in situ* hybridization GISH
17. Final practical Examination

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GPB 623 BREEDING FIELD CROPS - II (2+1)

Objectives

- To impart knowledge about the genetical ways of taming, training and improving crop plants
- To provide insight into recent advances in improvement of fibres, sugar crops, vegetables and forage crops using conventional and modern biotechnological approaches.

Unit I - Cash Crops

Origin, Evolution, and distribution of cultivated species – wild relatives and germplasm: Genetics and Cytogenetics and genome relationship – breeding objectives – yield, quality characters, biotic and abiotic stress resistance etc – variety release – seed production in the following crops Cotton, Jute, Mesta and Tobacco

Unit II - Sugar Crops

Sugarcane, Potato, Sweet Potato, Cassava

Unit III - Tropical Vegetable

Brinjal, Tomato, Chillies, Bhendi, Gourds, Onion and Beans

Unit IV - Temperate Vegetable

Cabbage, Knolkhol, Radish, Carrot, Turnip, Beetroot

Unit V - Forage crops

Fodder sorghum, Maize, Cumbu, Napier grass, Cumbu napier hybrid, Forage cowpea, Desmodium, Desmanthus, Lucerne and Pillipesara.

Practical

Floral morphology – Emasculation techniques – crossing techniques in the following crops. Cotton, Jute, Mesta, Sugarcane, Potato, Sweet Potato, Tobacco, Cassava, Brinjal, Tomato, Chillies, Bhendi, Gourds, Onion, and Beans

Theory Schedule

1. Breeding of Cotton
2. Breeding of Cotton
3. Breeding of Jute
4. Breeding of Mesta
5. Breeding of Sugarcane
6. Breeding of Sugarcane
7. Breeding of Sugarcane
8. Breeding of Potato
9. Breeding of Sweet Potato
10. Breeding of Tobacco
11. Breeding of Cassava
12. Breeding of Tomato
13. Breeding of Brinjal
14. Breeding of Chilles
15. Breeding of Bhendi
16. Breeding of Gourds
17. Mid semester examination
18. Breeding of Cabbage
19. Breeding of Onion
20. Breeding of Beans
21. Breeding of Knolkhol
22. Breeding of Radish
23. Breeding of Carrot
24. Breeding of Turnip
25. Breeding of Beetroot
26. Breeding of Forage Surghum
27. Breeding of Forage Maize
28. Breeding of Forage Cumbu
29. Breeding of Cumbu X Napier Hybrid
30. Breeding of Forage Cowpea
31. Breeding of Desmodium
32. Breeding of Desmanthus
33. Breeding of Lucerne
34. Breeding of Pillipesara

Practical Schedule

1. Emasculation and crossing techniques of Cotton
2. Emasculation and crossing techniques of Jute and Mesta
3. Emasculation and crossing techniques of Sugarcane
4. Emasculation and crossing techniques of Potato
5. Emasculation and crossing techniques of Sweet Potato
6. Emasculation and crossing techniques of Tobacco
7. Emasculation and crossing techniques of Cassava
8. Emasculation and crossing techniques of Brinjal

9. Emasculation and crossing techniques of Tomato
10. Emasculation and crossing techniques of Chillies
11. Emasculation and crossing techniques of Bhendi
12. Emasculation and crossing techniques of Gourds
13. Emasculation and crossing techniques of Onion
14. Emasculation and crossing techniques of Beans
15. Emasculation and crossing techniques of Forage maize and sorghum.
16. Emasculation and crossing techniques of legume fodder
17. Final Practical examination

References

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GPB 624 BIOTECHNOLOGY FOR CROP IMPROVEMENT (2+0)

Objective

- To impart knowledge and practical skills to use biotechnology tools in crop improvement.

Unit I - Introduction to Biotechnology

Biotechnology and its relevance in agriculture; Definition, terminologies and scope in plant breeding. Tissue culture – History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

Unit II - Various techniques in biotechnology & mapping sequences

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F_2 'S, back crosses, RILs, NILs AND DH), Next generation sequencing, GCMS, DNA fingerprinting.

Unit III - Molecular analysis and genome mapping

Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits: QTLs analysis in crop plants, Gene pyramiding. Genomics and genoinformatics. Integrating functional genomics information in plant breeding; Marker-assisted backcross breeding for rapid introgression.

Unit IV - Transgenic plants & genetic engineering

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, direct gene transfer - physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean,

oilseeds, sugarcane etc., Commercial releases – Edible vaccine production through genetic engineering – Blue Rose, Orange Petunia – Insect and disease resistance

Unit V - Biotechnology applications, IPR & Bioinformatics

Biotechnology applications in male sterility/hybrid breeding molecular farming, GMO's- related issues- risks and regulations regulatory procedures in major countries including India, ethical, legal and social issues; intellectual property rights. Bioinformatics ; Nanotechnology and its application in crop improvement programmes.

Theory schedule

1. Biotechnology and its relevance in agriculture definitions and terminologies and history of plant tissue culture
2. Plant tissue culture : general techniques. Tissue culture media – composition and their ready-made availability, importance of the nutrients added and their function
3. Culture establishment : cell, callus and organ cultures and special types.
4. Morphogenesis *in vitro* – introduction, influencing factors.
5. Organogenesis and embryogenesis
6. In vitro culture methods and applications meristem culture
7. Anther and pollen culture – applications and achievements
8. In vitro pollination and in vitro fertilization techniques, ovary, ovule, embryo and endosperm culture
9. Protoplast isolation and its culture
10. Somatic hybridization
11. Somaclonal variation and applications
12. Tissue culture and germplasm maintenance – cryopreservation
13. Techniques of DNA isolation, quantification and analysis
14. Genotyping, gene sequencing techniques
15. Vectors, vector preparation and cloning
16. Bio-chemical markers
17. Mid- semester examination
18. Molecular markers – RFLP, RAPD, AFLP
19. SSR, SNPs ESTS etc.
20. Molecular mapping and tagging of agronomically important traits
21. Statistical tools in marker analysis
22. Robotics
23. Marker assisted selection for qualitative traits
24. QTL analysis
25. Gene pyramiding
26. Genomics and genoinformatics
27. Functional genomics and plant breeding
28. Marker assisted back cross breeding
29. Methods of transformation
30. Vector mediated gene transfer, direct gene transfer

31. Transgenic plants in cotton, maize, wheat, rice, soybean, oilseeds, sugarcane etc.
32. Biotechnology applications in hybrid breeding
33. GMO's related issues and intellectual property rights
34. Bio informatics and nano-technology in crop improvement programme.

References

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4. Sambrook, J. and Russel, D. 2001. Molecular cloning – a laboratory Manual. 3rd Ed. Cold spring Harbor Lab press, USA.
5. Singh, B.D. 2005. Biotechnology, Expanding Horizons, Kalyani Publications, New Delhi.
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OPC-GPB 621 CONCEPTS OF CROP PHYSIOLOGY (2+1)

Objectives

- To impart knowledge in understanding the physiological processes taking place during growth and development of plants.
- To understand source sink relationship in different groups of plants and also hormonal, environmental and stress physiology in crop plants.

Theory

Unit I - Photo physiology

Role of physiology in different branches of agriculture. Physiological processes on productivity – Photosynthesis – Mechanism of light interaction. Physiological processes influenced by radiation. Light and phytochrome mediated processes. – CO₂ reduction – utilization of assimilatory power and carbohydrate synthesis - C₃, C₄ and CAM mechanisms – Major differences.

Unit II - Growth and Development

Growth Vs Development.. Dry Matter Accumulation and Harvest Index – components of Dry Matter Accumulation and Harvest Index and their role in productivity. Growth analysis. Photorespiration and dark respiration.

Unit III - Source sink relationship

LAI and its components –interception of solar energy. Photosynthates partitioning – source – sink relationship – mode of partitioning at different stages in different species. Role of growth regulators in monitoring source and sink.

Unit IV - Environmental physiology

Green house effect and Global warming. Ozone layer depletion - Causes, effects. CO₂ enrichment and plant productivity. Physiology of crops under high altitude and flooding – air pollution and plant growth – effect of effluent on plant growth.

Unit V - Stress physiology

Mechanisms of drought, salt, cold, heat and UV radiation stress tolerance – adaptation of crop plants – crop management practices under unfavourable situations – Importance of selection indices for crop productivity – recent advances in physiological research.

Practical

Leaf Area measurement – measurement of leaf angle and interception of solar radiation – light transmission ratio – measurement of photosynthesis – difference in the photosynthetic rate between the leaves at different position – photosynthetic efficiency of C₃ and C₄ plants – estimation of chlorophyll – RuBP case and PEP case – Measurement of respiration – Growth regulation – response to source and sink relationship – Measurement of water potential and its component. Measurement of leaf temperature, diffusive resistance and transpiration rate – use of antitranspirants – yield component analysis – study of selection indices.

Lecture Schedule

Theory

1. Role of physiology in different branches of agriculture
2. Physiological processes on productivity
3. Photosynthesis – Mechanism of light interaction
4. Photo Physiology
5. Physiological processes influenced by radiation
6. Light and phytochrome mediated processes
7. Utilization of assimilatory power and CH₂O synthesis
8. C₃-C₄ and CAM mechanisms and major differences
9. Photosynthetic measurements
10. Germination, growth and development
11. DMA and HI. Components of DMA and HI.
12. Role of DMA, LAI and HI in crop productivity
13. Growth analysis
14. Photorespiration and dark respiration
15. Oxidative phosphorylation.
16. Release and utilization of energy for various metabolisms.
17. Mid-Semester Examination
18. Interception of solar energy
19. Source-sink relationship
20. Photosynthate partitioning
21. Mode of partitioning at different stages and different species
22. Role of growth regulators in monitoring source-sink relationship
23. Growth regulators – auxins, gibberellins and cytokinins, biosynthesis, functions and agricultural role.
24. Abscisic acid and ethylene. Biosynthesis, functions and agricultural role.
25. Growth retardants. Role in agricultural and horticultural crops
26. Green house effect and plant productivity.
27. CO₂ enrichment and plant productivity.
28. Physiology of crops under high altitude flooding, air and water pollution

29. Water stress, effect of water stress on various physiological processes
30. Mechanisms of adaptation to stress condition.
31. Salt stress, classifications and its effects on physiological processes of plant
32. Temperature stress – cold tolerance – adaptation
33. Heat stress – Heat shock proteins – heat tolerance – adaptation.
34. Recent advances in physiological research

Practical Schedule

1. Leaf area index measurement. Measurement of leaf angle and interception of solar radiation
2. Measurement of photosynthesis
3. Determination of Photosynthetic efficiency of various crop plants
4. Estimation of soluble protein content
5. Estimation of chlorophyll contents
6. Estimation of water potential
7. Determination of chlorophyll stability index
8. Estimation of relative water content
9. Estimation of leaf proline content
10. Measurement of leaf temperature, diffusive resistance and transpiration
11. Growth analysis of field crops
12. Determination of nitrate reductase activity
13. Determination of IAA oxidase activity
14. Estimation of total phenolics
15. Estimation of peroxidase activity
16. Estimation of catalase activity
17. Final Practical Examination

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OPC-GPB 711 GERMPLASM COLLECTION, EXCHANGE AND QUARANTINE (2+1)

Objective

- To provide information about collection, germplasm exchange, quarantine, maintenance and use of plant genetic resources including genetically modified plants.

Theory

Unit I - Introduction

History and importance of germplasm exploration; Distribution and extent of prevalent genetic diversity; Phyto-geographical regions/ecological zones and associated diversity; Mapping eco-geographic distribution of diversity, threatened habitats, use of flora.

Unit II - Mating System

Concept of population and gene pool; Variations in population and their classification; Gene frequencies in populations, rare and common alleles; Gene pool sampling in self and cross pollinated and vegetatively propagated species; Non-selective, random and selective sampling strategies; Strategies and logistics of plant exploration and collection; Coarse and fine grid surveys; Practical problems in plant exploration; Use of *in vitro* methods in germplasm collection.

Unit III - Germplasm Collection

Ethnobotanical aspects of PGR; Crop botany, farming systems, collecting wild relatives of crop plants; Collection and preservation of specimens; Importance and use of herbaria and preparation of herbarium specimens.

Unit IV - Strategies in Collection of Germplasm

Post-exploration handling of germplasm collections; Present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum, sesame, *Brassica*, okra, eggplant, cotton, mango etc; approaches for collection including indigenous knowledge.

Unit V - Plant Quarantine

History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collection and exchange; Documentation and information management; Plant quarantine- introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India. Post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities; Domestic quarantine; seed certification; International linkages in plant quarantine; weaknesses and future thrust.

Practical

Plant exploration and collection; Techniques of coarse and fine grid surveys; Identification of wild relatives of crop plants- Example of collection, cataloguing and preservation of specimens; Sampling techniques of plant materials; Visiting ports, airports to study the quarantine regulations. Use of visual, qualitative, quantitative,

microscopic, molecular and plant growth related techniques(controlled green houses/growth chambers, etc); Study of post-entry quarantine operation, seed treatment and other prophylactic treatments.

Theory schedule

1. History and importance of germplasm exploration.
2. Distribution and extent of prevalent genetic diversity
3. Phyto-geographical regions/ecological zones and associated diversity
4. Mapping eco-geographic distribution of diversity.
5. Plant exploration and collection;
6. Concept of population and gene pool .
7. Coarse and fine grid surveys.
8. Gene pool sampling in self and cross pollinated and vegetatively propagated species.
9. Non-selective, random and selective sampling strategies.
10. Strategies and logistics of plant exploration and collection.
11. Practical problems in plant exploration.
12. *In vitro* methods in germplasm collection.
13. Ethnobotanical aspects of PGR.
14. Identification of wild relatives of crop plants.
15. Collection, cataloguing and preservation of specimens.
16. Post-exploration handling of germplasm collections.
17. Mid-semester examination
18. Present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum.
19. Present status and future strategies in collection of crops sesame, *Brassica*, okra, eggplant, cotton, mango.
20. History, principles, objectives and importance of plant introduction.
21. Documentation and information management
22. Importance and use of herbaria.
23. Preparation of herbarium specimens.
24. Sampling techniques of plant materials;
25. Plant quarantine- introduction, history, principles, objectives and relevance.
26. Regulations and plant quarantine set up in India.
27. Quarantine regulations.
28. Visual, qualitative, quantitative, microscopic, molecular and plant growth related techniques.
29. Study of post-entry quarantine operation.
30. Seed treatment and other prophylactic treatments.
31. Domestic quarantine.
32. Seed certification.
33. International linkages in plant quarantine.
34. Weaknesses and future thrust in plant quarantine

Practical Schedule

1. Plant exploration and collection.
2. Handling of germplasm collections.
3. Preparation of herbarium specimens.
4. Identification of wild relatives of crop plants.
5. Techniques of coarse and fine grid surveys.
6. Identification of wild relatives of crop plants.
7. Example of collection.
8. Cataloguing of collection.
9. Preservation of specimens.
10. Sampling techniques of plant materials.
11. Visiting ports, airports to study the quarantine regulations.
12. Use of visual, microscopic, molecular and plant growth related techniques (controlled green houses/growth chambers, etc);
13. Qualitative and quantitative related techniques.
14. Study of post-entry quarantine operation.
15. Seed treatment and other prophylactic treatments.
16. Seed certification.
17. Practical examination

Suggested Readings

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OPC-GPB 712 FUNDAMENDALS OF GENETICS (2+1)

Objectives

The course imparts knowledge to the students about the structure organization, function and transmission of chromosomes and genes and variation among them, It explains the parallelism between the behaviour of chromosomes and genes. It is useful in construction of linkage map and location of genes. It also explains about the molecular genetics of gene organization and function: the effects of mutagens on biological system and evolution of crop plants.

Theory

Unit I - Cytology

Earlier concepts of heredity – cell and cell organelles – Prokaryotes – Eukaryotes – study of mitosis and meiosis – cell cycle – Sporogenesis – Gametogenesis – Fertilization.

Unit II - Mendelian Genetics

Mendel's work – laws of heredity – Multiple alleles – gene interaction – penetrance – Expressivity – Pleiotropy – Modifying genes – Phenocopy – lethal genes – Multiple Factor hypothesis.

Unit III - Linkages

Linkage and Crossing over – Estimation of strength of linkage and crossing over value – two and three point test cross – genetic map – sex determination – genic balance theory – Sex linked – sex influenced and sex limited inheritance – cytoplasmic inheritance.

Unit IV - Cytogenetics

Chromosomal theory of inheritance – chromosome structure – chemical composition and nucleosome – Types of chromosomes – special chromosomes – Mutation – point mutation – Transition and Transversion – Variation in chromosome number and structure – Aneuploidy and Euploidy – Its genetic and cytological implications.

Unit V - Genetic at Molecular Level

Experiments showing DNA as genetic material – DNA Structure and function – DNA replication – Genetic code – central dogma of life – gene expression – protein synthesis and gene regulation – Operon concept – modern concept of gene.

Practical

Study of genetic ratios of – Monohybrid, Dihybrid, Polyhybrid, inheritance – co-dominance – incomplete dominance, gene interactions. Multiple alleles and Multiple factors. Study of linkage, estimation of strength of linkage and crossing over in two point and three point test cross – Drawing of genetic map – interference and coincidence. Preparation of fixatives and stains – Pretreatment of materials for mitosis and meiosis – Study of mitosis and meiosis.

Theory schedule

1. Concept of heredity – Vapour and fluid theory, Magnetic power theory, Preformation theory – Lamarck's theory, Darwin's theory, Germplasm theory and Mutation theory.
2. Definition of genetics, heredity and inheritance

3. Definition and Brief history of cytogenetics; structure and functions of cell and organelles – Difference between prokaryotes and Eukaryotes. Physical basis of heredity: Structure and function of cell and cell organelles – Differences between Prokaryotes and Eukaryotes.
4. Chromosome structure, chemical composition, nucleosome, centromere, telomere, euchromatin, NOR, satellite chromosome - karyotype, ideogram – types of chromosomes based on position of centromere.
5. Study of mitosis and meiosis – Cell cycle.
6. Work of Mendel – Characters studies, his observations and interpretation s- reasons for his success – Law of dominance. Law of segregation and Law of independent assortment.
7. Rediscovery of Mendel's work, chromosomal theory of inheritance
8. Definitions of gene, alleles, homozygous, heterozygous, genome, phenotype, genotype, monohybrid, dihybrid, polyhybrid, backcross and test cross.
9. Lethal genes, Pleiotrophy with examples; phenocopy, penetrance and expressivity, Allelic interaction – Types – Complete dominance, incomplete dominance, Co-dominance and Over dominance with examples.
10. Non allelic interaction – epistatic and hypostatic genes, types of epistasis – Non – allelic interaction without modifications in Mendelian ratio – Bateson and Punnett's experiment on fowl comb shape.
11. Epistasis with modification of Mendelian ratio – 1) Dominant epistasis, ii) Recessive epistasis, iii) Duplicate and additive epistasis
12. iv) Duplicate dominant epistasis, v) Duplicate recessive epistasis vi) Dominant and recessive epistasis.
13. Multiple alleles – characteristic features, study of blood group, coat colour in rabbits and self incompatibility in plants.
14. Multiple factor hypothesis – Nilson – Ehle – Wheat kernel colour experiment – polygenes – Transgressive segregation – Quantitative vs Qualitative characters and modifiers.
15. Linkage - coupling and repulsion - Experiment of Bateson and Punnett – Chromosomal theory of linkage of Morgan – Complete and incomplete linkage,
16. Crossing over – significance of crossing over - cytological proof for crossing over - Stern's experiment - Strength of linkage and recombination - Two point and three point test cross - Double cross over, interference and coincidence - genetic map.
17. Mid-semester examination
18. Sex determination – chromosomes mechanism of sex determination and its types – Genic balance theory of sex determination of Bridges.
19. Sex linked inheritance – Criss cross inheritance – reciprocal difference – Holandric genes – sex limited inheritance – sex determination in plants – *Melandrium*, papaya and maize.

20. Cytoplasmic inheritance – its characteristic features – examples of chloroplast, mitochondrial, plasmid and episomic inheritance.
21. DNA, the genetic material – Griffith's experiment, experiment of Avery, McCleod and McCarthy – confirmation by Hershey and Chase; RNA as genetic material – Frankel, Conrat and Singer experiment.
22. Structure of DNA – Watson and Crick model – mechanisms of DNA replication.
23. Models of DNA replication – Proof for semi-conservative method of DNA replication.
24. RNA types - mRNA, tRNA, rRNA; genetic code – Characteristic features – Central dogma of life.
25. Gene expression – protein synthesis.
26. Regulation of gene expression – operon model of Jacob and Monod; Structural genes and regulator genes.
27. Split genes, exons and introns – modern concept of gene – gene as cistron, muton and recon, complementation testy.
28. Special chromosomes – Polytene, Lamp brush. B. Ring and Iso chromosomes.
29. Variation in chromosome structure – deletion and duplication – genetic and cytological implications.
30. Inversion and translocation – genetic and cytological implications.
31. Variation in chromosome number – Euploid, aneuploid – types of euploids.
32. Polyploid – auto and allopolyploids.
33. Role of polyploidy in evolution of crops – wheat, cotton, tobacco and brassica
34. Types of aneuploids and their origin.

Practical Schedule

1. Principles of dominance, recessive, back cross, test cross, incomplets and co-dominance and lethal factor – principles of Chi- square test.
2. Study on genetic ratios – monohybrid – incomplete dominance and test cross ratios and in combination of one or two of the above.
3. Dihybrid ratio – dominance, incomplete dominance and test cross ration and in combination of one or two of the above.
4. simple interancetio of genes – comb character in fowls and Duplicate recessive epitasis.
5. Dominant epistasis and recesive epistasis.
6. Duplicate and additive epistasis. Duplicate dominant epistastis, duplicate recessive epistasis and dominant and recessive epistasis.
7. Multiple alleles and polygenec inheritance
8. Estimation of linkage with F2 and test cross data, coupling and repulsion
9. Problems on two point test cross.
10. Three point test cross – working out interference, coincidence and drawing genetic maps.
11. Principles of killing and fixing – preparation of stains and apreservatives

12. Studying the stages of mitosis and meiosis
13. Study of mitotic phases in roottips of onion / Aloe spa and Arabidopsis
14. Procedure for fixing and observing different meiotic phases in the inflorescence of Maize and pearl millet.
15. Repeating the exercise
16. Repeating the exercise with Maize, Pearl millet
17. Procedure for making temporary slides to permanent slides.

Reference books

1. Gupta P.K., 1997. Cytogenetics. Rastogi Publications, Meerut
2. Verma, P.S. and V.K. Agarwal. 2007. Genetics. S.Chand and Company Ltd./ New Delhi.
3. Stansfield, W.D. 1990. Theory and problems of genetics. Mc-Graw Hill Book Co., New York
4. Pundhan Singh. 2014. Elements of Genetics. Kalyani Publishers
5. Singh, B.D. 2004. Fundamentals of Genetics, Kalyani Publishers, Chennai
6. Benjamin Lewin. 2005. Genes IX Oxford University Press, Oxford.
7. Russel, P.J. 2000. Fundamentals of genetics. Addison Wesley Longman Publishers, USA
8. Daniel Sundararaj, G. Thulasidas and M. Stephen Dorairaj, 1997. Introduction to Cytogenetics and Plant Breeding. Popular Book Depot, Chennai -15.
9. Strickberger. M.W. 1996. Genetics. Prentice-Hall of India Pvt. Ltd. New Delhi.

**M.SC.(AG.) SEED SCIENCE AND TECHNOLOGY
COURSE – WISE DISTRIBUTION**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	SST 611	Floral biology, seed development and maturation	2 + 1
2.	SST 612	Principles of seed production	2 + 1
3.	SST 613	Seed Physiology	1 + 1
4.	SST 621	Seed production in field crops	2 + 1
5.	SST 622	Seed legislation and certification	2 + 1
6.	SST 623	Seed Processing and Storage	2 + 1
7.	SST 624	Seed quality testing	2 + 1
		Total	13+7=20
Minor- 9 credits			
1.	OPC- GPB 621	Concepts of crop physiology	2+1
2.	OPC-SST 711	Seed Production Techniques in Crops	2+1
3.	OPC-SST 712	Seed Quality Testing and Certification	2+1
		Total	6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistical Methods and Design of Experiments	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
		Total	3+2=5
Seminar + Research - 21 credits			
1.	SST -032	Seminar	0+1
2.	SST -011; 021;031 041	Research 011- 0+1 ; , 021- 0+2 ; , 031- 0+8 ; , 041- 0+9	0+20
		Grand Total	22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0+1
4	PGS 624	Library and information services	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture	1+0
6	PGS 716 e-course	Disaster management	1+0
			2 + 4=6

**M.SC.(AG.) SEED SCIENCE AND TECHNOLOGY
SEMESTER WISE DISTRIBUTION OF COURSES**

Semester I

S. No	Course No.	Title	Credit Hours T + P
1	SST 611	Floral biology, seed development and maturation	2 + 1
2	SST 612	Principles of seed production	2 + 1
3	SST 613	Seed Physiology	1 + 1
4	STA 611	Statistical methods and Designs of experiments	2 + 1
5	COM 611	Computer Application for Agricultural Research	1 + 1
6	SST 011	Research	0 + 1
7	PGS 611	Agricultural Research Ethics and Methodology (0 + 1)	-
8	PGS 612	Technical writing and communication skills (0 + 1)	-
		Total	8 + 6 = 14

Semester II

1	SST 621	Seed production in field crops	2 + 1
2	SST 622	Seed legislation and certification	2 + 1
3	SST 623	Seed Processing and Storage	2 + 1
4	SST 624	Seed quality testing	2 + 1
5	OPC-GPB 621	Concepts of Crop Physiology	2 + 1
6	SST 021	Research	0 + 2
7	PGS 623	Basic concepts in laboratory techniques (0 + 1)	-
8	PGS 624	Library and Information services (0 + 1)	-
		Total	10 + 7 = 17

Semester III

1	OPC-XXX 711	Minor Course - Related discipline	2 + 1
2	OPC-XXX 712	Minor Course - Related discipline	2 + 1
3	SST 031	Research	0 + 8
4	SST 032	Seminar	0 + 1
5	PGS 715 e-course	Intellectual property and its management in agriculture (1 + 0)	
6	PGS 716 e-course	Disaster management (1 + 0)	
		Total	4+ 11 =15

Semester IV

1	SST 041	Research	0 + 9
		Total	0 + 9
		Grand total	22 + 33 = 55

SST 611 FLORAL BIOLOGY, SEED DEVELOPMENT AND MATURATION (2+1)

Objective

- To impart basic knowledge of seed development and its structures.
- To appraise students with its relevance to production of quality seed.

Theory

Unit I - Introduction

Floral types, structure and biology in relation to pollination mechanisms. Sporogenesis, microsporogenesis and megasporogenesis. Gametogenesis- development of male and female gametes and their structures; effect of environmental factors on floral biology.

Unit II - Mode of pollination

Pollination-types –self and cross pollination- mechanism in promoting self and cross pollination- cleistogamy- chasmogamy-dicliny – dichogamy- protogyny – protandry –factors affecting pollination

Unit III - Sexual reproduction

Fertilization – embryo sac structure – process- barriers to fertilization- incompatibility and male sterility – factors affecting fertilization - Embryogenesis- development of typical monocot and dicot embryos; endosperm development, modification of food storage structures with reference to crop plants. Different types of embryos, endosperm and cotyledons; development and their structure in representative crop plants with reference to food storage.

Unit IV - Seed development and maturation

External and internal features of monocot and dicot seed; seed coat structure and development in representative crop plants – Germination – types, phases – factors affecting germination – dormancy, causes – breaking methods.

Unit V - Asexual reproduction

Apomixes – identification, classification, significance and its utilization in different crops for hybrid seed production; polyembryony - parthenocarpy – types and significance; haplontic and diplontic sterility, causes of embryo abortion, embryo rescue and synthetic seeds.

Practical

Study of floral biology of monocots and dicots. microsporogenesis and megasporogenesis. study of pollen grains – pollen morphology, pollen germination and pollen sterility- types monocot and dicot embryos. External and internal structures of monocot and dicot seeds. seed coat structures; preparation of seed albums and identification.

Theory schedule

1. Flower and fruit types, floral structure in relation to seed development
2. Microsporogenesis, megasporogenesis, development and structure of microsporogium and megasporangium.
3. Male and female gametophyte, developing ovule, structure and type.
4. Effect of environmental factors on floral biology.
5. Pollination and its types with reference to crop plants
6. Mechanism in promoting self pollination in crop plants

7. Mechanism in promoting cross pollination in crop plants
8. Factors responsible for pollination control
9. Fertilization –embryo sac structure and development.
10. Embryosac development process in monocot and dicot plants.
11. Barriers to fertilization incompatibility and male sterility.
12. Factors affecting fertilization.
13. Embryogenesis –development of typical monocot and dicot embryos and its types.
14. Endosperm development and types modification of food storage structure with reference to crop plants
15. Germination, types, phases and factor affecting germination
16. Dormancy, dormancy classification and breaking treatments / methods
17. Mid Semester Examination
18. External and internal features of dicot seeds
19. Seed coat structure and development in representative monocot seed
20. Seed coat structure and development in representative dicot seed
21. Mechanism of translocation into developing seeds of various crops
22. Deposition of reserves in the storage tissue of seeds
23. Synthesis and deposition of starch, fat and storage protein
24. Changes in the growth regulators of developing seeds composition and location
25. Changes in the physiological and biochemical characters during seed development
26. Maturity indices in agricultural crops
27. Maturity indices in horticultural crops
28. Influence of season, climate and nutrition on seed development and maturation in different kinds of seeds
29. Apomixis identification and classification
30. Significance and its utilization in different crops for hybrid seed production
31. Polyembryony types and significance
32. Influence of haplontic and diplontic sterility on hybrid production
33. Causes of embryo abortion and embryo rescue in hybrid production
34. Synthetic seeds– achievements

Practical schedule

1. Study of flower and fruit types
2. Floral biology of agricultural crops – monocots and dicots
3. Floral biology of horticultural crops – monocots and dicots
4. Microsporogenesis and megasporogenesis
5. Study of gametogenesis and pollen grains
6. Pollen morphology in monocot and dicot
7. Pollen viability testing
8. Physiological and Harvestable Maturity of various agricultural and horticultural crops

9. Chemical analysis of Carbohydrate, Fat and amino acids in various seeds
10. Influence of seed polymorphism on seed quality
11. Types of embryo in monocot
12. Types of embryo in dicot
13. External and internal structure of monocot
14. External and internal structure of dicot
15. Seed development and maturation study of monocot and dicot
16. Preparation of seed album and identification
17. Final practical examination

References

1. Bewley, J.D., Bradford, K., Hilhorst, H., Nonogaki, H., 2013. Physiology of Development, Germination and Dormancy, 3rd Edition. Springer-Verlag New York
2. Brian A. Larkins and Indra K. Vasil, 2012, Cellular and Molecular Biology of Plant Seed Development, Springer Netherlands
3. Bhojwani, S.S. & Bhatnagar, S.P. 1999. The embryology of Angiosperm. Vikas Publishing House, New Delhi.
4. Black M, Bewley D & Halmer, P. 2006. The encyclopedia of seeds: Science, Technology and uses. CABI, Wallingford, UK.
5. Chhabra, A.K. 2006. Practical Manual of floral biology of crop plants; Dept. of Plant Breeding, CCS HAU, Hisar.
6. Copeland, L.O. & McDonald, M.B. 2001. Principles of Seed Sciences and Technology. 4th Ed. Chapman & Hall, New York.
7. Frankel, R. & Galun, E. 1977. Pollination Mechanisms, Reproduction and Plant Breeding. Springer Verlag, New York.
8. Vanangamudi, K. 2014. Seed Science and Technology – An illustrated text book. New India Publishing Agency, New Delhi.

SST 612 PRINCIPLES OF SEED PRODUCTION (2+1)

Objective

- To introduce the basic principles of quality seed production
- To impart knowledge of seed quality control

Theory

Unit I - Introduction

Introduction: Seed as basic input in agriculture; seed development in cultivated plants; seed quality concepts and importance of genetic purity in seed production; types of cultivars, their maintenance and factors responsible for deterioration; seed production in self, cross and often cross pollinated crops.

Unit II - Principles

Mode of pollination and reproduction in crop plants and their modification in relation to hybrid seed production. Principles of hybrid seed production, isolation distance, synchronization of flowering, roguing etc. male sterility and incompatibility system in hybrid seed production, role of pollinators and their management.

Unit III - Seed production

Seed multiplication ratio-seed replacement rate, demand and supply; suitable areas of seed production and storage, agronomy of seed production- agro climatic requirements and their influence on quality seed production; generation system of seed multiplication; maintenance of nucleus seed, production of breeder, foundation and certified seed – criteria involved; life span of a variety and causes for its deterioration; certification standards for self, cross and often cross pollinated and vegetatively propagated crops.

Unit IV - Hybrid seed production

Hybrid seed – methods of development ; use of male sterility, self-incompatibility and CHA in hybrid seed production; one, two and three line system; maintenance of parental lines of hybrids; planning and management of hybrid seed production technology of major field crops and vegetables.

Unit V - Seed quality control

Planning of seed production for different classes of seeds for self, cross and often cross pollinated crops, seed quality control system and organization, seed village concept; seed production agencies, seed industry and custom seed production in India

Practicals

Identification of seeds- plants- characteristics of varieties –hybrids- seed multiplication ratios- seed replacement rate- demand and supply forecast- methods of nucleus and breeder seed production-identification of rogues and off types-pollen management – rogueing techniques-planning for seed production in varieties and hybrids-cost benefit ratio- visit to seed production area- seed processing unit-seed production agencies- seed village concept.

Theory schedule

1. Seed basic input in agriculture- seed development and maturation in cultivated plants
2. Importance and characteristics of quality seed
3. Differences between seed and grain, seed production and crop production
4. Difference between angiospermic seed and gymnospermic seed – importance of quality seeds
5. Different types of cultivars and their maintenance
6. Varietal deterioration their maintenance- factors responsible for deterioration
7. Maintenance of genetic purity in seed production
8. Methods of seed production in self- pollinated crops
9. Methods of seed production in cross and often cross pollinated crops
10. Pollination and reproduction techniques and their modifications in relation to hybrid seed production
11. Principles of hybrid seed production- isolation distance-synchronization of flowering, rogueing etc.
12. Male sterility and self incompatibility in hybrid seed production
13. Role of pollinators and their management
14. Seed multiplication ratio and seed replacement rate

15. Seed demand and seed forecasting
16. Selection of suitable area for seed production and storage.
17. Mid-semester examination
18. Agronomy of seed production- agro-climatic requirements and their influence on quality seed production
19. Generation system of seed multiplication- maintenance of nucleus and breeder seed
20. Criteria for foundation and certified seed production
21. Life span of variety, seed deterioration – factors causing seed deterioration
22. Certification standards for self, cross and vegetatively propagated crops
23. Hybrid seeds – methods and developments
24. Different sex forms and hybrid seed production
25. Transgenic male sterility
26. Harvest indices for agricultural and horticultural crops
27. Seed harvesting and threshing techniques
28. Supplementary pollination and pollen management in seed production
29. Planning of seed production for varieties
30. Planning of seed production for hybrids
31. Seed quality control system and organizations
32. Seed village concept
33. Seed production agencies and seed industry in India
34. Custom seed production in India

Practical Schedule

1. & 2. Identification of seed characteristics of agricultural crops
3. & 4. Identification of morphological features of horticultural crops
5. Visit to breeder seed production unit
6. & 7. Planting design and identification of rogues and off types in varieties and hybrids of agricultural crops
8. Study of supplementary pollination and pollen management techniques in seed production.
9. Hybrid seed production techniques in agricultural crops.
10. Study of physiological maturity indices for crops
11. Influence of grading techniques on seed quality characters.
12. Planning seed production for different classes of seeds in varieties of agricultural crops
13. Planning seed production for different classes of seeds in hybrids of agricultural crops
14. Cost benefit ratio for seed production
15. Visit to seed production field and processing unit
16. Visit to private seed industry
17. Final practical examination

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1. Agarwal, R.L. 1997. Seed Technology. 2nd Ed. Oxford & IBH, New Delhi.

2. Chhabra, A.K. 2006. Practical Manual of Floral Biology of Crop Plants. Dept. of Plant Breeding, CCS HAU, Hisar.
3. Desai, B.B. 2004. Seeds Handbook. Marcel Dekker, New York.
4. McDonald, M.B. & Copeland, L.O. 1997. Seed Production: Principles and Practices. Chapman & Hall, New York.
5. Poehlman, L.M. & Sleper, D.A. 2006. Breeding of Field Crops. Blackwell Publishing, Ames, IA, USA.
6. Singh, B.D. 2005. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
7. Singhal, N.C. 2003. Hybrid Seed Production in Field Crops. Kalyani Publishers, New Delhi.
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9. Tunwar, N.S. & Singh, S.V. 1985. Handbook of Cultivars. CSCB, GOI. New Delhi.
10. Bhaskaran, M., A. Bharathi, K. Vanangamudi, N. Natarajan, P. Natesan, R. Jerlin and K. Prabhakar. 2003. Principles of seed production, Kaisher Graphier, Coimbatore.

SST 613 SEED PHYSIOLOGY (1+1)

Objective

- To provide an insight into physiological processes regarding seed germination, dormancy and physiological processes governing seed quality and its survival.

Theory

Unit I - Introduction

Introduction, importance of seeds, seed structure and function, chemical composition of seed, seed development and maturation – physiological aspects; hormonal regulation of seed development, desiccation tolerance and sensitivity in relation to seed longevity, LEA protein.

Unit II - Physiology of germination

Seed germination; factors affecting germination; role of embryonic axis; growth hormones and enzyme activities, effect of age, size and position of seed on germination. Physiological processes during seed germination; seed respiration, breakdown of stored reserves in seeds, mobilization and interconversion pathways. Physiological aspects and control of germination and dormancy.

Unit III - Physiology of dormancy

Seed dormancy- types, significance, mechanism, endogenous and exogenous factors regulating dormancy, role of phytochrome and PGR, genetic control of dormancy

Unit IV - Physiology of seed deterioration

Seed viability and longevity, pre and post-harvest factors affecting seed viability; physiology of seed deterioration; biochemical of seed deterioration; means to prolong seed viability; seed viability and its evaluation.

Unit V - Seed vigour

Seed vigour and its concept, vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield.

Practical

Proximate analysis of chemical composition of seed; methods of testing viability; Kinetics of seed imbibitions and solute leakage; seed germination and dormancy breaking methods; Seed invigoration and priming treatments and its physiological basis; accelerated ageing and controlled deterioration tests; enzymatic activities and respiration during germination; effect of accelerated ageing; prediction of seed dormancy using mathematical models, seed respiration, vigour testing methods etc.

Theory Schedule

1. Introduction, importance of seeds, seed structure and function
2. Chemical composition of seed, seed development and maturation – physiological aspects
3. Hormonal regulation of seed development, desiccation tolerance and sensitivity in relation to seed longevity, LEA protein
4. Seed germination; factors affecting germination; role of embryonic axis related to seed germination.
5. Growth hormones and enzyme activities related to seed germination
6. Physiological processes during seed germination; seed respiration, breakdown of stored reserves in seeds, mobilization and interconversion pathways
7. Sugar and abscisic acid regulation of germination and transition to seedling growth
8. Physiological aspects and control of germination and dormancy
9. Mid- Semester Examination
10. Seed dormancy- types, significance, mechanism, endogenous and exogenous factors regulating dormancy
11. Role of phytochrome and PGR, genetic control of dormancy
12. Seed viability and longevity
13. Post-harvest factors affecting seed viability
14. Physiology and biochemical aspects of seed deterioration; means to prolong seed viability
15. Seed viability and its evaluation
16. Seed vigour and its concept, vigour test methods
17. Factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield

Practical Schedule

1. Proximate analysis of chemical composition of seed
2. Methods of testing viability
3. Kinetics of seed imbibitions and solute leakage
4. Effect of different enzymes on physiology of seed germination
5. Role of plant growth hormone on physiology of seed germination
6. Dormancy breaking methods
7. Effect of age, size and position of seed on germination
8. Prediction of seed dormancy using mathematical models
9. Seed invigoration treatment on seed germination and its physiological basis
10. Priming treatments on seed germination and its physiological basis

11. Accelerated ageing test
12. Controlled deterioration tests
13. Enzymatic activities and respiration during germination
14. Effect of accelerated ageing on seed viability
15. Seed respiration
16. Vigour testing methods
17. Practical Examination

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2. Baskin CC & Baskin JM. 1998. *Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination*. Academic Press.
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12. Murray DR. 1984. *Seed Physiology*. Vols. I, II. Academic Press.
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SST 621 SEED PRODUCTION IN FIELD & HORTICULTURAL CROPS (2+1)

Objectives

- To impart knowledge of basic principles involved in seed production
- To impart comprehensive knowledge of seed production in field crops with adequate practical training.

Theory

Unit I - Principles of seed production

Basic principles in seed production and importance of quality seed. Floral structure, breeding and pollination mechanism in self-pollinated cereals and millets

viz., wheat, barley, paddy & ragi. Methods and techniques of quality seed production in self-pollinated cereals and millets.

Unit II - Floral biology and harvesting mechanism of cereals

Floral structure, breeding and pollination mechanism in cross-pollinated cereals and millets viz., maize, sorghum and bajra; Methods and techniques of quality seed production in cross-pollinated cereals and millets.

Unit III - Floral biology and harvesting mechanism of pulses & oil seeds

Floral structure, breeding and pollination mechanism in Pulses viz., pigeon pea, chick pea, green gram, black gram, field beans and peas ; Methods and techniques of seed production in pulses, groundnut, castor, sunflower and sesame.

Unit IV - Floral biology and harvesting mechanism of oil seeds

Floral structure, breeding and pollination mechanism in oil seeds viz., groundnut, castor, sunflower, safflower, rape and mustard, linseed and sesame ; Methods and techniques of seed production in major oil seeds.

Unit V - Floral biology and harvesting mechanism of horticultural crops

Floral structure, breeding and pollination mechanism in tomato, bhendi, brinjal, chilies, cucurbits and flower crops

Practical

Planning of seed Production, requirements for different classes of seeds in field crops - unit area and rate; Seed production in cross pollinated crops with special reference to land, isolation, planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; supplementary pollination, pollen storage, hand emasculation and pollination in Cotton, detasseling in maize, identification of rogues and pollen shedders; Pollen collection, storage, viability and stigma receptivity; gametocide application and visits to seed production plots etc.

Theory Schedule

1. Basic principles in seed production
2. Importance of quality seed and its production.
3. Floral structure, breeding and pollination mechanism in cereals and pulses.
4. Methods and techniques of quality seed production in Wheat.
5. Methods and techniques of quality seed production in self-pollinated crop-Paddy.
6. Methods and techniques of quality seed production in self-pollinated crop-Barley.
7. Methods and techniques of quality seed production in self-pollinated crop-Ragi.
8. Floral structure, breeding and pollination mechanism in cross-pollinated crops.
9. Methods and techniques of quality seed production in cross-pollinated crop -Maize
10. Methods and techniques of quality seed production in cross-pollinated crop -Sorghum
11. Methods and techniques of quality seed production in cross-pollinated crop -Bajra.

12. Floral structure, breeding and pollination mechanism in Pulses.
13. Seed production and harvesting techniques in pigeonpea.
14. Seed production and harvesting techniques in chickpea
15. Seed production and harvesting techniques in greengram
16. Seed production and harvesting techniques in blackgram
17. Mid semester examination
18. Seed production and harvesting techniques in fieldbean
19. Seed production and harvesting techniques in peas
20. Seed production and harvesting techniques in soyabean.
21. Seed production and harvesting techniques in cowpea
22. Floral structure, breeding and pollination mechanism in oilseeds.
23. Seed production and harvesting techniques in groundnut.
24. Seed production and harvesting techniques in castor.
25. Seed production and harvesting techniques in sunflower
26. Seed production and harvesting techniques in sesame.
27. Seed production and harvesting techniques in cotton
28. Seed production and harvesting techniques in tomato and brinjal
29. Floral structure, breeding and pollination mechanism in bhendi and chilly
30. Methods and techniques of quality seed production in bitter gourd and ashgourd
31. Methods and techniques of quality seed production in cucumber and snake gourd.
32. Methods and techniques of quality seed production in watermelon
33. Methods and techniques of quality seed production in marigold and petunia.
34. Methods and techniques of quality seed production in turmeric and ginger.

Practical schedule

1. Planning of Seed Production in self pollinated cereals
2. Planning of Seed Production in cross pollinated cereals
3. Planning of Seed Production in pulses
4. Planning of Seed Production in oilseeds
5. Planning of Seed Production in fibres and sugars.
6. Seed production in self pollinated crops with special reference to land, isolation, planting ratio of male and female lines.
7. Seed production in cross pollinated crops with special reference to land, isolation, planting ratio of male and female lines.
8. Synchronization of parental lines and methods to achieve synchrony for hybrid seed production in self pollinated crops
9. Synchronization of parental lines and methods to achieve synchrony for hybrid seed production in cross pollinated crops
10. Supplementary pollination.
11. Hand emasculation and pollination in Cotton
12. Detasseling in maize
13. Identification of rogues and pollen shedders

14. Pollen collection, storage, viability and stigma receptivity
15. Gametocide application for quality seed production
16. Visits to seed production plots
17. Practical Examination.

References

1. Agarwal, R.L. 1997. Seed Technology. 2nd Ed. Oxford & IBH, New Delhi.
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SST 622 SEED LEGISLATION AND CERTIFICATION (2+1)

Objective

- To apprise students with the legislative provisions and processes and the mechanisms of seed quality control.

Theory

Unit I - History of seed certification

Historical development of Seed Industry in India; Seed quality: concept and factors affecting seed quality during different stages of production, processing and handling; seed quality control- concept and objectives; Central seed certification board (CSCB).

Unit II - Seed legislation in India

Regulatory mechanisms of seed quality control- organizations involved in seed quality control programme; seed legislation and seed law enforcement as a mechanism of seed quality control; The Seeds Act (1966), Seed Rules (1968), Seed (Control) Order 1983; Essential Commodities Act (1955); Plants, Fruits and Seeds Order (1989); National Seed Development Policy (1988) and EXIM Policy regarding seeds, plant materials; New Seed Bill-2004. Introduction, objectives and relevance of plant quarantine, regulations and plant quarantine set up in India.

Unit III - Seed certification

Seed Certification- history, concept and objectives of seed certification; seed certification agency/organization and staff requirement; legal status and phases of seed certification; formulation, revision and publication of seed certification standards; Indian Minimum Seed Certification Standards (I.M.S.C.S.)- general and specific crop standards including GM varieties, field and seed standards; planning and management of seed certification programmes- eligibility of a variety for certification, area assessment, cropping history of the seed field, multiplication system based on limited generation concept, isolation and land requirements etc.

Unit IV - Seed testing

Field Inspection- principles, phases and procedures; reporting and evaluation of observations; pre and post-harvest control tests for genetic purity evaluation (grow-out tests); post harvest inspection and evaluation; seed sampling, testing,

labeling, sealing and grant of certificate; types and specifications for tags and labels; maintenance and issuance of certification records and reports; certification fee and other service charges; training and liaison with seed growers. OECD seed certification schemes.

Unit V - Seed law enforcement

Introduction to WTO and IPRs; Plant Variety Protection and its significance; UPOV and its role; DUS testing- principles and applications; essential features of PPV & FR Act, 2001 and related Acts.

Practical

General procedure of seed certification ; identification of weed and other crop seeds as per specific crops; field inspection at different stages of a crop and observations recorded on contaminants and reporting of results; inspection and sampling at harvesting/threshing, processing and after processing for seed law enforcement; testing physical purity, germination and moisture; specifications for tags and labels to be used for certification purpose; grow-out tests for pre and post-harvest quality control; visits to regulatory seed testing laboratory, including Plant quarantine lab and Seed Certification agency.

Theory Schedule

1. Historical development of Seed Industry in India & world
2. Seed quality: concept and factors affecting seed quality during different stages of production
3. Factors affecting seed quality during processing and handling
4. Seed quality control- concept and objectives
5. Central Seed Certification Board and its function
6. Regulatory mechanisms of seed quality control
7. Organizations involved in seed quality control programmes
8. The Seeds Act (1966) and Seed Rules (1968)
9. The Seed (Control) Order 1983 and Essential Commodities Act (1955)
10. The Plants, Fruits and Seeds Order (1989) and National Seed Development Policy (1988)
11. EXIM Policy regarding seeds, plant materials and New Seed Bill-2004 etc.
12. Introduction, objectives and relevance of plant quarantine.
13. Plant quarantine set up in India.
14. Seed Certification- history, concept and objectives of seed certification
15. Seed certification agency/organization and staff requirement
16. Legal status and phases of seed certification; formulation, revision and publication of seed certification standards
17. Mid semester examination
18. Indian Minimum Seed Certification Standards (I.M.S.C.S.)- general and specific crop standards including GM varieties,
19. Field and seed standards.
20. Eligibility of a variety for certification, area assessment, cropping history of the seed field, multiplication system based on limited generation concept
21. Isolation and land requirements for seed certification

22. Field Inspection- principles, phases and procedures
23. Pre and post-harvest control tests for genetic purity evaluation (grow-out tests)
24. Post harvest inspection and evaluation
25. Testing of seed sample
26. Maintenance and issuance of certification records and reports
27. Certification fee and other service charges for seed certification
28. Training and liaison with seed growers.
29. OECD seed certification schemes
30. Introduction to WTO and IPRs
31. Plant Variety Protection and its significance
32. UPOV and its role
33. DUS testing- principles and applications
34. Essential features of PPV & FR Act, 2001

Practical schedule

1. General procedure of seed certification
2. Field inspection at different stages of a crop and observations recorded on contaminants and reporting of results.
3. Preparation of Field Inspection report
4. Field counting procedure for different crops
5. Seed processing
6. Seed sampling, methods, equipments-mixing and dividing
7. Testing for seed physical purity,
8. Testing for seed germination and evaluation
9. Moisture test-equipments used and Methods
10. Seed vigour tests
11. Seed viability test
12. Grow-out tests
13. Varietal Identification-methods
14. Visits to seed testing laboratory
15. Visit to plant quarantine laboratory
16. Visit to seed certification agency.
17. Final Practical examination

References

1. Agarwal, R.L. 1997. Seed Technology. Oxford & IBH, New Delhi.
2. Anonymous, 1992. Legislation on Seeds. NSC Ltd., Department of Agriculture and Cooperation, Ministry of Agriculture, New Delhi.
3. Nema, N.P. 1986. Principles of Seed Certification and Testing. Allied Publishers, New Delhi.
4. Tunwar, N.S. & Singh, S.N. 1988. Indian Minimum Seed Certification Standards. CSCB, Ministry of Agriculture, New Delhi.

SST 623 SEED PROCESSING AND STORAGE (2+1)

Objective

- To impart knowledge on the principles and techniques of seed processing for quality up gradation.
- To provide understanding of the mechanism of seed ageing during storage, factors affecting it and its control and comprehensive knowledge about various storage methods.

Theory

Unit I - Seed Processing and Equipments

Introduction: Principles of seed processing; methods of seed drying including dehumidification and its impact on seed quality - Seed cleaning equipment and their functions: Preparing seed for processing; functions of scalper debearder, scarifier, huller, seed cleaner and grader - Screen cleaners, specific gravity separator, indented cylinder, velvet, spiral, disc separators, colour sorter, delinting machines.

Unit II - Seed processing plant

Mechanical injury, assembly line of processing and storage, receiving, elevating and conveying equipments - plant design and layout, requirements and economic feasibility of seed processing plant - Concept of seed ageing and deterioration, its causes, symptoms, mechanisms and related theories.

Unit III - Seed classification and storage

Life span of seeds of plant species; classification of seeds on the basis of storage behavior - orthodox and recalcitrant seeds; types of storage; kinds of seed storage - Factors affecting seed storability- biotic and abiotic and pre- and post-harvest factors affecting seed longevity- Thumb rules of seed storage; loss of viability in important agricultural and horticultural crops, viability equations and application of nomograph.

Unit IV - Seed longevity and its Maintenance

Maintenance of viability and vigour during storage – Relative humidity and equilibrium moisture content of seed; Seed treatments-methods of seed treatment, Packaging: principles, practices and materials; bagging and labeling - mid storage corrections and seed blending.etc.

Unit V - Seed storage methods

Storage methods and storage structures available in the country and their impact on short and long term storage - Storage methods and godown sanitation - Storage problems of recalcitrant seeds and their conservation-Cryo preservation – Storage of synthetic seed –vegetative propagated materials – storage pests identification and management – seed borne disease – detection and management

Practical

Operation and handling of mechanical drying equipments; effect of drying temperature and duration on seed germination and storability with particular reference to oil seeds; seed extraction methods; seed processing equipments; seed treating equipments; treatment and fumigation. visit to seed processing plant. To study the effect of storage environmental factors (RH, SMC and temperature) on seed longevity; to study the effect of packaging materials, seed on storability; prediction of storability and longevity of seed-lots standardization of accelerated ageing (AA) technique for assessing the seed storability of various crops; estimation

of carbohydrates, proteins, fats, enzyme activities, respiration rate and nucleic acids in fresh and aged seeds; use of eco-friendly products and amelioration techniques to enhance quality of stored seeds, visit to seed stores.

Theory Schedule

1. Introduction: Principles of seed processing.
2. Processing plant design and layout
3. Seed drying including dehumidification and its impact on seed quality.
4. Preparing seed for processing and Seed cleaning equipment and their functions
5. Functions of scalper debearder, scarifier and huller.
6. Functions of specific gravity separator, indented cylinder, velvet-spiral separator and magnetic separator.
7. Functions of disc separators, colour sorter, delinting machines
8. Seed blending concept
9. Mechanical injury and its detection techniques
10. Basic principles of processing and storage
11. Economic feasibility of seed processing plant
12. History and method of seed treatments
13. Special seed treatment techniques
14. Devices in seed treatment
15. Packaging, bagging and labeling of seed materials
16. Various seed classification on the basis of storage behavior and Life span of seeds of plant species.
17. Mid-semester examination
18. Factors affecting seed storability- biotic and abiotic factors affecting seed longevity.
19. Thumb rules on seed moisture and relative humidity with relation to seed storage
20. Loss of viability in important agricultural and horticultural crops
21. Viability equations and application of nomograph
22. Concept of seed ageing and deterioration its causes, symptoms, mechanisms and Various seed deterioration theory
23. Seed longevity and factors affecting seed longevity
24. Traditional seed storage techniques
25. Effect of drying temperature and duration on storability
26. Concepts and significance of moisture equilibrium
27. Methods to minimize the loss of seed vigour and viability, Factors influencing storage losses.
28. Effects of packaging materials, storage fungi and insects on seed longevity
29. Seed treatment and fumigation and storage environmental conditions on seed storability
30. Types of storage and kinds of seed storage (open, bulk, controlled, hermetic, germplasm, cryopreservation)

31. Storage methods- Types of storage structure and their impact on storage and godown sanitation
32. Storage problems of recalcitrant seeds and their conservation
33. Cryo preservation techniques and Storage of synthetic seed
34. Storage of vegetative propagated materials

Practical Schedule

1. Seed processing equipments and layout of seed processing for various crops.
2. Operation and handling of mechanical drying equipments
3. Seed extraction methods
4. Visit to seed processing plant
5. Seed blending
6. Classification of seeds based on their longevity
7. Effect of packaging materials on seed quality
8. Standardization and Prediction of storability by accelerated ageing and controlled deterioration tests
9. Detection techniques for mechanical injury
10. Effect of mid storage correction on seed storability
11. Study of Seed treating equipments.
12. Effect of seed treatment and fumigation on seed storability
13. Estimation of carbohydrates, fats and proteins in fresh and aged seeds
14. Use of eco-friendly products to enhance quality of stored seeds
15. Use of amelioration techniques to enhance and mid storage correction of stored seeds.
16. Visit to seed stores / warehouse
17. Final Practical examination.

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3. Doijiode, S.D, 2014. Storage of Horticultural crops, CRC Press, India
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5. Barton, L.V. 1985. Seed Preservation and Longevity. International Books and Periodicals Supply Service, New Delhi.
6. Hall, C.W. 1966. Drying of Farm Crops. Lyall Book Depot, Ludhiana, Punjab, India.
7. Justice, O.L. & Bass, L.N. 1978. Principles and Practices of Seed Storage. Castle House Publications. Ltd, UK.
8. Sahay, K.M. & Singh, K. K. 1991. Unit Operations in Food Engineering. Vikas Publisher, New Delhi.
9. Viridi, S.S. & Gregg, B.G. 1970. Principles of Seed Processing. National Seed Corporation, New Delhi.

SST 624 SEED QUALITY TESTING (2+1)**Objective**

- To provide a comprehensive knowledge on all aspects of seed quality evaluation and their relevance to crop performance.

Theory**Unit I - History of Seed Testing**

Introduction: Structure of monocot and dicot seeds; seed quality: objectives, concepts and components and their role in seed quality control; Instruments, devices and tools used in seed testing. ISTA and its role in seed testing. Seed Sampling: definition, objectives, seed-lot and its size; types of samples; sampling devices; procedure of seed sampling; sampling intensity; methods of preparing composite and submitted samples; sub-sampling techniques, despatch, receipt and registration of submitted sample in the laboratory, sampling in the seed testing laboratory.

Unit II - Testing for purity and Moisture

Physical Purity: definition, objectives and procedure, weight of working samples for physical purity analysis; components of purity analysis and their definitions and criteria; pure seed definitions, applicable to specific genera and families; multiple seed units; general procedure of purity analysis; calculation and reporting of results, prescribed seed purity standards; determination of huskless seeds; determination of weed seed and other crop seeds by number per kilogram; determination of other distinguishable varieties (ODV); determination of test weight and application of heterogeneity test. Seed moisture content: importance of moisture content; equilibrium moisture content; principles and methods of moisture estimation - types, instruments and devices used; pre-drying and grinding requirements, procedural steps in moisture estimation; calculation and reporting of results.

Unit III - Germination, Vigour and Viability testing

Germination: importance; definitions; requirements for germination, instruments and substrata required; principle and methods of seed germination testing; working sample and choice of method; general procedure for each type of method; duration of test; seedling evaluation; calculation and reporting of results; dormancy: definition, importance, causal mechanisms, types and methods for breaking dormancy. Viability and Vigour Testing: definition and importance of viability tests; different viability tests; quick viability test (TZ- test) - advantages, principles, preparation of seeds and solutions, procedure, evaluation and calculation of test results. Vigour testing: concept, historical development, definitions, principles and procedures of different methods used for testing vigour.

Unit IV - Test for Genetic purity and Seed health

Genetic purity testing : objective and criteria for genetic purity testing; types of test; laboratory, growth chamber and field testing based on seed, seedling and mature plant morphology; principles and procedures of chemical, biochemical and molecular tests. Seed health Testing: field and seed standards ; designated diseases, objectionable weeds - significance of seed borne disease vis-a-vis seed

quality - seed health testing and detection methods for seed borne fungi, bacteria, viruses and nematodes.

Unit V - Storage of Seed sample

Testing of GM seeds and trait purity, load of detection (LOD). preparation and despatch of seed testing reports; storage of guard samples; application and use of seed standards and tolerances.

Practical

Structure of monocot and dicot seeds of important plant species; identification and handling of instruments used in seed testing laboratory; identification of seeds of weeds and crops; physical purity analysis of samples of different crops; estimation of seed moisture content (oven method); seed dormancy breaking methods, requirements for conducting germination test, specifications and proper use of different substrata for germination; seed germination testing in different agricultural crops; seedling evaluation; normal and abnormal seedling, viability testing by tetrazolium test in different crops; seed and seedling vigour tests applicable in various crops; species & cultivar identification; genetic purity testing by chemical, biochemical and molecular methods; seed health testing for designated diseases, blotter methods, agar method and embryo count methods; testing coated/pelleted seeds.

Theory Schedule

1. Seed quality: objectives, concepts and components
2. National and International agencies involved in seed testing
3. Instruments, devices and tools used in seed testing
4. ISTA and its role in seed testing.
5. Seed Sampling: definition, objectives and procedure
6. Physical Purity: definition, objective and procedure of purity analysis
7. Heterogeneity test
8. Seed moisture content: importance, principles and methods of moisture estimation, Instruments and devices used for moisture estimation calculation and reporting of results
9. Testing of coated seeds
10. Germination: importance; definitions; types - requirements for germination,
11. Methods of seed germination testing
12. Seedling evaluation, calculation and reporting of results
13. Determination of huskless seeds, weed seeds and other crop seeds
14. Determination of other distinguishable varieties (ODV)
15. & 16. Determination of test weight for different agri and horti crops
17. Mid Semester examination
18. Dormancy: definition, importance, causal mechanisms, types
19. Methods for breaking dormancy.
20. Definition and importance of viability tests; different viability tests
21. Quick viability test (TZ- test) - advantages, principle.
22. Vigour testing: concept, historical development, definitions

23. Procedures of different methods used for testing vigour.
24. Genetic purity testing : objective, types of test
25. Principles and procedures of chemical, biochemical and molecular tests
26. Modern varietal identification techniques
27. Seed health Testing: field and seed standards
28. Significance of seed borne disease vis-a-vis seed quality
29. Seed health testing and detection methods for seed borne fungi and bacteria.
30. Seed health testing and detection methods for viruses and nematodes.
31. Testing of GM seeds and trait purity, load of detection (LOD)
32. Preparation and despatch of seed testing reports
33. Storage of guard samples
34. Application and use of seed standards and tolerances

Practical Schedule

1. Physical purity analysis of samples of different crops
2. Estimation of seed moisture content (oven method)
3. Seed dormancy breaking methods
4. Requirements for conducting germination test, specifications and proper use of different substrata for germination
5. Seed germination testing in different agricultural crops
6. Seed germination testing in different horticultural crops
7. Seedling evaluation in agricultural crops
8. Seedling evaluation in horticultural crops
9. Viability testing by tetrazolium test in different crops
10. Seed vigour tests
11. Grow out test
12. Genetic purity testing by chemical, biochemical and molecular methods
13. Varietal identification through electrophoresis
14. Seed health testing for designated diseases, blotter methods, agar method and embryo count methods
15. Testing coated/pelleted seeds.
16. Visit to Seed Testing laboratory
17. Final Practical examination

References

1. Agarwal, R.L. 1997. Seed Technology. Oxford & IBH, New Delhi.
2. Agrawal, P.K. & Dadlani, M. 1992. Techniques in Seed Science and Technology. 2nd Ed. South Asian Publishers, New Delhi.
3. Agrawal, P.K. (Ed.). 1993. Handbook of Seed Testing. Ministry of Agriculture, GOI, New Delhi.
4. Copland, L.O. & McDonald, M.B. 1996. Principles of Seed Science and Technology. Kluwer Academic Publishers, New York.
5. ISTA, 2006. Seed Testing Manual. ISTA, Switzerland.
6. Martin, C. & Barkley, D. 1961. Seed Identification Manual. Oxford & IBH, New Delhi.

7. Tunwar, N.S. & Singh, S.V. 1988. Indian Minimum Seed Certification Standards. Central Seed Certification Board, Ministry of Agriculture, New Delhi.

OPC-SST 711 SEED PRODUCTION TECHNIQUES IN CROPS (2+1)

Objective

- To introduce the basic principles of quality seed production

Theory

Unit I - Introduction

Introduction: Seed as basic input in agriculture; Seed multiplication ratios- seed replacement rate, generation system of seed multiplication; variety and causes for its deterioration;

Unit II - Principles

Mode of pollination and reproduction in crop plants and their modification in relation to hybrid seed production. Principles of hybrid seed production, isolation distance, synchronization of flowering, roguing etc. male sterility and incompatibility system in hybrid seed production, role of pollinators and their management.

Unit III - Classes of seeds and their production techniques

Seed multiplication ratio- seed replacement rate, demand and supply; suitable areas of seed production and storage, agronomy of seed production- agro climatic requirements and their influence on quality seed production; generation system of seed multiplication; maintenance of nucleus seed, production of breeder, foundation and certified seed – criteria involved; life span of a variety and causes for its deterioration; certification standards for self, cross and often cross pollinated and vegetatively propagated crops.

Unit IV - Hybrid seed production

Hybrid seed – methods of development ; use of male sterility, self-incompatibility and CHA in hybrid seed production; one, two and three line system; maintenance of parental lines of hybrids; planning and management of hybrid seed production technology of major field crops

Unit V - Seed quality control

Planning of seed production for different classes of seeds for self, cross and often cross pollinated crops, seed quality control system and organization, seed village concept; seed production agencies, seed industry and custom seed production in India

Theory schedule

1. Seed basic input in agriculture
2. Importance and characteristic of quality seed
3. Different types of cultivars and their maintenance
4. Difference between seed and grain, seed production and crop production
5. Varietal deterioration their maintenance- factors responsible for deterioration
6. Maintenance of genetic purity in seed production
7. Pollination and reproduction techniques and their modifications in relation to hybrid seed production

8. Principles of hybrid seed production- isolation distance-synchronization of flowering, rogueing etc.
9. Seed multiplication ratios and seed replacement rate
10. Agronomy of seed production- agro-climatic requirements and their influence on quality seed production
11. Generation system of seed multiplication- maintenance of nucleus and breeder seed
12. Floral structure, breeding and pollination mechanism in cross-pollinated cereals and millets.
13. Methods and techniques of quality seed production in cross-pollinated crop –Rice
14. Methods and techniques of quality seed production in cross-pollinated crop -Maize
15. Methods and techniques of quality seed production in -Sorghum
16. Methods and techniques of quality seed production in–Bajra.
17. Mid semester examination
18. Methods and techniques of quality seed production in pigeonpea.
19. Methods and techniques of quality seed production in Chickpea
20. Methods and techniques of quality seed production in greengram
21. Methods and techniques of quality seed production in blackgram
22. Methods and techniques of quality seed production in soyabean.
23. Methods and techniques of quality seed production in cowpea
24. Floral structure, breeding and pollination mechanism in Oilseeds.
25. Methods and techniques of quality seed production in groundnut.
26. Methods and techniques of quality seed production in castor.
27. Methods and techniques of quality seed production in sunflower
28. Methods and techniques of quality seed production in sesame
29. Methods and techniques of quality seed production in cotton.
30. Methods and techniques of quality seed production in Sugarcane.
31. Seed quality control system and organizations
32. Genetic purity testing- GOT
33. Seed village concept
34. Seed production agencies, seed industry and customs in India

Practical Schedule

1. & 2. Identification of seed structure of agricultural crops
3. Visit to seed production unit
4. Hybrid seed production techniques in agricultural crops
5. Planting design and identification of rogues and off types in varieties and hybrids of agricultural crops
6. Study of supplementary pollination and pollen management techniques in agricultural crops.
7. Identification of physiological maturity for agricultural crops
8. Influence of grading techniques on seed quality characters.

9. Planning seed production for different classes of seeds in varieties of agricultural crops
10. Planning seed production for different classes of seeds in varieties of horticultural crops
11. Visit to seed production field and processing unit
12. Visit to private seed industry
13. Seed enhancement techniques
14. Detasseling in maize
15. Identification of rogues and pollen shedders
16. Gametocide application for hybrid seed production
17. Practical Examination.

References

1. Agarwal, R.L. 1997. Seed Technology. 2nd Ed. Oxford & IBH, New Delhi.
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3. Kelly, A.F. 1988. Seed Production of Agricultural Crops. John Wiley, New York.
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5. Singhal, N.C. 2003. Hybrid Seed Production in Field Crops. Kalyani Publishers, New Delhi.

OPC-SST 712 SEED QUALITY TESTING AND CERTIFICATION (2+1)

Objective

- To provide a comprehensive knowledge on all aspects of seed quality evaluation and their relevance to crop performance.

Theory

Unit I - History of Seed Testing

Introduction: Structure of monocot and dicot seeds; seed quality: objectives, concept and components and their role in seed quality control; Instruments, devices and tools used in seed testing. ISTA and its role in seed testing. Seed Sampling sampling in the seed testing laboratory.

Unit II - Testing for purity and Moisture

Physical Purity: definition, objective and procedure, weight of working samples for physical purity analysis; components of purity analysis and their definitions and criteria; pure seed definitions applicable to specific genera and families; multiple seed units; general procedure of purity analysis; calculation and reporting of results, prescribed seed purity standards; determination of huskless seeds

Unit III - Germination, Vigour and Viability testing Test for Genetic purity

Germination: importance; definitions; requirements for germination, instrument and substrata required; principle and methods of seed germination testing; dormancy: definition, importance, causal mechanisms, types and methods for breaking dormancy. Viability and Vigour Testing: definition and importance of viability tests; different viability tests; quick viability test (TZ- test) - advantages, principle, preparation of seeds and solutions, procedure, evaluation and calculation

of test results. Vigour testing: Genetic purity testing : objective and criteria for genetic purity testing; types of test; laboratory

Unit IV - Seed legislation in India

Seed legislation and seed law enforcement as a mechanism of seed quality control; The Seed Act (1966), Seed Rules (1968), Seed (Control) Order 1983; Essential Commodities Act (1955); Plants, Fruits and Seeds Order (1989); National Seed Development Policy (1988) and EXIM Policy regarding seeds, plant materials; New Seed Bill-2004. Introduction, objectives and relevance of plant quarantine, regulations and plant quarantine set up in India.

Unit V - Seed Certification aspects

Seed Certification- history, concept and objectives of seed certification; seed certification agency/organization and staff requirement; legal status and phases of seed certification; formulation, revision and publication of seed certification standards; Indian Minimum Seed Certification Standards (I.M.S.C.S.)- general and specific crop standards including

Theory Schedule

1. Seed quality: objectives, concept and components
2. Instruments, devices and tools used in seed testing
3. National and International agencies involved in seed testing
4. ISTA and its role in seed testing.
5. Seed Sampling: definition, objectives and procedure
6. Physical Purity analysis
7. Seed moisture content: importance, principles and methods of moisture estimation
8. Germination: importance; definitions; types - requirements for germination,
9. Methods of seed germination testing for agricultural crops
10. Methods of seed germination testing for horticultural crops
11. Seedling evaluation, calculation and reporting of results for agricultural crops
12. Seedling evaluation, calculation and reporting of results for horticultural crops
13. Dormancy: definition, importance, causal mechanisms, types
14. Methods for breaking dormancy.
15. Quick viability test (TZ- test) - advantages, principle.
16. Vigour testing: concept, historical development, definitions
17. Mid Semester examination
18. Procedures of different methods used for testing vigour.
19. Genetic purity testing : objective, types of test
20. Historical development of Seed Industry in India
21. Seed quality: concept and factors affecting seed quality during different stages of production
22. Seed quality control- concept and objectives
23. Central Seed Certification Board and its function
24. Organizations involved in seed quality control programmes
25. The Seed Act (1966) and Seed Rules (1968)
26. The Seed (Control) Order 1983 and Essential Commodities Act (1955)
27. EXIM Policy regarding seeds, plant materials and New Seed Bill-2004 etc.

28. Introduction, objectives and relevance of plant quarantine.
29. Seed Certification- history, concept and objectives of seed certification
30. Indian Minimum Seed Certification Standards (I.M.S.C.S.)- general and specific crop standards
31. Field Inspection- principles, phases and procedures
32. Pre and post-harvest control tests for genetic purity evaluation (grow-out tests)
33. Post harvest inspection and evaluation
34. Essential features of PPV & FR Act, 2001

Practical Schedule

1. Identification and handling of instruments used in seed testing laboratory
2. Seed sampling and sampling procedure
3. Physical purity analysis of samples of different crops
4. Estimation of seed moisture content (oven method)
5. Seed dormancy breaking methods
6. Seed germination testing in different agri-horticultural crops
7. Seedling evaluation
8. Viability testing by tetrazolium test in different crops
9. Seed vigour tests
10. Grow out test
11. Varietal identification through electrophoresis
12. Visit to Seed Testing laboratory
13. General procedure of seed certification
14. Field inspection at different stages of a crop and observations recorded on contaminants and reporting of results.
15. Field counting procedure for different crops
16. Preparation of Field Inspection report
17. Final Practical examination

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8. Agarwal, R.L. 1997. Seed Technology. Oxford & IBH, New Delhi.
9. Nema, N.P. 1986. Principles of Seed Certification and Testing. Allied Publishers, New Delhi.

**M.SC.(AG.) AGRICULTURAL BIOTECHNOLOGY
COURSE-WISE DISTRIBUTION**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	ABT 611	Principles of Biotechnology	2 + 1
2.	ABT 612	Fundamentals of Molecular Biology	2 + 1
3.	ABT 613	Techniques in Molecular Biology	2 + 1
4.	ABT 621	Molecular Cell Biology	2 + 1
5.	ABT 622	Plant Tissue Culture & Genetic Transformation	2 + 1
6.	ABT 623	Genomics & Proteomics	2 + 1
7.	ABT 624	Molecular Plant Breeding	2 + 0
		Total	14+6=20
Minor- 9 credits			
1.	OPC- GPB 621	Concepts of crop physiology	2+1
2.	OPC- ABT 711	Bio-Instrumentation	2+1
3.	OPC- ABT 712	Plant Tissue Culture	2+1
		Total	6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistical Methods and Design of Experiments	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
		Total	3+2=5
Seminar + Research - 21 credits			
1.	ABT -032	Seminar	0+1
2.	ABT -011; 021;031;041	Research 011-0+1; , 021-0+2; , 031- 0+8; , 041- 0+9	0+20
		Grand Total	22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0+1
4	PGS 624	Library and information services	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture	1+0
6	PGS 716 e-course	Disaster management	1+0
			2 + 4=6

**M.SC.(AG.) AGRICULTURAL BIOTECHNOLOGY
SEMESTER WISE DISTRIBUTION**

S.No.	Course No.	Courses	Credit Hours
FIRST SEMESTER			
1.	ABT 611	Principles of Biotechnology	2+1
2.	ABT 612	Fundamentals of Molecular Biology	2+1
3.	ABT 613	Techniques in Molecular Biology	2+1
4.	STA 611	Statistical methods and Designs of experiments	2+1
5.	COM 611	Computer Applications for Agri. Research	1+1
6.	ABT 011	Research	0+1
7.	PGS 611	Agriculture research ethics and methodology (0+1)	-
8.	PGS 612	Technical writing and communication skills (0+1)	-
		Total	9+6=15
SECOND SEMESTER			
1.	ABT 621	Molecular Cell Biology	2+1
2.	ABT 622	Plant Tissue Culture & Genetic Transformation	2+1
3.	ABT 623	Genomics & Proteomics	2+1
4.	ABT 624	Molecular Plant Breeding	2+0
5.	OPC GPB 621	Concepts of crop physiology	2 +1
6.	ABT 021	Research	0+2
7.	PGS 623	Basic concepts in laboratory techniques (0+1)	-
8.	PGS 624	Library and information services (0+1)	-
		Total	10+6=16
THIRD SEMESTER			
1.	OPC-XXX 711	Minor Course - Related discipline	2+1
2.	OPC-XXX 712	Minor Course - Related discipline	2+1
3.	ABT 032	Research	0+8
4.	ABT 031	Seminar	0+1
5.	PGS 715 e-course	Intellectual property and its management in agriculture (1+0)	-
6.	PGS 716 e-course	Disaster management (1+0)	-
		Total	4+11 =15
FOURTH SEMESTER			
1.	ABT 041	Research	0 + 9
		Total	0 + 9
		Grand Total	23+32 = 55

ABT 611 - PRINCIPLES OF BIOTECHNOLOGY (2+1)

Objective

- To familiarize the students with the fundamental principles of biotechnology, various developments and their applications and scope.

Theory

Unit I - DNA science

History, scope and importance of biotechnology - Nucleic acid structure and its function-Modes of DNA replication- Genetic code - Central dogma of life - Transcription - Translation.

Unit II - DNA technology

Recombinant DNA technology - DNA modifying enzymes - Cloning Vectors - Plasmids-cosmids-phagemids-Shuttle vectors-BAC-YAC-HAC-applications - Gene libraries - Genomic DNA and cDNA; Applications - Nucleic acid hybridization; Methods and Uses, Gene cloning and its applications in basic and applied research.

Unit III - Molecular markers & genome editing

Variants of PCR, Molecular markers-PCR and Restriction based markers-applications of molecular markers- DNA sequencing- Sanger-Gilbert techniques-Omics-Genomics- transcriptomics-proteomics and phenomics - Genome editing technologies - Meganucleases, ZFM, TALEN, CRISPR Cas9, MAGE - Applications and Limitations.

Unit IV - Gene transfer & M.A.S.

Gene transfer methods - *Agrobacterium* - mediated gene transfer, direct gene transfer, gene silencing - Principles of QTL and Marker Assisted Selection (MAS) - Achievements - Transgenic plants - Achievements - Current trends.

Unit V - IPR in biotechnology

Intellectual property rights (IPR) in biotechnology. Bio-safety and bioethics issues - Public perception of biotechnology - Application of biotechnology in Agriculture, Medicine, Animal husbandry, Environmental remediation, Energy production and Forensics.

Practical

Gel electrophoresis techniques-Restriction enzyme digestion, ligation, transformation and screening of transformants- PCR and molecular marker analysis-Plant tissue culture: media preparation, cell and explant culture-regeneration and transformation.

Theory schedule

1. History, scope and importance
2. Nucleic acid structure and its function
3. Modes of DNA replication
4. Central dogma of life ,
5. Genetic code & Transcription
6. Translation
7. DNA modifying enzymes
8. Cloning vectors
9. Artificial chromosomes as cloning vectors
10. Gene libraries
11. CDNA libraries
12. Nucleic acid hybridization

13. Plant cell and tissue culture techniques and their applications.
14. Molecular markers and their applications
15. PCR amplification and variants
16. DNA sequencing methods
17. Mid-semester examination
18. Applications of gene cloning in basic and applied research
19. Genetic engineering and transgenics; Genomics, Transcriptomics
20. Proteomics and Phenomics
21. Genome editing tools, applications and limitations.
22. Agro bacterium-mediated gene transfer
23. Direct gene transfer,
24. Introduction to QTL
25. MAS
26. Transgenic plants: insect resistance,
27. Genetic engineering for virus resistance,
28. Genetic engineering for to fungal / bacterial diseases,
29. Genetic engineering for longer shelf life
30. Intellectual property rights in biotechnology
31. General application of biotechnology in Agriculture
32. Public perception, Bio-safety and bioethics issues
33. Energy production and Forensics
34. Applications of biotechnology

Practical Schedule

1. Laboratory equipment handling and safety guidelines
2. Preparation of buffers, reagents and media etc
3. Isolation and characterization of genomic DNA for *E.coli*
4. Cutting of DNA and clean up of DNA for ligation
5. Demonstration of PCR
6. Analysis of amplified product
7. Minipreparation & digestion of plasmid DNA
8. Demonstration of DNA sequencing
9. Casting sequencing gel
10. Gel electrophoresis
11. Autoradiography
12. Agrobacterium-mediated gene transfer
13. Direct gene transfer
14. Demonstration of RFLP, RAPD and AFLP
15. Plant tissue culture media preparation
16. Micropropagation and its stages
17. Practical examination

References

1. Brown TA. Gene Cloning and DNA Analysis. 2006. 5th Ed. Blackwell Publishing.
2. Brown CM, Campbell I and Priest FG. 2005. Introduction to Biotechnology. Panima Publications

3. Bhojwani and Dantu, 2013. Plant tissue culture: An introductory text, Springer, New Delhi.
4. Chawla, H.S. 2008. Introduction to Plant Biotechnology, 3rd Ed. Oxford IBH, India.
5. Dale, J.W. and Von Schantz, M. 2002. From Genes to Genomes: Concepts and Applications of DNA Technology. John Wiley & Sons, New York, USA.
6. Nigel W. Scott, Mark R. Fowler and Adrian Slater. 2008. Plant Biotechnology: The genetic manipulation of Plants. 2nd Ed. Oxford University Press.
7. Singh BD. 2012. Biotechnology: Expanding Horizons, 4th Ed. Kalyani Publishers, New Delhi.

ABT 612 - FUNDAMENTALS OF MOLECULAR BIOLOGY (2+1)

Objectives

- To familiarize the student with basic structure and functions of macromolecules in a cell.
- To provide the students about the various cellular process mediated by the macromolecules

Unit I - Structure of DNA

Historical developments of molecular biology- its importance – central dogma of molecular biology – Constituents of a cell - Small Organic molecules – Chemistry and Structure - Carbohydrates, Lipids, Nucleic acids, Proteins - Nucleic acids as genetic material – DNA content – chemistry – Purines and Pyrimidines – nucleosides and nucleotides – structure of DNA and RNA – Primary, secondary and tertiary structure.

Unit II - DNA replication

Non-coding DNA sequence, Extra genic sequence, gene families – DNA Packaging – viral DNA, Bacterial DNA, Eukaryotic DNA, Chromatin organization- Organelle Genome – Mitochondrial genome, Chloroplast genome- DNA replication – features – replication in prokaryotes- initiation, elongation, maturation of Okazaki fragments – Replication in Eukaryotes – Termination and regulation of replication.

Unit III - Endonucleases and DNA modification

DNA modification enzymes – Polymerases, Ligases, Phosphatases, Polynucleotide kinases – DNA degrading enzymes – Nucleases – Endo and Exo nucleases, Restriction endonucleases – Types of DNA Damages and repair – Nucleotide excision repair, base excision repair, mismatch excision repair, double stand break repair – DNA recombination and events.

Unit IV - Transcription and post transcription changes

Transcription in Prokaryotes – Initiation, elongation, termination, regulation – Transcription in Eukaryotes – Promoters of polymerases, transcriptional factors, transcription activators, chromatin and transcription – Post transcriptional events – splicing, RNA editing, processing of mRNA at 3' end and 5' end – production of mature rRNA, tRNA -Translation and post-translational modifications - - Lac operon concept - trp operon.

Unit V - Protein synthesis

Protein synthesis in prokaryotes –Components of protein synthesis – Messenger RNA, transfer RNA, Ribosome – Mechanism – Initiation, elongation,

termination – Regulation of protein synthesis – global regulation, mRNA specific regulation – protein folding – protein modifications – glycosylation, attachment of lipids and glycolipids, protein phosphorylation – protein degradation – Lysosomal pathway, Ubiquitin-proteasome pathway.

Practical

Laboratory safety measure - extraction of proteins - quantification - Isoenzymes - SDS PAGE - Western blotting - Isoelectric focusing - Genomic DNA, total RNA, mRNA extraction - quality and quantity check - Northern blotting- Cell free system and protein synthesis.

Theory Schedule

1. Historical developments of molecular biology and its importance
2. Central dogma of molecular biology
3. Constituents of a cell
4. Small Organic molecules
5. Chemistry and Structure of Carbohydrates, Lipids, Nucleic acids, Proteins
6. Nucleic acids as genetic material
7. Structure of DNA and RNA and its properties
8. Non-coding DNA sequence, Extra genic sequence and gene families
9. DNA Packaging for viral DNA and Bacterial DNA
10. Eukaryotic DNA, Chromatin organization
11. Organelle Genome, Mitochondrial genome and Chloroplast genome
12. DNA replication
13. Features and replication in prokaryotes- initiation, elongation, maturation of Okazaki fragments
14. Features and Replication in Eukaryotes – Termination and regulation of replication.
15. DNA modification enzymes like Polymerases, Ligases, Phosphatases, Polynucleotide kinases
16. DNA degrading enzymes like Nucleases, Endo and Exo nucleases.
17. Mid-semester examination
18. Restriction endonucleases
19. Types of DNA Damages and repair
20. Nucleotide excision repair, base excision repair, mismatch excision repair, double stand break repair
21. DNA recombination and events.
22. Transcription in Prokaryotes, Initiation, elongation, termination, regulation
23. Transcription in Eukaryotes, Promoters of polymerases, transcriptional factors, transcription activators, chromatin and transcription
24. Post transcriptional events like splicing, RNA editing, processing of mRNA at 3'end and 5' end and production of mature rRNA, tRNA
25. Translation and post-translational modifications
26. Lac operon concept - trp operon, Protein synthesis in prokaryotes .
27. Components of protein synthesis

28. Messenger RNA, transfer RNA, Ribosome
29. Mechanism – Initiation, elongation, termination
30. Regulation of protein synthesis and global regulation, mRNA specific regulation
31. Protein folding and protein modifications
32. Glycosylation, attachment of lipids and glycolipids, protein phosphorylation
33. Protein degradation
34. Lysosomal pathway, Ubiquitin-proteasome pathway.

Practical Schedule

1. Laboratory safety guidelines.
2. Extraction of proteins.
3. Quantification by Lowry's and Bradford method.
4. Polyacrylamide gel electrophoresis - Isoenzymes.
5. Electrophoretic separation of proteins by SDS - PAGE.
6. Western blotting.
7. Isoelectric focusing - I.
8. Isoelectric focusing - II.
9. Extraction of DNA.
10. Quality and quantity check of the DNA.
11. Extraction of total RNA & Purification of RNA.
12. Northern blotting - I.
13. Northern blotting - II.
14. Cell- free system of protein synthesis - I.
15. Cell- free system of protein synthesis - II.
16. Electrophoresis, staining, destaining and documentation.
17. Final Practical Examination.

References

1. Benjamin Lewin. 2007. Genes IX. Jones and Bartlett publishers, Inc., 892p Brown, T. A. 2007.
2. Genome 3. Garland Science Publishing. 713p Malacinski, G.M. 2007. Essentials of Molecular
3. Biology (IV edn.) Jones and Bartlett Publishers, Inc., 491p Watson, J. D., T. A. Baker, S. P. Bell, A.
4. Gann, M. Levine, R. Losic. 2006. (V edn.) Molecular Biology of the Gene. Pearson Education. 732p.
5. Campbell, M. K., S. O. Farrel. 2007. Biochemistry. (V edn.) Baba Barkha Nath Printers. Delhi. 689p.

ABT 613 TECHNIQUES IN MOLECULAR BIOLOGY (2+1)

Objective

- To provide hands on training on basic molecular biology techniques
- To provide the knowledge of various technology in field of molecular biology

Unit I - Quantification of macro-molecules

Good lab practices-Preparation of buffers and reagents, Principle of centrifugation- analytical and preparative – Differential centrifugation-

Chromatographic techniques (TLC, Gel Filtration Chromatography, Ion exchange Chromatography, Affinity Chromatography). Electron microscopy-preparation of specimens-TEM and SEM-UV and spectrophotometric techniques

Unit II - Gel electrophoresis

Extraction of Nucleic acid-CTAB-Delaporta- Electrophoresis of nucleic acids-agarose gel electrophoresis, DNA sequencing gels, pulse field gel electrophoresis. Electrophoresis of proteins- SDS-PAGE-Native gels, gradient gels, isoelectric focusing, 2-D PAGE. Cellulose acetate electrophoresis, Detection, estimation and recovery of proteins in gels, Autoradiography.

Unit III - Molecular techniques

PCR- principle and applications-Primer designing-Modified PCR techniques-Reverse transcriptase PCR and Real time PCR. DNA Sequencing- chemical and enzymatic methods. Blotting techniques-Southern, Northern, Western and alternative blotting techniques. Preparation of probes. DNA fingerprinting.

Unit IV- Gene cloning

Recombinant DNA technology-YAC, BAC and cosmid library construction-Genomic and cDNA libraries-screening using heterologous and homologous probes - differential screening - expression library screening-functional complementation

Unit V - Immunological techniques

Dot blot analysis-ELISA- Immunoelectrophoresis, RIA, immunoblotting.

Practical

Centrifugation techniques- Chromatography-Electron microscopy-Electrophoresis of DNA and proteins-PCR- Primer designing-blotting techniques-DNA sequencing methods- DNA fingerprinting- YAC, BAC libraries- cDNA libraries-screening using heterologous and homologous probes - screening-functional complementation

Lecture schedule

Theory

1. Good lab practices
2. Preparation of buffers and reagents,
3. Principle of centrifugation
4. Analytical and preparative centrifugation
5. Principle involved in Chromatography
6. UV and Nano drop spectrophotometer
7. Electron microscopy-preparation of specimens-TEM and SEM.
8. Agarose gel electrophoresis
9. Electrophoresis of nucleic acids
10. DNA sequencing gels, pulse field gel electrophoresis.
11. Electrophoresis of proteins- SDS-PAGE.
12. Native gels, gradient gels, isoelectric focusing, 2-D PAGE.
13. Cellulose acetate electrophoresis.
14. Detection, estimation and recovery of proteins in gels,
15. Autoradiography
16. PCR- principle and applications.
17. Mid- semester examination

18. Primer designing
19. Modified PCR techniques
20. Reverse transcriptase PCR and Real time PCR
21. DNA Sequencing- chemical and enzymatic methods.
22. Blotting techniques: Southern
23. Northern blotting techniques
24. Western and alternative blotting techniques.
25. DNA fingerprinting.
26. Recombinant DNA technology
27. YAC and BAC library construction
28. Cosmid library construction
29. Genomic and cDNA libraries
30. Screening using heterologous and homologous probes
31. Differential screening
32. Expression library screening
33. Functional complementation
34. Immunoelectrophoresis., RIA, dot blot, Immunoblotting

Practical schedule

1. Preparation of stock solutions and reagents.
2. Extraction of plant genomic DNA by Dellaporta method.
3. Extraction of plant genomic DNA by CTAB method.
4. Centrifugation technique
5. Chromatography technique
6. UV- spectrophotometer
7. Restriction digestion of DNA.
8. Southern transfer, labelling of DNA, Southern hybridization.
9. Northern and western blotting procedure
10. Autoradiography.
11. Amplification of DNA with thermocycler with random primers.
12. Analysis of PCR products through agarose gel eletrophoresis and gel scanning.
13. Primer designing
14. DNA sequencing.
15. Genomic library construction
16. ELISA
17. Final Practical Examination.

Suggested Readings

1. Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA and Struhl K. 2002. Short Protocols in Molecular Biology. John Wiley, USA.
2. Sambrook J, Russell DW. 2001. Molecular Cloning: A laboratory manual, 3rd edition, Cold Spring Harbor Laboratory Press, New York.
3. Joseph Sambrook and David Russell. 2006. The Condensed Protocols From Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press, New York.

4. Old, R.W. and Primrose, S.B. 1989. Principles of gene manipulation. An introduction to genetic engineering, 4th edition, Blackwell Scientific Publications, Oxford, England.
5. Good man, R.N., Z.Kiraly and K.R. Wood. 1986. The Biochemistry and physiology of Plant Diseases, Univ. of Missouri Press, Columbia, M.O.

ABT 621 MOLECULAR CELL BIOLOGY (2+1)

Objective

- To familiarize the students with the cell biology at molecular level
- To enrich the students with genomic organization of organelles in the cell

Theory

Unit I - Cell structure & cell organelles

Cell theory, Structure of prokaryotic and eukaryotic cells- Similarities and distinction between plant and animal cells; Structure and function of major organelles: Nucleus, Chloroplasts, Mitochondria, Ribosomes, Lysosomes, Peroxisomes, Endoplasmic reticulum, Microbodies, Golgi apparatus, Vacuoles, etc.

Unit II - Cell physiology

Cell division and regulation of cell cycle; Membrane transport; Transport of water, ion and biomolecules; Diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of protein sorting and regulation of intracellular transport, cell communication and cell signaling ; cell junctions- gap junctions, extracellular matrix, integrins, actin filaments, actin-binding proteins, fibroin and muscle, Protein targeting.

Unit III - Genome organisation

Organization of bacterial genome-Plant genome-Choloroplast genome-mitochondrial genome-Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin Genome organization of *Arabidopsis thaliana*

Unit IV - Microbial genetics

Genome size and evolutionary complexity; Microbial genetics: plasmids, conjugation, transduction and transformation in bacteria. Bacteriophages-Lytic and lysogenic phases of phage, Genetic recombination and its molecular mechanism.

Unit V - Cell signaling in plants

Cellular responses to environmental signals in plants and animals: mechanisms of signal transduction (Rhizobium legume symbiosis, steroids, protein/peptides).

Practical

Microscopy - light, fluorescent, phase contrast - electron and scanning microscopes. Fractionation of tissues and cells - Methods of separating whole cells - Quantification of cells - Cellular micrometry - Microscopic preparations - fixatives, differential action of fixatives, pretreatment of specimen, staining procedures, microtomy. Mitosis and meiosis - identification stages.

Lecture Schedule

Theory

1. Cell theory
2. Structure of prokaryotic

3. structure of eukaryotic cells
4. Similarities and distinction between plant and animal cells
5. Structure and function of major organelles
6. Nucleus Chloroplasts, Mitochondria, Ribosomes
7. Lysosomes, Peroxisomes
8. Endoplasmic reticulum
9. Microbodies, Golgi apparatus, Vacuoles
10. Cell division
11. regulation of cell cycle
12. Membrane transport
13. Transport of water molecules-Aquaporin
14. Transport of ion
15. Transport of biomolecules
16. Diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of protein sorting and regulation of intracellular transport, cell communication and cell signaling
17. Mid Semester examinations
18. Cell junctions- gap junctions, extracellular matrix, integrins , actin filaments, actin-binding proteins, fibroin and muscle ; Protein targeting.
19. Organization of bacterial genome
20. Plant genome-Choloroplast genome
21. Plant genome-Mitochondrial genome
22. Genome organization of *Arabidopsis thaliana*
23. Structure of eukaryotic chromosomes
24. Role of nuclear matrix in chromosome organization and function
25. Matrix binding proteins
26. Heterochromatin and Euchromatin
27. Genome size and evolutionary complexity
28. Microbial genetics: plasmids, conjugation
29. transduction and transformation in bacteria
30. Bacteriophages and their genetic systems
31. Lytic and lysogenic phases of λ phage
32. Genetic recombination and its molecular mechanism
33. Cellular responses to environmental signals in plants
34. Mechanisms of signal transduction (Rhizobium legume symbiosis, steroids, protein/peptides).

Practical

1. Cell staining techniques
2. Microscopy: Bright field and dark field
3. Phase contrast Microscopy
4. Fluorescence Microscopy
5. Electron microscopy
6. Microtomy & Histochemical techniques
7. Demonstration of Mitosis

8. Demonstration of Meiosis
9. Bacterial conjugation,
10. Bacterial transduction and transformation,
11. Isolation of bacterial genome
12. Nuclear genome isolation
13. Chloroplast genome isolation
14. Mitochondrial genome isolation
15. Agarose gel electrophoresis
16. Gel-documentation –Autoradiography
17. Final practical examination

Suggested Readings

1. Gupta PK. 2003. Cell and Molecular Biology. 2nd Ed. Rastogi Publication, Meerut, UP, India
2. Benjamin Lewin, 2007. Gene IX, 9th Edition, Jones and Bartlett Publishers international, London.
3. Harvey Lodish, Arnold Beck, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Matthew P. Scott. 2012. Molecular Cell Biology, 7th edition, W. H. Freeman and Company, USA.
4. Watson JD, Hopkins NH, Roberts JW, Seitz JA and Weiner AM. 2007. Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, USA.
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. 2002. Molecular Biology of the Cell, 4th edition, Garland Science; New York, USA.
6. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D Watson. 2007. Molecular Biology of the Cell Fifth Edition. Garland Science New York

ABT 622 - PLANT TISSUE CULTURE AND GENETIC TRANSFORMATION (2+1)

Objective

- To familiarize the students and provide hands on training on various techniques of plant tissue culture.
- The students will learn how the genes can be cut and pasted from one organism to another and what are its implications

Theory

Unit I - Introduction to plant tissue culture

History of plant cell and tissue culture; Culture media-Laboratory organisation - sterile techniques - Nutrition of plant cells - Media composition- callus differentiation-Techniques in Micropropagation- stages- Organogenesis-somatic embryogenesis.

Unit II - Types of *in vitro* culture

Embryo rescue techniques-artificial seeds-Somatic hybridization: protoplast fusion, cybrids- Meristem and virus elimination –Haploid production & diploidization- Somaclonal variation- Secondary metabolites in cell suspension

culture-*In vitro* germplasm conservation- Application of plant cell culture in crop improvement.

Unit III - Plant genetic engineering

Plant transformation vectors and transgene design-Promoters and Marker genes-scorable and reporter genes- Plant transformation methods -Vector mediated methods of transformation-*Agrobacterium* biology and genetic engineering-Indirect gene transfer methods-Biolistic gun - protoplast mediated transformation - microinjection techniques- Organellar transformation - chromosome Engineering

Unit IV - Transgenics in crop improvement

Molecular pharming-Analysis of transgenic plants- Application of genetic engineering in crop improvement and crop productivity - resistance to disease - herbicides - stress conditions -quality characters - Plant genetic engineering - current status - problems and strategies for practical applications.

Unit V - Gene silencing and genome editing

Gene knockout technologies-Cas9-Cre-Lox recombination system- Genome editing using CRISPR -Terminator gene technology-Development of marker-free plants- Identification of gene integration site - Advance methods-cisgenesis, intragenesis.

Practical

PCR- Variation in PCR- RT - PCR - PCR - based analysis of transformants - Primer designing-Induction and analysis of crown gall tumour in intact plant - Isolation of Ti-Plasmid. Isolation of DNA and organelle DNA - *Agrobacterium* mediated transfer

Lecture Schedule

Theory

1. Laboratory organization-sterile techniques
2. Nutrition of plant cells-media composition.
3. Establishment and maintenance of calluses and suspension culture - cellular differentiation and regulation of morphogenesis.
4. Somatic embryogenesis - molecular aspects - control of organogenesis and embryogenesis - single cell methods - cytology of callus.
5. Haploid production : Androgenesis - anther and microspore culture.
6. Diplodization and double haploids
7. Gynogenesis - embryo culture and rescue in agricultural and horticultural crops.
8. *In vitro* pollination and fertilization.
9. Protoplast isolation - culture - regeneration.
10. Somatic hybrids - cybrids.
11. *In vitro* genetic conservation.
12. Somatic emryogenesis and artificial seeds.
13. Meristem culture and virus elimination - shoot tip culture.
14. Somaclonal variation in *in vitro* cultures
15. Secondary metabolites in cell culture - essential oils - scented varieties
16. Application of various techniques for crop improvement in agriculture, horticulture and forestry.

17. Mid semester examination
18. Methods of plant transformation
19. *Agrobacterium* biology and genetic engineering
20. Biolistic method - protoplast mediated transformation
21. Microinjection techniques
22. Terminator gene technology
23. Chromosome Engineering
24. organellar transformation
25. Molecular pharming
26. Genetic and molecular analyses of transgenics
27. Genetic engineering for resistance to insect, disease and herbicides
28. Genetic engineering for quality characters
29. Gene knockout technologies
30. Cas9-Cre-Lox recombination
31. Genome editing using CRISPR Cas9
32. Development of marker-free plants-
33. Identification of gene integration site
34. Advance methods-cisgenesis, intragenesis

Practical

1. Laboratory set-up.
2. Preparation of nutrient media; handling and sterilization of plant
3. Explant inoculation, subculturing and plant regeneration.
4. Anther and pollen culture.
5. Embryo rescue.
6. Suspension cultures and production of secondary metabolites.
7. Protoplast isolation, culture and fusion.
8. Gene cloning and vector construction.
9. Isolation of plasmids with reporter (*gus*) gene,
10. Preparation of microprojectiles, transformation using a particle gun, GUS staining.
11. Leaf disc transformation using *Agrobacterium*, establishment of transgenic plants, and
12. GUS staining or GFP viewing.
13. DNA extraction from transgenic plants, DNA estimation, PCR analysis,
14. Southern blot analysis to prove T-DNA integration,
15. RT-PCR to study transgene expression
16. Western blotting to study the accumulation of transgene-encoded protein.
17. Final Practical Examination.

Suggested Readings

1. Bhojwani SS. 1983. Plant Tissue Culture: Theory and Practice. Elsevier
2. Gamborg OL and. Philips GC. 1995. Plant Cell, Tissue and organ culture. Fundamental Methods, Narosa Publishing House, New Delhi.
3. Potrykus F and Spangenberg. 1995. Gene Transfer to Plants, Springer Verlag, Germany.

4. Brown T A. 2010. Gene Cloning and DNA Analysis: An Introduction, 6th Edition, Blackwell publications, USA.
5. Christou P & Klee H. 2004. Handbook of Plant Biotechnology. John Wiley & Sons.
6. Singh BD. 2007. Biotechnology: Expanding Horiozon. Kalyani.
7. Lewin's Genes XI 2012. Jones and Bartlett Learning, USA
8. U. Satyanarayana. Biotechnology, Book and allied (P), Ltd, 2013.

ABT 623 GENOMICS AND PROTEOMICS (2+1)

Objectives

- To familiarize the students with recent tools used for genome analysis and their applications and to provide knowledge on analysis of genome and proteome.

Theory

Unit I - Structural genomics

Structural genomics : Organization of genomes: main features of bacterial and eukaryotic genome organization – Gene library and mapping - Strategies for genome sequencing: Next Generation Sequencing, pyrosequencing, Illumina Sequencing, Sequence assembly - Clone contig and shotgun approaches. Model plant genome project and its applications. Locating the genes: ORF scanning, homology searches. Identification and classification using molecular markers - 16S rRNA typing/sequencing, EST's and SNP's.

Unit II - Functional genomics

Functional genomics: Determination of the functions of genes, candidate gene identification in crop plants, gene inactivation (knock-out, anti-sense and RNA interference) and gene over expression. Approaches to analyze global gene expression: transcriptome, Serial Analysis of Gene Expression (SAGE), Expressed Sequence Tags (ESTs), Massively Parallel Signature Sequencing (MPSS), microarray and its applications, gene tagging; Metagenomics.

Unit III - Proteomics

Proteomics – introduction, Expressional Proteomics, Functional Proteomics, Structural Proteomics-Techniques in Proteomics , Protein separation techniques - Strategies in protein identification, 2D Gel electrophoresis, Isoelectric Focusing (IEF). Mass spectrometry in proteomics – Principle, techniques (MALDI-TOF) and analysis, SAGE, applications. Protein- Protein interactions- experimental and computational- Differential display proteomics, Protein sequence analysis - N-terminal determination methods- Protein modification – Yeast two hybrid system.

Unit IV - Structural proteomics

Structural proteomics: protein structure determination, prediction and threading, software and data analysis/ management, etc. - DNA chips and their use in transcriptome analysis; Metabolomics and ionomics for elucidating metabolic pathways, etc. Application of metabolomics in elucidating metabolic pathways, metabolic pathways resources: KEGG, Biocarta etc., Nutrigenomics and metabolic health

Unit V - Proteome analysis and application

Protein Biomarker - Discovery and Validation – Emerging technologies: Microfluidics. Analysis of microarray data; Protein and peptide microarray-based

technology; PCR-directed protein *in situ* arrays; Applications of genomics and proteomics in agriculture, human health and Industry.

Practical

Isolation of genomic DNA and proteins- RAPD-RFLP-AFLP-SNPs-2-D electrophoresis of proteins; isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Theory schedule

1. Structural genomics
2. Organisation of genome
3. Genomic libraries and physical mapping of genomes
4. Strategies for genome sequencing
5. Clone contigs and Shotgun approaches
6. Plant genome projects; locating the genes
7. Identification and classification using molecular markers-16S rRNA typing/sequencing, EST's and SNP's
8. Functional genomics
9. Gene inactivation and over expression
10. SAGE, EST, MPSS
11. Microarray and applications
12. Gene tagging, Metagenomics
13. Proteomics, types
14. Protein separation techniques
15. Protein identification
16. Protein analysis (amino-acid composition, N-terminal sequencing);
17. Mid- semester examination
18. 2-D electrophoresis of proteins & Isoelectricfocusing
19. Peptide fingerprinting,
20. Mass spectroscopy, principles
21. LC/MS-MS for identification of proteins and modified proteins;
22. MALDI-TOF and SAGE
23. Differential display proteomics
24. Protein-protein interactions and N-terminal determination methods
25. Yeast two hybrid system.
26. Protein structure determination
27. DNA chips in transcriptome analysis
28. Metabolomics and ionomics
29. Elucidating metabolomic pathways
30. KEGG, Biocarta, Nurtigenomics
31. Protein biomarkers
32. Microfluidics
33. Analysis of microarray data
34. Applications of genomics and proteomics in agriculture, human health and Industry.

Practical schedule

1. Physical mapping of genome
2. Genetic mapping
3. Linkage mapping
4. Molecular mapping using RFLP
5. Molecular mapping using RAPD
6. Molecular mapping using AFLP
7. Molecular mapping using SNP
8. Gene prediction and annotation using database
9. Database for Comparative Genomics
10. DNA microarrays technology
11. DNA chips technology
12. Protein microarray
13. Peptide microarray
14. 2-D electrophoresis of proteins
15. LC/MS-MS for identification of proteins and modified proteins
16. MALDI-TOF and SAGE for protein-protein interaction
17. Practical examination

References

1. Campbell, A.M. and Heyer, L.J. 2007. Discovering Genomics, Proteomics and Bioinformatics, 2nd edition, Benjamin Cummings, UK.
2. Liebler, D.C. 2002. Introduction to Proteomics – Tools for the New Biologist, 1st Edition, Humana Press Inc, New Jersey, USA.
3. Orengo, C.A., Jones, D.T. and Thornton, J.M. 2003. Bioinformatics – Genes, Proteins and Computers, 1st Edition, BIOS Scientific Publishers Limited, Oxford, UK.
4. Primrose, S.B. and Twyman, R.M. 2003. Principles of Genome Analysis and Genomics, 3rd edition, Blackwell Publishing Company, Oxford, UK.
5. Twyman, R.M. Principles of Proteomics. BIOS Scientific Publisher, New York. 2004.
6. Dubitzky W., Granzow M., Berrar D.P. (2007) Fundamentals of Data Mining in Genomics and Proteomics. Springer Science- Business Media.
7. Lovric J. (2011) Introducing Proteomics: From concepts to sample separation, mass spectroscopy and data analysis. John Wiley and Sons Ltd.
8. Mine Y., Miyashita K., Shahidi F. (2009) Nutrigenomics and Proteomics in Health and Disease: Food Factors and Gene Interaction. Wiley Blackwell

ABT 624 MOLECULAR PLANT BREEDING (2+0)**Objectives**

- To familiarize the students about the use of molecular biology tools in plant breeding.
- To provide the knowledge of various recent advances in agriculture.

Unit I - Methods in plant breeding

Principles of plant breeding; Breeding methods for self and cross pollinated crops; Heterosis breeding; Limitations of conventional breeding; Aspects of molecular breeding.

Unit II - Molecular markers

Molecular markers – History of Molecular markers- Restriction based and PCR based; DNA profiling using different assays- RFLP, RAPD, AFLP, ISSR, SNP etc. Development of SCAR and SSR markers.

Unit III- QTL mappings

Linkage disequilibrium- Linkage mapping- QTL analysis- QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis; -Gene pyramiding; Transcript mapping techniques. Development of ESTs-AB-QTL analysis; Association mapping of QTL; Fine mapping of genes/QTL; Map based gene/QTL isolation and development of gene based markers; Allele mining by TILLING and Eco-TILLING

Unit IV- Marker Assisted Selection

Use of markers in plant breeding. Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS. Marker Assisted Selection (MAS), screening and validation; Marker assisted selection (MAS) in backcross and heterosis breeding- Mapping genes on specific chromosomes-Transgenic breeding; Foreground and background selection; MAS for gene introgression and pyramiding; MAS for specific traits with examples.

Unit V-Techniques in DNA analysis

Recent advances – Non gel based techniques for plant genotyping – Homogenous assays – Qualitative/Real Time assays; DNA Chip and its technology. Phenomics- Application of high-throughput phenotyping platforms in plant breeding

Theory schedule

1. Principles of plant breeding
2. Breeding methods for self and cross pollinated crops
3. Heterosis breeding
4. Limitations of conventional breeding
5. Aspects of molecular breeding.
6. Molecular markers
7. Restriction based and PCR based
8. DNA profiling using different assays
9. RFLP, RAPD ,AFLP
10. ISSR, SNP
11. Development of SCAR and SSR markers
12. Marker Assisted Selection (MAS)
13. Screening and validation
14. Marker assisted selection (MAS) in backcross
15. Marker assisted selection in heterosis breeding
16. Mapping genes on specific chromosomes
17. Mid semester examination
18. Transgenic breeding; Foreground and background selection;
19. MAS for gene introgression and pyramiding:
20. MAS for specific traits with examples.
21. Linkage disequilibrium

22. QTL mapping using structured populations
23. Gene pyramiding; Transcript mapping techniques.
24. Development of ESTs-AB-QTL analysis
25. Association mapping of QTL
26. Fine mapping of genes/QTL
27. Map based gene/QTL isolation and development of gene based markers;
28. Allele mining by TILLING and Eco-TILLING
29. Use of markers in plant breeding.
30. Non gel based techniques for plant genotyping
31. Homogenous assays
32. Qualitative/Real Time assays;
33. DNA Chip and its technology
34. high-throughput phenotyping platforms

References

1. Chittaranjan, K. 2006-07. Genome Mapping and Molecular Breeding in Plants. Vols. I-VII. Springer -Verlag, USA.
2. Henry, R.J. 2005. Plant Genotyping: The DNA fingerprinting of plants. CABI, New Delhi
3. Newbury, H.J. 2003. Plant Molecular Breeding. Blackwell Publication, Oxford, UK.
4. Weising K., Nybom, H., Wolff, K. and Kahl, G. 2005. DNA Fingerprinting in Plants: Principles, Methods and Applications. Taylor & Francis, London.
5. Nagata, T., Lorz, H. and Widholm, J. M. (2005) Molecular Marker Systems in Plant Breeding and Crop Improvement . Springer-Verlag Berlin, German
6. Kang, M. S. (2002) Quantitative Genetics, genomics, and Plant Breeding. CABI, USA.
7. Srivastava, P.S., Narula A., Srivastava Sh.(2005). Plant biotechnology and molecular markers . Anamaya Publishers, New Delhi, India
8. Kang MS. (2003). Handbook of Formulas and Software for Plant Geneticists and Breeders. Haworth Press Inc, New York, USA

OPC-ABT 711 BIO-INSTRUMENTATION (2+1)

Objective

- To provide hands on training on basic molecular biology techniques
- To provide the knowledge of various technology in field of molecular biology

Unit I - Spectroscopy & Microscopy

Spectroscopy-Principle, instrumentation and applications of UV – visible spectrophotometry and spectrofluorimetry-luminometry-Atomic spectroscopy-Microscopy- SEM and TEM.

Unit II - Centrifugation

Basic principles of sedimentation-Clinical Bench Centrifuges-High Speed Refrigerated Centrifuges-Continuous flow Centrifuges-Ultracentrifuges-Analytical ultracentrifuge -instrumentation and applications-Preparative ultracentrifuge

Unit III - Chromatography

Principle of chromatography-Types- Column Chromatography-Paper Chromatography-Thin Layer Chromatography-Gas Chromatography-High

Performance Liquid Chromatography-Affinity Chromatography-Ion-Exchange Chromatography

Unit IV - PCR and Electrohoresis

PCR-principles. RT-PCR. Real time PCR-DNA/RNA-Agarose gel electrophoresis-Principles-Protein electrophoresis-principles-SDS and Native PAGE, 2D-gel electrophoresis.

Unit V- Blotting techniques

Blotting techniques-Southern-Northern-Western. DNA sequencing techniques, Dot blot analysis-ELISA- Immunoelectrophoresis, RIA, immunoblotting

Practical

Centrifugation techniques - Chromatography - Electron microscopy - Electrophoresis of DNA and proteins-PCR-blotting techniques-DNA sequencing techniques.

Lecture schedule

Theory

1. Good lab practices
2. Preparation of buffers and reagents,
3. Principle of centrifugation
4. Analytical and preparative centrifugation
5. Principle involved in Chromatography
6. UV and Nano drop spectrophotometer
7. Ion exchange spectroscopy
8. Atomic absorption spectroscopy
9. Electron microscopy
10. TEM and SEM.
11. Agarose gel electrophoresis
12. Electrophoresis of proteins-principles
13. Native and SDS PAGE
14. Gradient gel
15. Isoelectric focusing
16. 2-D PAGE.
17. Mid- semester examination
18. Detection, estimation of proteins
19. Recovery of proteins in gels,
20. Autoradiography
21. PCR- principle and applications
22. Mid semester examination
23. Modified PCR techniques
24. Reverse transcriptase PCR
25. Real time PCR
26. DNA Sequencing
27. Chemical method
28. Enzymatic method
29. Blotting techniques: Southern
30. Northern blotting techniques

31. Western blotting techniques.
32. Immunoelectrophoresis
33. RIA
34. Dot blot technique and immunoblotting.

Practical schedule

1. Preparation of stock solutions and reagents.
2. Extraction of plant genomic DNA by Dellaporta method.
3. Extraction of plant genomic DNA by CTAB method.
4. Centrifugation technique
5. Chromatography technique
6. UV- spectrophotometer
7. Restriction digestion of DNA.
8. Southern transfer, labelling of DNA, Southern hybridization.
9. Northern and western blotting procedure
10. Autoradiography.
11. Amplification of DNA with thermocycler with random primers.
12. Analysis of PCR products through agarose gel electrophoresis and gel scanning.
13. Primer designing
14. DNA sequencing.
15. Genomic library construction
16. ELISA
17. Final Practical Examination

Suggested Readings

1. Wilson and Walker. A biologist's guide to principles and techniques of practical biochemistry. 5th ed. Cambridge University Press 2000.
2. Boyer, R. Modern Experimental Biochemistry. 3rd ed. Addison Wesley Longman, 2000.
3. Upadhyay, Upadhyay and Nath. Biophysical Chemistry Principles and Techniques. Himalaya Publ. 1997.
4. Simpson CFA & Whittaker, M. Electrophoretic techniques.
5. Sambrook. Molecular Cloning. Cold Spring Harbor Laboratory, 2001.
6. Friefelder and Friefelder. Physical Biochemistry – Applications to Biochemistry and Molecular Biology. WH Freeman & Co. 1994.
7. Pavia et al. Introduction to Spectroscopy. 3rd ed. Brooks/Cole Pub Co., 2000.

OPC-ABT 712 PLANT TISSUE CULTURE (2+1)

Objective

- To familiarize the students and provide hands on training on various techniques of plant tissue culture.
- The students will learn how the genes can be cut and pasted from one organism to another and what are its implications

Theory

Unit I - Basic principles

History of plant cell and tissue culture; Culture media- sterile techniques - Media in plant tissue culture-Plant Growth Regulators-Components of a Plant

Tissue Culture Medium-Explants-callus-totipotency-Basic concepts Plant tissue culture.

Unit II - Micropropagation method

Basic techniques in plant tissue culture-Techniques in Micropropagation-stages- Organogenesis-somatic embryogenesis-Virus free plants production

Unit III - In vitro culture techniques

Callus culture- Suspension culture- Single cell culture- Organ culture- Seed, embryo, endosperm, nucellus, shoot, root, leaf, anther and ovary. Protoplast culture-somatic hybridization-cybrids.

Unit IV - Haploids production

Embryo rescue techniques-artificial seeds-Haploid production & diploidization-Somaclonal variation- *In vitro* germplasm conservation- Application of plant cell culture in crop improvement.

Unit V - Genetic engineering

Plant transformation methods- *Agrobacterium*-Biolistic gun- Analysis of transgenic plants- Application of genetic engineering in crop improvement and crop productivity - resistance to disease – herbicides-quality characters.

Practical

PCR- Variation in PCR- RT - PCR - PCR - based analysis of transformants – Primer designing-Induction and analysis of crown gall tumour in intact plant - Isolation of Ti-Plasmid. Isolation of DNA and organelle DNA - *Agrobacterium* mediated transfer

Lecture Schedule

Theory

1. Laboratory organization-sterile techniques
2. Nutrition of plant cells-media composition.
3. History of plant cell and tissue culture
4. Culture media-Sterile techniques
5. Media in plant tissue culture
6. Plant Growth Regulators
7. Components of a Plant Tissue Culture Medium
8. Explants-callus-totipotency
9. Basic concepts Plant tissue culture.
10. Basic techniques in plant tissue culture
11. Micropropagation stages-Organogenesis-Somatic embryogenesis
12. Virus free plants production
13. Callus culture
14. Midterm examination
15. Suspension culture
16. Single cell culture.
17. Mid-semester examination
18. Organ culture
19. Seed, embryo,endosperm, nucellus
20. Shoot, root, leaf culture
21. Protoplast culture
22. Somatic hybridization-cybrids.

23. Embryo rescue techniques
24. Artificial seeds
25. Haploid production-diplodization
26. Somaclonal variation
27. *In vitro* germplasm conservation
28. Application of plant cell culture in crop improvement
29. Plant transformation methods
30. *Agrobacterium* mediated gene transfer
31. Biolistic gun
32. Genetic and molecular analyses of transgenics
33. Genetic engineering for resistance to insect pests
34. Genetic engineering for resistance to herbicides and quality characters.

Practical

1. Laboratory set-up.
2. Preparation of nutrient media; handling and sterilization of plant
3. Explant inoculation, subculturing and plant regeneration.
4. Anther and pollen culture.
5. Embryo rescue.
6. Suspension cultures and production of secondary metabolites.
7. Protoplast isolation, culture and fusion.
8. Preparation of microprojectiles, transformation using a particle gun, GUS staining.
9. Leaf disc transformation using *Agrobacterium*, establishment of transgenic plants, and
10. DNA extraction from transgenic plants, DNA estimation
11. Protein extraction
12. Agarose and PAGE electrophoresis
13. Southern blot analysis to prove T-DNA integration
14. PCR
15. RT-PCR to study transgene expression
16. Western blotting to study the accumulation of transgene-encoded protein.
17. Final Practical Examination.

Suggested Readings

1. Bhojwani SS. 1983. Plant Tissue Culture: Theory and Practice. Elsevier
2. Gamborg OL and. Philips GC. 1995. Plant Cell, Tissue and organ culture. Fundamental Methods, Narosa Publishing House, New Delhi.
3. Potrykus F and Spangenberg. 1995. Gene Transfer to Plants, Springer Verlag, Germany.
4. Brown T A. 2010. Gene Cloning and DNA Analysis: An Introduction, 6th Edition, Blackwell publications, USA.
5. Christou P & Klee H. 2004. Handbook of Plant Biotechnology. John Wiley & Sons.
6. Singh BD. 2007. Biotechnology: Expanding Horiozon. Kalyani.
7. Lewin's Genes XI 2012. Jones and Bartlett Learning, USA
8. U. Satyanarayana. Biotechnology, Book and allied (P), Ltd, 2013.

**M.SC. (AG.) PLANT PATHOLOGY
COURSE- WISE DISTRIBUTION**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	PAT 611	Mycology	2+1
2.	PAT 612	Plant Bacteriology	2+1
3.	PAT 613	Principles and Applied Plant Pathology	2+1
4.	PAT 621	Plant Virology	2+1
5.	PAT 622	Disease Resistance, Epidemiology and Forecasting of Plant Diseases	2+1
6	PAT 623	Diseases of Crop Plants	2+1
7	PAT 624	Post Harvest Pathology and Mushroom Production	1+1
		Total	13+7=20
Minor- 9 credits			
1.	OPC- GPB 621	Concepts of crop physiology	2+1
2.	OPC- PAT 711	Biological Control of Crop Diseases	2+1
3.	OPC- PAT 712	Mushroom Technology	2+1
		Total	6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistical Methods and Design of Experiments	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
		Total	3+2=5
Seminar + Research - 21 credits			
1.	PAT -032	Seminar	0+1
2.	PAT -011; 021;031; 041	Research 011-0+1; , 021-0+2; , 031- 0+8; , 041- 0+9	0+20
		Grand Total	22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0 + 1
4	PGS 624	Library and information services	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture	1+0
6	PGS 716 e-course	Disaster management	1+0
			2 + 4=6

M.SC. (AG.) PLANT PATHOLOGY
SEMESTER WISE DISTRIBUTION OF COURSES

S.No.	Course No.	Courses	Credit Hours
FIRST SEMESTER			
1.	PAT 611	Mycology	2+1
2.	PAT 612	Plant Bacteriology	2+1
3.	PAT 613	Principles and Applied Plant Pathology	2+1
4.	STA 611	Statistical Methods and Design of Experiments	2+1
5.	COM 611	Computer Programming and its Applications	1+1
6.	PAT 011	Research	0+1
7.	PGS 611	Agricultural Research Ethics & Methodology (0+1)	-
8.	PGS 612	Technical Writing and Communication Skills (0+1)	-
		Total	9+6=15
SECOND SEMESTER			
1.	PAT 621	Plant Virology	2+1
2.	PAT 622	Disease Resistance, Epidemiology and Forecasting of Plant Diseases	2+1
3.	PAT 623	Diseases of crop Plants	2+1
4.	PAT 624	Post Harvest Pathology and Mushroom Production	1+1
4.	OPC GPB 621	Concepts of crop Physiology	2 +1
5.	PAT 021	Research	0+2
6.	PGS 623	Basic Concepts in Laboratory Techniques (0+1)	-
7.	PGS 624	Library and Information Services (0+1)	-
		Total	9+7=16
THIRD SEMESTER			
1.	OPC XXX 711	Minor Course - Related discipline	2+1
2.	OPC XXX 712	Minor Course - Related discipline	2+1
3.	PAT 031	Research	0+8
4.	PAT 032	Seminar	0+1
5.	PGS 715 e-course	Intellectual property and its management in agriculture (1+0)	-
6.	PGS 716 e-course	Disaster management (1+0)	-
		Total	4+11 =15
FOURTH SEMESTER			
1.	PAT 041	Research	0 + 9
		Total	0 + 9
		Grand Total	22+33 = 55

PAT 611 MYCOLOGY (2+1)

Objectives

To study the nomenclature, classification and life cycle of *Protozoa*, *Chromista* and *Fungi* of agricultural importance.

Theory**Unit – I Taxonomy and Nomenclature of Fungi**

Landmarks in the history and development of taxonomy and nomenclature – General characters – Mode of nutrition – Asexual and sexual reproduction in fungi – Classification of fungi – Ainsworth and Bisby's classification – Dictionary of Fungi, 10th edition (Kirk *et al.*, 2008) – Symbiotic associations of *fungi*.

Unit – II Protozoa and Chromista

Kingdom: Protozoa, Phylum: Plasmodiophoromycota, Class: Plasmodiophoromycetes (Plasmodiophorales) II. Kingdom: Chromista, Phylum: Oomycota, Class: Oomycetes (Pythiales and Peronosporales).

Unit – III Chytridiomycota, Blastocladiomycota and Zygomycota

Kingdom: Fungi. Phylum: Chytridiomycota, Class: Chytridiomycetes (Chytridiales, Spizellomycetales); Phylum: Blastocladiomycota, Class: Blastocladiomycetes (Physodermaceae); Phylum: Zygomycota, Class: Zygomycetes (Mucorales).

Unit – IV Ascomycota

Phylum: Ascomycota, Classes: Taphrinomycetes (Taphrinales), Dothideomycetes (Dothidiales, Capnodiales and Pleosporales) Eurotiomycetes (Eurotiales), Leotiomyces (Erysiphales and Helotiales), Sordariomycetes (Hypocreales, Phyllochorales and Diaporthales), Pezizomycetes (Pezizales) and Mitosporicascomycetes.

Unit – V Basidiomycota

Phylum: Basidiomycota, Classes: Agaricomycetes (Agaricales, Corticiales, Cantharellales and Polyporales), Pucciniomycetes (Pucciniales) and Ustomycetes (Exobasidiales, Ustilaginales and Tilletiales).

Theory Schedule

1. Definition, need and objectives of taxonomy and nomenclature of *Fungi* - binomial and trinomial systems.
2. Landmarks in the history and development of taxonomy and nomenclature and contributors.
3. International rules of botanical nomenclature.
4. Classification of fungi as per Ainsworth and Bisby's Dictionary of Fungi 10th Edition (2008).
5. Classification of fungi.
6. Classification of fungi.
7. Symbiotic associations of Fungi.
8. Kingdom: Protozoa, Phylum: Plasmodiophoromycota
9. Class: Plasmodiophoromycetes (Plasmodiophorales)
10. Kingdom: Chromista, Phylum: Oomycota
11. Class: Oomycetes (Pythiales)
12. Class: Oomycetes (Peronosporales)

13. Kingdom: Fungi. Phylum: Chytridiomycota
14. Class: Chytridiomycetes (Chytridiales, Spizellomycetales)
15. Phylum: Blastocladiomycota
16. Class: Blastocladiomycetes (Physodermaceae)
17. Mid-semester Examinations
18. Phylum: Zygomycota
19. Class: Zygomycetes (Mucorales)
20. Phylum: Ascomycota
21. Classes: Taphrinomycetes (Taphrinales)
22. Dothideomycetes (Dothidiales)
23. Capnodiales and Pleosporales
24. Eurotiomycetes (Eurotiales)
25. Leotiomycetes (Erysiphales and Helotiales)
26. Sordariomycetes (Hypocreales)
27. Phyllochorales and Diaporthales
28. Pezizomycetes (Pezizales) and Mitosporic ascomycetes
29. Phylum: Basidiomycota
30. Classes: Agaricomycetes (Agaricales, Corticiales)
31. Cantharellales, Polyporales
32. Pucciniomycetes (Pucciniales)
33. Ustomycetes (Exobasidiales)
34. Ustomycetes (Ustilaginales and Tilletiales)

Practical Schedule

Culturing of representative genus and microscopic examination of generic level taxonomic key:

1. Plasmodiophora, Saprolegnia
2. Pythium, Phytophthora and Albugo
3. Plasmopara, Peronospora, Pseudoperonospora, Bremia, Sclerospora and Peronosclerospora
4. Rhizopus and Mucor
5. Saccharomyces and Taphrina
6. Mycosphaerella, Cochliobolus, Lewia and Venturia
7. Botryosphaeria and Macrophomina
8. Eurotium and Talaromyces
9. Erysiphe, Leveillula, Phyllactinia and Uncinula
10. Sclerotinia and Claviceps
11. Gibberella, Glomerella, Magnaporthe and Gloeosporium
12. Agaricus, Pleurotus and Volvariella
13. Thanatephorus, Athelium and Ganoderma
14. Puccinia, Uromyces and Hemileia
15. Ustilago and Sporisorium
16. Moesziomyces and Exobasidium
17. Preparation of plant pathogenic pure culture and permanent slides

Reference Books

1. Alexopoulos, C.J, Mims, C.W and Blackwell M. 2010. Introductory Mycology. Wiley Publication.
2. Aneja, K.R. and Mehrotra, R.S. 2015. An Introduction to Mycology. New Age International Publishers.
3. Dube, H.C. 2012. An Introduction to Fungi, 4th edition. Scientific Publishers.
4. Ingold, C.T. and Hudson, H.J. 2013. The Biology of Fungi, 6th Edition. Scientific Publishers.
5. Kirk, P. M *et al.* 2008. Dictionary of the Fungi, 10th edition, CABI Publication.
6. Satish Kumar 2016. The Fungi. Pragati Prakashan.
7. Satyanarayana, T., Deshmukh, S.K. and Johri, B.N. 2018. Developments in Fungal Biology and Applied Mycology. Springer Publications.
8. Sethi, I.K. and Walia, S.K. 2018. Textbook of Fungi and Their Allies. Scientific International Pvt. Ltd.
9. Vashishta B.R. and Sinha A.K. 2016. Botany for Degree Students-Fungi. S. Chand & Company Ltd.
10. Webster, J. and Weber, R.W.S. 2007. Introduction to Fungi, 3rd edition. Cambridge University Press.

e-References

1. Webster, J. and Weber, R.W.S. 2007. An Introduction to Fungi.
2. San-Blas, G. and Calderone, R.A. 2004. Pathogenic Fungi: Structural Biology and Taxonomy.
3. <http://www.ima-mycology.org/>
4. <http://www.atcc.org/>
5. <http://www.apsnet.org/Pages/default.aspx>

Journals

1. Kavaka
2. Mycologia
3. Annual Review of Phytopathology

PAT 612 PLANT BACTERIOLOGY (2+1)

Objectives

To study the phytopathogenic bacteria and the crop diseases caused by them. The various molecular tests for the detection and for the management of the bacterial diseases are also being taught.

Theory

Unit – I Taxonomy of bacteria

Scope and importance of bacterial plant pathology, Classification of phytopathogenic bacteria, criteria for classification Chemotaxonomy, Pyrotaxonomy–Recent trends, numerical, molecular (DNA, RNA, and protein homology) – International code of nomenclature –Names of phytopathogenic bacteria – New Nomenclature of phyto- pathogenic bacteria.

Unit II Morphology and Physiology of bacteria

Morphology, bacterial cell arrangement, shape, size, flagellation – Structure and composition – Growth and reproduction –Nutrition – Growth curve, Koch's

Postulates – Bacterial metabolism – Life cycle of phytoplasma and other fastidious prokaryotes – Prokaryotes: mode of action - Growth curve, nutrition and auxotrophic mutants, secretion systems – Bacteriophages: lytic and lysogenic cycle.

Unit – III Detection of bacteria

Genetics – Mutation, conjugation, transformation, transduction – Race – Pathotype - Staining techniques, biochemical tests – Serological methods, Nucleic acid-based methods (cDNA probe, RAPD, RFLP, AFLP and DNA finger printing, host specificity (lectins) – Resting cells in prokaryotes, elementary bacterial genetics and variability.

Unit – IV Pathogenesis

Portals of entry, infection process, factors influencing infection –Pathogenesis, inoculum potential, rhizosphere and phyllosphere population in relation to infection, methods of survival and dissemination (over wintering and over summering) – Biology of extra chromosomal elements: plasmid borne genes and their expression: *avr* and *pat* genes – Mechanism of pathogenesis of bacterial wilts, soft rots, blight, crown gall, and cankers, lesions, scab, gummosis – Symptomatology – Role of enzymes and toxins in pathogenesis, virulent and avirulent genes (*hrp*, *avr*) - Economic use of prokaryotes.

Unit – V Management of bacterial diseases

Chemical, biological control –Bacteriocins, siderophores –Bdellovibrios, bacteriophages and Cultural methods – Active resistance, preformed resistance, disease cycles, Integrated disease management.

Theory Schedule

1. Scope and importance of bacterial plant pathology.
2. Morphology, bacterial cell arrangement, shape, size, flagellation.
3. Structure, composition and reproduction of bacteria.
4. Life cycle of phytoplasma and other fastidious prokaryotes.
5. Koch's Postulates, bacterial metabolism.
6. Growth - different growth phase - lag - static - log phases and nutrition, Growth curve, nutrition and auxotrophic mutants, secretion systems and Bacteriophages: lytic and lysogenic cycle.
7. Classification of phytopathogenic bacteria and criteria for classification.
8. Recent trends, numerical Molecular (DNA, RNA, and protein homology) approaches.
9. Chemotaxonomy, pyrotaxonomy and protein homology.
10. International code of Nomenclature - names of Phytopathogenic bacteria and New Nomenclature of phyto pathogenic bacteria.
11. Genetics - Mutation, conjugation.
12. Transformation, transduction - Race - pathotype appearance.
13. Staining techniques.
14. Biochemical tests.
15. Serological methods.
16. Nucleic acid based methods (cDNA probe, RAPD, RFLP).
17. Mid-semester Examinations
18. Nucleic acid-based methods (AFLP and DNA finger printing).

19. Lectins and host specificity.
20. Resting cells in prokaryotes, elementary bacterial genetics and variability.
21. Portals of entry, infection process, factors influencing infection process.
22. Pathogenesis, inoculum potential, rhizosphere and phyllosphere population in relation to infection.
23. Methods of survival and dissemination (over wintering and over summering).
24. Role of enzymes and toxins in pathogenesis.
25. Virulent and avirulent genes (hrp, avr).
26. Biology of extra chromosomal elements: plasmid borne genes and their expression.
27. Economic use of prokaryote.
28. Active resistance, preformed resistance.
29. Mechanism of pathogenesis of bacterial wilts, soft rots and blight – Symptomatology.
30. Mechanism of pathogenesis of Crown gall, and cankers, lesions, scab, gummosis – Symptomatology.
31. Chemical control/management of bacterial diseases.
32. Biological control - bacteriocins, siderophore.
33. Bdellovibrios and bacteriophages.
34. Cultural methods and IDM.

Practical

Isolation of plant pathogenic bacteria –Purification techniques –Staining: Gram staining, Flagella staining, Endospore staining and Capsule staining – Biochemical tests –Gelatin liquification – H₂S production, indole production, methyl red test, starch hydrolysis – Gas production – Growth on various C,N sources – Bioassay of antibiotics – Bacteriocin production – Serological tests – Artificial inoculation methods – Study of symptoms of bacterial diseases.

Practical schedule

1. Isolation of plant pathogenic bacteria - purification methods.
2. Isolation of plant pathogenic bacteria - purification methods, Bacteriophages isolation and typing.
3. Preparation of stains and bacterial smears.
4. Staining - simple, Gram staining, flagella staining.
5. Endospore staining and capsule staining.
6. Biochemical tests - Gelatin liquefaction, H₂S production, indole production.
7. Methyl red test, starch hydrolysis, growth on potato plug.
8. Growth on various C, N sources, gas and acid production.
9. Bioassay of antibiotics, plant products and antagonists.
10. Bioassay of antibiotics, plant products and antagonists.
11. Bacteriocin and siderophore production.
12. Ooze test and Serological tests.
13. Different methods of artificial inoculation - water conjection - spray.

14. Clip inoculation, pin pricking.
15. Root dip, seed inoculation, grafting.
16. Study of diagnostic symptoms of bacterial diseases.
17. Record Certification.

Reference Books

1. Aneja, K.R. 2018. Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom, 5th Edition. New Age International Publishers.
2. Borkar, S.G. 2017. Laboratory Techniques in Plant Bacteriology. CRC Press.
3. Dale, J.W. 1998. Molecular Genetics of Bacteria, 3rd edition. John Wiley and Sons,
4. Goto, M. 1992. Fundamental of Bacterial Plant Pathology. Academic Press.
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4. <https://plantpathology.ces.ncsu.edu/>
5. <https://www.plantmanagementnetwork.org/pub/php/review/antibiotic/>

Journals

1. Plant Pathology
2. Phytopathology
3. Plant Disease

PAT 613 PRINCIPLES AND APPLIED PLANT PATHOLOGY (2+1)

Objective

To study the various principles of Plant Pathology and the principles involved in the plant disease management. Also classification of fungicides, methods of application of fungicides and employing the various bio control agents used in the management of crop diseases are taught.

Unit – I History and General Principles

Landmarks in the development of Plant Pathology–Contributions of Indian Plant Pathologists – Plant Pathology, definition – Pathogens: Algae, fungi, bacteria, virus, viroid, phytoplasma, fastidious vascular bacteria, spiroplasma and

phanerogamic parasites and nutritional disorder– Total and partial, stem and root – Survival, mode of entry and spread of plant pathogens – Physiological specialization in fungi, bacteria, virus – Differences between diseases by fungi, bacteria, mollicutes, virus and nutritional disorders.

Unit – II Principles of Plant Disease Management

General principles of Plant Disease Management – Exclusion – Quarantine and post-entry quarantine – Eradication – Seed-borne pathogens – Simple diagnostic techniques for plant pathogen – Molecular diagnostic tests – Seed health tests – Soil-borne pathogens – Cultural methods and resistance breeding in the management of plant diseases. Cultural methods – Soil solarization. Effect of environmental factors and host nutrition – Resistance breeding in plant disease management – Marker assisted selection and biotechnology methods.

Unit – III Biological Control

Biological control – Importance – Antagonistic fungi and bacteria – Isolation and purification, mass multiplication of fungal and bacterial biocontrol agents – Delivery systems of biocontrol agents – Quality parameters in biocontrol – Botanicals in plant disease management.

Unit – IV Fungicides

Fungicides – CIB&RC rules – Classification of fungicides – Group of fungicides: Copper and Sulphur fungicides, Mercury fungicides, Quinone compounds, Heterocyclic nitrogenous compounds, Organotin compounds and their mode of actions – Systemic fungicides, Antibiotics and new generation fungicides and their mode of actions – Fungicide resistance – Methods of application of fungicides – Seed, soil and foliar application – Special methods of fungicide application – Compatibility – Phytotoxicity.

Unit–V Host Nutrition interaction

Recognition concept and infection, symptomatology, disease development – Role of enzymes, toxins – Altered plant metabolism as affected by plant pathogens – Suppression of plant diseases with mineral nutrients – Effect of nutrition, role of macro and microelements on the growth of plant pathogens.

Theory Schedule

1. Landmarks in the development of plant pathology.
2. Contributions of Plant Pathologist in India.
3. Principles in plant pathogen interactions.
4. Exclusion of plant diseases, Quarantine and post-entry quarantine.
5. Eradication of plant pathogens.
6. Seed-borne diseases, Simple diagnostic techniques.
7. Molecular diagnostic tests.
8. Seed health tests.
9. Eradication of plant pathogens, soil-borne diseases.
10. Cultural methods and resistance breeding in the management of plant diseases.
11. CIB&RC rules.
12. Classification of fungicides - Protectants, Eradicants, therapeutants, fungicide formulations.

13. Characters of ideal fungicide, precaution during storing and handling.
14. Copper fungicides.
15. Sulphur fungicides.
16. Mercury fungicides.
17. Quinone compounds.
18. Mid-semester Examinations
19. Heterocyclic nitrogenous compounds, organotin compounds and their mode of action.
20. Systemic fungicides and miscellaneous groups of fungicides and their mode of action.
21. Antibiotics, methods of application of fungicides, seed soil and foliar application.
22. New generation fungicides.
23. Development of fungicide resistance.
24. Foliar application and special methods of fungicide application, compatibility, phytotoxicity.
25. Biological control, importance and antagonistic fungi.
26. Bacterial biocontrol agents.
27. Mass multiplication of fungal, bacterial biocontrol agents.
28. Delivery systems in biocontrol and Quality parameters in biocontrol.
29. Botanicals and disease management.
30. Recognition concept and infection, symptomatology, disease development.
31. Role of enzymes and toxins in disease development.
32. Altered plant metabolism as affected by plant pathogens.
33. Suppressing plant diseases with mineral nutrients.
34. Effect of nutrition, role of macro and microelements, carbon and N nutrition on the growth of plant pathogens.

Practical

Study of various fungicides, commercial formulations belonging to various groups –Preparation of Bordeaux mixture and Bordeaux paste –Methods of application of fungicides - Seed treatment: dry, wet and pelleting – soil and foliar application –Study of plant protection equipments –Special methods of application of fungicides –Laboratory and field evaluation of fungicides –Phytotoxicity symptoms of fungicides –Isolation techniques of biocontrol agents –Methods of mass multiplication and application of biocontrol agents –Botanicals –Methods of preparation and application – IPM in protected cultivation system.

Practical schedule

1. Familiarization of commercial formulations of different groups of fungicides and their uses, dosage and application.
2. Preparation of Bordeaux mixture and Bordeaux paste.
3. Seed treatment: dry, wet and pelleting.
4. Soil application methods.
5. Foliar application, sprayer, duster and ULV sprayer.
6. Special methods of application of fungicides.

7. Laboratory evaluation of fungicides: poisoned food technique and spore germination assay.
8. Field evaluation of fungicides, based on application and scoring of the disease incidence.
9. Isolation of antagonistic fungi and bacteria from soils
10. Testing the biocontrol agents against plant pathogens, dual culture technique and paper disc assay.
11. Mass multiplication of fungal antagonists.
12. Mass multiplication of bacterial antagonists.
13. Methods of application of biocontrol agents: seed soil, foliar and root dipping.
14. Study on the compatibility of biocontrol and bio-fertilizers.
15. Study on the compatibility of biocontrol agents with fungicides.
16. Study of botanical pesticides, preparation of antimicrobial principles.
17. Record Certification.

Reference Books

1. Bindra, O.S. and Singh, H. 1980. Pesticide Application Equipments. Oxford and IBH Publishing Company.
2. Das Gupta, M.K.1988. Principles of Plant Pathology. Allied Publishers Ltd.
3. Dent, D. 1995. Integrated Pest Management, Chapman and Hall.
4. Mehrotra, R.S. and Ashok Aggarwal. 2017. Plant Pathology. Tata McGraw Hill Education.
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6. Prakasam, V., Prabakar, K., Raguchander, T., Eraivan, K. and Narayanasamy, P. 1996. Disease Management in Crop Plants. A.E. Publications.
7. Rangaswami, G.1988. Diseases of Crop Plants in India. Prentice Hall of India Pvt. Ltd.
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3. <http://www.ext.colostate.edu/mg/gardennotes/331.pdf>
4. <http://edis.ifas.ufl.edu/pdffiles/MG/MG44200.pdf>
5. <http://agritech.tnau.ac.in/pdf/9.pdf>

Journals

1. Indian Phytopathology
2. Plant Disease Research
3. Journal of Mycology and Plant Pathology
4. Indian Journal of Plant Protection

PAT 621 PLANT VIROLOGY (2+1)**Objectives**

To study the plant viruses, their biological properties, diseases caused by plant viruses, diagnostics and their management.

Theory**Unit – I History and importance**

Economic importance of plant virus diseases and Land marks in the development of virology – Nomenclature and classification of viruses – Nature of virus, occurrence, Mycoviruses, arboand baculoviruses, satellite viruses, satellite RNAs and viroids.

Unit – II Properties of virus

Properties of Virus – Structure and morphology of plant viruses –Chemical composition and physical properties –Virus-vector relationship – Methods of transmission: mechanical, graft, dodder, seed, insect vector, nematode and fungi.

Unit – III Detection techniques

Symptoms of plant virus diseases – Isolation and purification –Electron microscopy–Production of antisera: Polyclonal and monoclonal antibody production–Detection Techniques: Serological techniques – ELISA,different types and forms of ELISA – ISEM – Detection using cDNA – Different PCR techniques.

Unit – IV Genetics of virus

Variation, mutation and origin of viruses and virus strains – Mechanism of resistance, genetic engineering – Process of virus infections and replications – Movement of viruses – Physiology of virus infected plants.

Unit – V Management of viral diseases

Principles of management of virus diseases – Different methods – Cultural, vector management, therapy, chemotherapy, Antiviral principles (AVP)– Production of disease-free planting materials – Cross protection, induced resistance, tissue culture techniques.

Theory Schedule

1. Land marks in the development of virology.
2. Economic importance of plant virus diseases.
3. Nomenclature and classification of viruses.
4. Nature of virus, occurrence, properties and multiplication of viruses.
5. Mycoviruses, arboand baculoviruses
6. Satellite viruses, satellite RNAs
7. Viroids
8. Properties of virus.
9. Structure and morphology of plant viruses.
10. Chemical composition of plant viruses.
11. Physical properties of plant viruses.
12. Virus-vector relationship.
13. Mechanicaltransmission of virus diseases.
14. Vegetative, seed and dodder transmission of virus diseases.
15. Insect vectortransmission of virus diseases.
16. Nematode and fungitransmission of virus diseases.
17. Mid-semester Examinations

18. Symptoms of plant virus diseases.
19. Isolation and purification of viruses.
20. Electron microscopy.
21. Production of antisera: Polyclonal and monoclonal antibody production
22. Detection of virus using serological techniques.
23. ELISA techniques.
24. PCR techniques.
25. Variation, mutation and origin of viruses.
26. Virus strains.
27. Mechanism of resistance, genetic engineering.
28. Process of virus infection and replication.
29. Movement of viruses.
30. Physiology of virus infected plants.
31. Principles of management of virus diseases.
32. Cultural, vector, therapy, chemotherapy of virus diseases management.
33. Antiviral principles, production of disease-free planting materials.
34. Cross protection, induced resistance, tissue culture techniques.

Practical

Symptoms of plant virus and phytoplasma diseases –Preparation of buffer – transmission: mechanical, seed, dodder and graft –Insect vector transmission – Physical properties: TIP, LIV, DEP – Local lesion assay – Purification – Serological tests –Testing AVP and chemicals against viruses – Electron microscopy and preparation of grids – Examinations of plant viruses – Tissue culture techniques.

Practical schedule

1. Symptoms of plant virus and phytoplasma diseases.
2. Preparation of buffer.
3. Transmission: Mechanical and seed.
4. Transmission: Dodder and Graft.
5. Insect vector transmission: Aphid, whitefly, thrips and hopper.
6. Physical properties TIP, LIV and DEP.
7. Local lesion assay.
8. Purification of virus.
9. Purification of virus.
10. Serological tests.
11. Preparation of AVP.
12. Testing AVP against virus diseases.
13. Testing chemicals against virus diseases.
14. Tissue culture techniques.
15. Preparation of grids and other materials.
16. Electron microscopy and examinations of plant viruses.
17. Record Certification

Reference Books

1. Agrios, G.N. 2005. Plant Pathology, 5th Edition, Elsevier Academic Press, USA
2. Bawden, F.C. 1996. Plant Viruses and Virus diseases, Chronica Botanica Company.

3. Brunt, A.A, Krabtree, K, Dallwitz, M.J, Gibbs, A.J. and Watson, L. 1995. Virus of plants. Descriptions and lists from VIDE Database. CAB International.
4. Fauquet, C, Mayo, M.A. Maniloff, J. Desselberger, U. and Ball, L.A. 2005. Virus Taxonomy. VIIIth Report of the ICTV. Academic Press.
5. Hull, R. 2013. Mathew's Plant Virology, 5th edition. Academic Press.
6. Jones, P, Jones, P.G. and Sutton, J.M. 1997. Plant Molecular Biology: Essential Techniques. John Wiley & Sons.
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<http://www.freebookcentre.net/biology-books-download/Molecular-Virology.html>
4. Viral Replication by German Rosas Acosta -
<http://www.freebookcentre.net/biology-books-download/Viral-Replication.html>
5. <http://www.springer.com/biomed/virology/book/978-3-642-40828-1>

Journals

1. Archives of Virology
2. Virus Research
3. Journal of Virology

PAT 622 DISEASE RESISTANCE, EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES (2+1)

Objective

To study the disease resistance mechanisms in plants; the importance of epidemiology and its relationship to the crop diseases.

Theory

Unit– I Introduction

Historical developments on disease resistance – Dynamics of pathogenicity: penetration, infection, regulation of infection processes–disease escape, disease tolerance – resistance biology– types of resistance–non-host resistance, horizontal resistance and vertical resistance– variability in plant pathogens, mechanisms of variability – physiological races of pathogens.

Unit –II Defence mechanisms and Resistance in plants

Host defence mechanisms –Morphological and anatomical resistance – Phytoanticipins –Induced structural and biochemical defences–Phytoalexins, defense-related proteins, Hypersensitivity and its mechanisms –Induced resistance–systemic acquired resistance (SAR) and induced systemic resistance (ISR) –Genetics

of disease resistance – Gene-for-gene hypothesis –Avirulence(avr) genes – Protein for protein – Resistance (R) genes of plants.

UIN- III Signal transduction in plants and introduction to epidemiology

Recognition of pathogens by plants – Elicitors –Host plant receptors –Signal transduction –Signal cross talk. Epidemic concept of disease and historical developments in epidemiology–Impact of epidemics –Disease triangle – Pathometry and crop growth stages –Analysis of epidemics: monocyclic, polycyclic and polyetic diseases.

Unit –IV Aerobiology and disease assessment

Weather: Effect of temperature, light, humidity, moisture, rain and drought – Microclimate and Macroclimate–Host: Boom and Burst population growth cycle– Area under disease progress curve (AUDPC) –Different disease progress model and correction factors –Inoculum dynamics –Population biology of pathogens –Temporal spatial variability in plant pathogens – Mathematical models in epidemiology.

Unit –V Disease forecasting

Principles and pre-requisites of forecasting, systems (positive and negative) – Early forecasting procedures based on weather and inoculum potential –Disease prediction–Infection models –Factors affecting various components of forecasting – Disease progress models –Yield loss models and computerized disease forecasting systems–Remote sensing.

Theory schedule

1. Introduction and historical development on disease resistance.
2. Dynamics of pathogenicity: penetration, infection, regulation of infection processes.
3. Basic terms in resistance biology: pathogen virulence, aggressiveness, susceptibility, disease tolerance, disease resistance, local resistance, systemic resistance.
4. Disease escapes, non-host resistance.
5. Types of resistance: horizontal resistance and vertical resistance.
6. Variability in plant pathogens, mechanisms of variability, physiological races of pathogens.
7. Host defense mechanisms, morphological and anatomical resistance.
8. Phytoanticipins and induced structural and biochemical defences.
9. Cork layers, abscission layer, tyloses, gums– cell wall modifications: papilla-callose, HRGP, lignifications, suberization.
10. Phytoalexins and defense-related proteins.
11. Hypersensitivity and its mechanisms.
12. Induced resistance: systemic acquired resistance, induced systemic resistance.
13. Genetics of disease resistance, Gene-for-gene theory, avirulence (avr) genes, characteristics of avr gene-coded proteins, hrp genes.
14. Protein-for-protein, resistance (R) genes of plants, management of resistance genes.
15. Recognition of pathogens by plants.

16. Elicitors-general and race-specific elicitors, endogenous and exogenous elicitors.
17. Mid-term examination
18. Host plant receptors, signal transduction and signal cross-talk.
19. Plant disease epidemics – introduction, epidemic concept and historical development of epidemiology.
20. Disease triangle, pyramid: Host, environment and pathogen.
21. Pathometry and crop growth stages.
22. Analysis of epidemics - monocyclic, polycyclic and polyetic diseases.
23. Weather: effect of temperature, light, humidity, moisture, rain and drought, microclimate and macroclimate.
24. Host: Boom and Burst cycle.
25. Area under disease progress curve (AUDPC).
26. Different disease progress model and correction factors.
27. Inoculum dynamics, population biology of pathogens.
28. Temporal spatial variability in plant pathogens.
29. Mathematical models in epidemiology.
30. Principles and pre-requisites of forecasting.
31. Forecasting systems (positive and negative), early forecasting procedures based on weather and inoculum potential.
32. Disease prediction- infection models, factors affecting various components of forecasting.
33. Disease progress models, yield loss models and computerized disease forecasting systems.
34. Remote sensing.

Practical

Introduction to disease resistance in plants-methods of resistance breeding– Different types of spore traps and collection of spores – Measurement of diseases– Disease intensity – Disease assessment – Recording disease intensity at different crop stages– foliar and root disease – Growth curve analysis of Plant diseases – Spatial analysis of plant diseases –Model preparation and validation – Computerized disease forecasting systems– remote sensing –Record certification.

Practical Schedule

1. Introduction of disease resistance in plants.
2. Mechanism of disease resistance.
3. Methods of resistance breeding, Back cross method.
4. Development of multiline.
5. Tissue culture techniques.
6. Different types of spore traps and collection of spores.
7. Measuring disease intensity.
8. Disease assessment.
9. Field visit.
10. Recording disease intensity at different crop stages: foliar and root disease.
11. Growth curve analysis of plant disease.

12. Growth curve analysis of plant disease.
13. Model preparation and validation.
14. Model preparation and validation.
15. Computerized disease forecasting systems.
16. Remote sensing.
17. Record Certification.

Reference Books

1. Campbell, C.L. and Madden L.V. 1990. Introduction to Plant Disease Epidemiology. John Wiley & Sons.
2. Cooke, B.M., Jones, D.G. and Kaye, B. 2006. The Epidemiology of Plant Diseases. Springer Publications.
3. Datta, S.K. and Muthukrishnan, S. 1999. Pathogenesis-Related Proteins in Plants. CRC Press.
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7. Nagarajan, S. 1983. Plant Disease Epidemiology. Oxford and IBH Publishing Company.
8. Punja, Z.K. (2004). Fungal Disease Resistance in Plants - Biochemistry, Molecular Biology and Genetic Engineering. Haworth Press.
9. Stevenson, K.L. and Jeger, M.J. 2014. Exercises in Plant Disease Epidemiology. APS Press.
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3. <http://eagri.org/eagri50/PATH171/lec19.pdf>
4. plantpath.ifas.ufl.edu
5. <http://agrilife.org/amarillo/files/2010/10/Application-of-Spatial-Statistics-Workneh.pdf>

Journals

1. Journal of General Plant Pathology
2. Current Science
3. Molecular Plant Pathology

PAT 623 DISEASES OF CROP PLANTS (2+1)

Objective

To study the various diseases of field and horticultural crops, their distribution, economic importance, causative agents, diagnostic symptom,

pathogen characters, favourable conditions, mode of infection, mode of survival, spread and the integrated management strategies.

Theory

Unit I - Cereals and Pulses

Rice, Wheat, Maize, Sorghum, Cumbu, Ragi and Minor millets. Red gram, Bengal gram, Soybean, Field bean, Cowpea, Black gram and Green gram.

Unit II - Oilseeds and Cash Crops

Groundnut, Gingelly, Sunflower, Castor, Safflower, Mustard, Linseed and Jatropha. Sugarcane, Cotton, Tobacco, Jute, Sugar beet and Mulberry.

Unit III - Fruits and Vegetables

Mango, Banana, Citrus, Grapes, Guava, Sapota, Pomegranate, Custard apple, Papaya, Jack, Pineapple, Ber, Aonla, Apple, Pear, Peach and Plum. Brinjal, Tomato, Bhendi, Cucurbits, Crucifers, Beans, Peas and Moringa.

Unit IV - Tuber crops, Spices and Condiments

Potato, Sweet Potato, Beet Root, Radish, Yam, Taro and Cassava. Onion, Garlic, Chillies, Cardamom, Pepper, Betel vine, Turmeric, Ginger, Fenugreek, Coriander, Clove, Nutmeg and Cinnamon.

Unit V - Plantation Crops and Flower Crops

Tea, Coffee, Cocoa, Rubber, Coconut, Arecanut and Vanilla. Rose, Jasmine, Crossandra, Chrysanthemum, Tuberose, Carnation, Lillium and Marigold. Spoilage of grains by fungi during storage and their management. Post-harvest diseases of fruits and vegetables and their management.

Theory Schedule

1. Diseases of Rice
2. Diseases of Wheat
3. Diseases of Maize
4. Diseases of Sorghum, Cumbu, Ragi and minor millets
5. Diseases of Red gram, Bengal gram and Soybean
6. Diseases of, Black gram, Green gram, Cowpea and Field bean
7. Spoilage of grains by fungi during storage and their management
8. Diseases of Groundnut
9. Diseases of Gingelly and Sunflower
10. Diseases of Mustard, Safflower, Niger, Linseed, Castor and Jatropha
11. Diseases of Sugarcane
12. Diseases of Cotton and Tobacco
13. Diseases of Jute, Sugar beet and Mulberry
14. Diseases of Mango
15. Diseases of Banana
16. Diseases of Citrus, Guava, Sapota and Grapes
17. Mid-semester Examinations
18. Diseases of Pomegranate, Custard apple, Papaya, Jack, Pineapple, Ber and Aonla
19. Diseases of Apple, Pear, Peach and Plum
20. Diseases of Tomato, Brinjal and Bhendi
21. Diseases of Cucurbits

22. Diseases of Crucifers, Beans, Peas and Moringa
23. Post-harvest diseases of fruits and vegetables and their management
24. Diseases of Potato
25. Diseases of Sweet Potato, Beet Root and Radish,
26. Diseases of Cassava, Yam and Taro
27. Diseases of Chillies
28. Diseases of Onion and Garlic
29. Diseases of Turmeric and Ginger
30. Diseases of Cardamom, Pepper, Betel vine, Fenugreek, Coriander, Clove, Nutmeg and Cinnamon
31. Diseases of Tea and Coffee
32. Diseases of Coconut
33. Diseases of Cocoa, Rubber, Arecanut and Vanilla
34. Diseases of Rose, Jasmine, Crossandra, Chrysanthemum, Tuberose, Carnation, Lillium and Marigold

Practical

Observation of symptoms in the field and hot spot areas and examinations of specimens in the laboratory – Studying host-parasite relationship and characteristic of causal organism of the diseases of above crops – Examinations of cultures of important pathogens.

Practical schedule

1. Rice and Wheat
2. Maize, Sorghum, Cumbu and Ragi
3. Field bean, Cowpea, Black gram and Green gram
4. Groundnut, Gingelly, Sunflower, Castor and Cashew
5. Sugarcane
6. Field visit
7. Cotton, Tobacco and Mulberry
8. Mango, Citrus, Guava, Sapota, Pomegranate, Papaya, Jack
9. Banana
10. Apple, Pear, Peach and Plum
11. Tomato, brinjal, bhendi and cucurbits
12. Crucifers, Beans, Peas and Moringa
13. Chillies, Turmeric and Ginger
14. Coffee, Tea, Pepper and Cardamom
15. Field visit
16. Coconut and Oil palm
17. Rose, Jasmine, Crossandra, Chrysanthemum, Tuberose, Carnation, Lillium and Marigold

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1. http://agritech.tnau.ac.in/crop_protection/crop_prot.html
2. <https://www.forestryimages.org/diseases.cfm>
3. <https://www.unl.edu/psi/>
4. <http://www.knowledgebank.irri.org/diseases>
5. <https://itunes.apple.com/us/app/tomato-diseases/id1156884649?mt=8>

Journals

1. Indian Journal of Agricultural Sciences
2. Pestology
3. Journal of Pesticide Science
4. Crop Protection

PAT 624 POST HARVEST PATHOLOGY AND MUSHROOM PRODUCTION (1+1)

Objective

To study the various Seed borne diseases, Post-harvest diseases and their management strategies. Also it covers the techniques in mushroom cultivation.

Theory

Unit – I Introduction to Seed Pathology

Problems and prospects of seed pathology – Economic importance of seed-borne diseases–Significance of seed transmission compared to other means – Infection of seeds – Location and survival of inoculum – Longevity of seed borne organisms – Seed contamination.

Unit – II Seed certification and storage

Quarantine for seed – Disease-free seed production and certification – Seed act – Global seed trade, Phytosanitary certificates under WTO and TRIPS – Pest Risk Analysis – Seed quality – Storage and field fungi – mycotoxins – Storage methods detection of seed-borne organisms – Seed certification standards, Seed health testing – Seed crop management.

Unit – III Introduction to post-harvest pathology

Post-harvest loss – Definition – Deterioration of fruits and vegetables – Nature and kind of post-harvest loss – Types of post-harvest problems both by biotic and abiotic causes, rhizosphere colonization, microbial associations, concept, operational mechanisms and its relevance in control. Estimation of post-harvest loss – Pathogenicity – Field fungi and storage fungi– Biological and environmental causes of losses, their significance in grain and horticultural produce – Mycotoxins

– Post-harvest diseases caused by fungi and bacteria in fruits – Post-harvest diseases in transit and storage.

Unit – IV Management of post-harvest disease

Strategies of plant defenses – Aflatoxins and their integrated management. Methods for the management of post-harvest diseases– Biological control of post-harvest diseases in fruits and vegetables –Physical, chemical and natural fungicides for management of post-harvest diseases – Merits and demerits – Application and use of post-harvest fungicides – Integrated approach in controlling diseases and improving the shelf life of produce–Application and monitoring for any health hazard, knowledge of Codex Alimentarius for each product and commodity.

Unit – V Mushroom production

Mushroom science: Importance, related fields and their contribution global production– Morphology and life cycle: *Pleurotus*, *Calocybe*, *Agaricus* and *Volvariella*. Poisonous mushrooms. Cultivation: oyster mushroom, milky mushroom, paddy straw mushroom, button mushroom and other edible mushrooms. Problems in cultivation: weed moulds, diseases, pests and abiotic disorders.

Theory Schedule

1. History, importance and significance of seed transmission.
2. Crop losses caused by seed-borne diseases.
3. Effect of temperature and humidity on seed borne diseases.
4. Deficiency diseases, contaminated parts of seed.
5. Infection directly from mother plant.
6. Seed contamination.
7. Epidemiology of seed-borne pathogen.
8. Survival and longevity of pathogen. factors affecting transmission of seed borne inoculum.
9. Mid-semester Examinations.
10. Certification, Quarantine, Integrated disease input of seed-borne disease.
11. Post-harvest loss – Deterioration of fruits and vegetables – Estimation of post-harvest loss – Pathogenicity – Field fungi and storage fungi – Mycotoxins.
12. Post-harvest diseases caused by fungi and bacteria in fruits - Post harvest diseases in transit and storage.
13. Strategies of plant defenses –Biological control of post-harvest diseases in fruits and vegetables –Physical, chemical and natural fungicides for management of post-harvest diseases.
14. Integrated approach in controlling diseases and improving the shelf life of produce –application and monitoring for any health hazard, knowledge of Codex Alimentarius for each product and commodity.
15. Mushroom science: Importance, morphology and life cycle, poisonous mushroom.
16. Cultivation: Oyster mushroom, Milky mushroom, Paddy straw mushroom and Button mushroom.
17. Problems in cultivation: weed moulds, diseases, pests and abiotic disorders.

Practical Schedule

1. Seed sampling and dry seed examinations.
2. Physical purity, analysis of seed samples for seed discolouration abnormalities, fungal structures, galls, plant parts and inert matters.
3. Seed washing techniques: Examinations of seed wash, enumeration and estimation of important seed-borne organisms.
4. Incubation methods: Blotter method, 2,4-D blotter method, deep freezing method and agar plate method.
5. Detection of seed-borne pathogens by non-destructive method.
6. Determination of seed quality: Growing on test, roll towel method and sand method and testing of treated seed (biological method).
7. Physical, chemical and biological methods of controlling seed-borne pathogens.
8. Estimation of mycotoxin (Aflatoxin) from infested seeds.
9. Visit to seed production field, seed testing laboratory, seed godowns and warehouses.
10. Major post-harvest diseases of fruits and vegetables: fruit spots, blight, soft rot, anthracnose.
11. Spoilage of grains in storage.
12. Field fungi and storage fungi in horticultural crops.
13. Assessment of loss due to post-harvest diseases.
14. Visit to local market to study spoilage of fruits and vegetables.
15. Cultivation of oyster mushroom and milky mushroom
16. Cultivation of paddy straw mushroom and button mushroom
17. Record Certification

Reference Books

1. Agarwal, V.K. 1988. Principles of Seed Pathology, CRC Publication.
2. Anna Snowdon 2001. A Colour Atlas of Post-Harvest Diseases and Disorders of Fruits and Vegetables. Volume 1. General Introduction and Fruits. Iowa State University Press.
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6. Karuna Vishunavat 2016. Fundamentals of Seed Pathology. Kalyani publishers
7. Neergaard, P. 1987. Seed Pathology. Macmillan Publication.
8. Prusky, D. and Gullino, M.L. 2014. Plant Pathology in 21st Century - Post Harvest Pathology. Springer Publication.
9. Suman, B.C. and Sharma, V. P. 2007. Mushroom Cultivation in India. Daya Publishing House.
10. Susamma Philip 2014. Management of Post-Harvest Diseases of Fruits, Vegetables and Tuber Crops. ICAR Publications.

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2. postharvest.tfrec.wsu.edu
3. <https://fungiforthepeople.org>
4. http://agritech.tnau.ac.in/crop_protection/crop_prot.html
5. <https://www.seedtest.org/>

Journals

1. Canadian Journal of Plant Pathology
2. European Journal of Plant Pathology
3. Mushroom Research – An International
4. Indian Journal of Mushroom Research

OPC PAT 711 BIOLOGICAL CONTROL OF CROP DISEASES (2+1)**Objective**

To study the principles and application of eco-friendly and sustainable biological management strategies of plant diseases.

Theory**Unit – I History and importance**

Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.

Unit – II Mechanisms of biocontrol agents

Types of biological interactions, competition, mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological control.

Unit – III Compatibility and management strategies of plant pathogens

Factors governing biological control, role of physical environment, agro ecosystem, operational mechanisms and cultural practices in biological control of pathogens, pathogens and antagonists and their relationship. Comparative approaches to biological control of plant pathogens by resident and introduced antagonists, management of soil-borne, seed borne and foliar diseases. Compatibility of different bioagents.

Unit – IV Mass multiplication and quality control

Commercial production of antagonists, their delivery systems, application and monitoring of biocontrol agents. Biopesticides available in market. Quality control system of biocontrol agents.

Unit – V Cross protection and botanicals

Pre-immunization technique, hypovirulence. Plant extracts, essential oils, antiviral principles. Mycoherbicides, entomophagous fungus. Antagonist fortified manure.

Theory Schedule

1. Introduction to biological control of plant diseases, Biocontrol: concept and definitions.
2. History of Biological control of crop diseases, principles of plant disease management with bioagents.

3. Merits and demerits of biological control of plant diseases.
4. Mechanisms of disease control by biocontrol agents.
5. Mechanisms of disease control by biocontrol agents.
6. Hypovirulence-Its role in disease management.
7. Competitive saprophytic ability and rhizosphere colonization.
8. Induced systemic resistance and its role in plant disease resistance.
9. Mycorrhizal associations-VAM- Its operational mechanisms in plant disease management.
10. Factors governing biological control.
11. Role of environment in the biological control of plant diseases.
12. Comparative approaches to biological control of plant pathogens by resident and introduced antagonists.
13. Comparative approaches to biological control of plant pathogens by resident and introduced antagonists.
14. Biological control of soil-borne diseases.
15. Biological control of seed borne and foliar diseases.
16. Compatibility of different biocontrol agents.
17. Mid-semester Examination.
18. Isolation of *Trichoderma* spp. and *Pseudomonas* spp. from soil.
19. Mass production of fungal and bacterial biocontrol agents.
20. Mass production of VAM.
21. Precaution in the formulation of biocontrol agents.
22. Delivery systems of biocontrol agents.
23. Assessment of survival of biocontrol agents.
24. Significance of PGPR.
25. Mechanisms of disease control by fungal and bacterial biocontrol agents.
26. Induction of defense enzymes in plants by application of biocontrol agents.
27. Quality control systems of bioformulations.
28. Biopesticides available in the market.
29. Commercial aspects of mass production of biocontrol agents.
30. Commercial aspects of mass production of VAM.
31. Pre-immunization technique.
32. Role of plant extracts in plant disease management.
33. Mycoherbicides and entomophagous fungus.
34. Antagonist enriched farmyard manure.

Practical

Isolation, characterization and maintenance of antagonists, methods of study of antagonism and antibiosis, defense enzymes, application of antagonists against pathogen *in vitro* and *in vivo* conditions. Mass multiplication, commercial formulation and Study of cfu/g. Cross protection, preparation and application of plant extracts, isolation and formulation of mycoherbicides, entomophagous fungus.

Practical Schedule

1. Introduction to biological control of plant diseases.
2. Isolation and molecular characterization of biocontrol agents.

3. Isolation of VAM.
4. Testing the antagonistic efficacy of fungal and bacteria antagonists.
5. Testing the compatibility among the biocontrol agents.
6. Methods of application of biocontrol agents.
7. Antibiotic production of biocontrol agents.
8. Estimation of defense enzymes in plants by application of biocontrol agents.
9. Management of microbial contaminants.
10. Fermentation technology and formulation development.
11. Methods of quality control tests.
12. Packing and storage of biocontrol formulations.
13. Cross protection technique.
14. Preparation and application of plant extracts in plant disease management.
15. Application of mycoherbicides and entomophagus fungus.
16. Preparation of antagonist enriched farmyard manure.
17. Visit to Commercial biocontrol units.

Reference

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2. Chincholkar and Mukerji, K.G. 2007. Biological Control of Plant Diseases. Oxford and Imprint of Haworth Press.
3. Cook, R.J. and Baker, K.F. 1983. Nature and Practice of Biological Control of Plant Pathogens. APS Press.
4. Fokkemma, M.J. 1986. Microbiology of the Phyllosphere. Cambridge University Press.
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6. Gnanamanickam, S.S. 2009. Biological Control of Rice Diseases. Springer Publications.
7. Heikki, M.T. and James, M. 1996. Biological Control Benefits and Risks. Cambridge University Press.
8. Narayanasamy, P. 2015. Biological Management of Diseases of Crops. Vol.1. Characteristics of Biological Control Agents. Springer Publications.
9. Narayanasamy, P. 2015. Biological Management of Diseases of Crops. Vol.2. Integration of Biological Control Strategies with Crop Disease Management Systems. Springer Publications.
10. Pratibha Sharma 2014. Biological Control of Plant Diseases and Weeds. ICAR Publications.

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1. <https://www.apsnet.org/edcenter/advanced/topics/Pages/BiologicalControl.aspx>
2. [https://www.appsnet.org/Publications/Brown_Ogle/27%20Control-biological%20\(AMS&GRS\).pdf](https://www.appsnet.org/Publications/Brown_Ogle/27%20Control-biological%20(AMS&GRS).pdf)
3. <http://handelsmanlab.sites.yale.edu/sites/default/files/Future%20trends%r20in%20biocontrol.pdf>

4. <http://www.arc.agric.za/arc-ppri/Leaflets%20Library/Principles%20of%20biological%20control.pdf>
5. teca.fao.org/read/8372

Journals

1. Biocontrol
2. Biocontrol Science and Technology

OPC PAT 712 MUSHROOM TECHNOLOGY (2+1)

Objectives

To study the various techniques involved in cultivation, maintenance, cropping pattern, harvest, problems due to pest and diseases and its management and also nutritional value and preservation of edible mushroom

Theory

Unit– I Importance of Mushroom

Mushroom science: Importance, related fields and their contribution –Global production – Morphology and life cycle: *Pleurotus*, *Calocybe*, *Agaricus*, *Lentinus* and *Volvariella*. Morphogenesis in mushrooms –Role of enzymes in mycelium and basidioma development; physiology of fruiting body development; poisonous mushrooms and mushroom poisoning.

Unit – II Breeding and techniques

Genetics and breeding of cultivated mushrooms: homothallism and heterothallism, primary and secondary mycelium, parasexuality, homokaryotic fruiting. Approaches to breeding: Selection, mutation and hybridization – Tissue culture, single and multispore isolates – Biotechnological methods for strain improvement; study of strain variability using markers –Allozyme, RFLP, AFLP, RAPD and PCR –Laboratory techniques, equipments, culture media, sterilization, pure culture techniques – Preservation of cultures. Spawn types: mother spawn and bed spawn.

Unit – III Production and constraints

Cultivation: oyster mushroom, milky mushroom, paddy straw mushroom, button mushroom and other edible mushrooms – Outdoor cultivation – Ectomycorrhizal mushrooms. Problems in cultivation: weed moulds, diseases, pests and abiotic disorders.

Unit – IV Mushroom usage

Uses of mushroom as food, nutritional and pharmaceutical values. Post-harvest technology: Methods of preservation and value addition. Mushroom recipes: Cooking methods, value added products, pickling, sauce, ketchup and chutney, instant food mixes, extruded and bakery products, quality and sensory evaluation.

Unit – V Cost- Benefit ratio

Cost analysis and project preparation: Principles of enterprise management, preparation of projects, project analysis and financial management – Market survey, export procedures. Agricultural finance: Sources of finance and acquisition.

Practical

Introduction to mushroom – Edible and poisonous type – Edible mushrooms: *Pleurotus*, *Agaricus*, *Volvariella*, *Lentinus* and *Calocybe* –Preparation of culture media – Pure culture techniques – Sterilizing techniques – Media – Maintenance of culture – Mother spawn production – Type of spawn – Polybag method – Multiplication of spawn mushroom cultivation techniques – Maintenance of spawn running and

cropping room – Harvest – Packing and storage of mushroom – Problems in cultivation: pests, diseases and weed moulds, management strategies – Nutritional value – Post-harvest technology – Methods of preservation – Other uses of mushroom – Cost analysis and project preparation.

Lecture Schedule

1. Introduction to Mushroom technology.
2. Morphology and life cycle of *Pleurotus* and *Calocybe*.
3. Morphology and life cycle of *Agaricus*, *Lentinus* and *Volvariella*.
4. Role of enzymes in mycelium and basidioma development.
5. Role of amylolytic enzymes in mushroom morphogenesis.
6. The physiology of fruiting body development.
7. Poisonous mushrooms.
8. Genetics and breeding of cultivated mushrooms.
9. Biotechnological methods for strain improvement.
10. Study of strain variability using markers: Allozyme, RFLP, AFLP, RAPD and PCR.
11. Laboratory techniques, preservation of cultures.
12. Spawn types, mother spawn and bed spawn.
13. Cultivation of oyster mushroom.
14. Cultivation of milky mushroom.
15. Cultivation of paddy straw mushroom.
16. Cultivation of button mushroom.
17. Mid-semester Examination.
18. Cultivation of shiitake mushroom
19. Outdoor visit.
20. Ectomycorrhizal mushroom.
21. Problems in cultivation: weeds and diseases.
22. Problems in cultivation: pests and abiotic disorder.
23. Uses of mushroom as food (nutritional value).
24. Uses of mushrooms as medicine.
25. Post-harvest technology, method of preservation and value addition
26. Mushrooms recipes.
27. Cost analysis in mushroom production.
28. Project preparation.
29. Project preparation.
30. Principles of enterprise management.
31. Market survey.
32. Export procedures.
33. Agricultural finance: source of finance and acquisition.

Practical Schedule

1. Introduction to mushrooms.
2. Preparation of culture media.
3. Collection, identification and pure culturing of mushrooms.
4. Collection, identification and pure culturing of mushrooms.
5. Strain improvement method: single spore isolation, hyphal anastomosis and chemical mutation.

6. Preparation of mother spawn.
7. Preparation of bed spawn.
8. Maintenance of mushroom shed.
9. Cultivation of oyster mushroom.
10. Cultivation of oyster mushroom.
11. Cultivation of milky mushroom.
12. Cultivation of milky mushroom.
13. Harvest, packing and storage of mushroom.
14. Problems in cultivation and its management.
15. Post-harvest technology of mushroom.
16. Cost analysis and project preparation.
17. Visit to Commercial mushroom production units.

Reference Books

1. Aneja, K.R. 2018. Experiments in Microbiology, Plant Pathology, Tissue culture and Cultivation of Mushroom, New Age International Publishers.
2. Bahl, N. 2000. Handbook of Mushrooms. Oxford & IBH Publishing Co. Pvt. Ltd.
3. Chadha, K.L. and Sharma, S.R. 1995. Mushroom Biotechnology Advances in Horticulture. Malhotra Publishing House.
4. Chauhan, N.M., Gagre, N.K. and Prajapati, V.P. 2013. Scientific Cultivation of Mushroom. Biotech books.
5. Kannaiyan, S., Marimuthu, T. and Leni, K. 2011. Diversity and Production of Edible Mushrooms. Associated Publishing Company.
6. Krishnamoorthy, A.S., Marimuthu, T. and Nakkeeran, S. 2005. Mushroom Biotechnology, TNAU Press, Coimbatore.
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8. Miles, P.G. and Chang, S.T. 2004. Mushrooms: Cultivation, Nutritional Value, Medicinal Effect and Environmental Impact. CRC Press.
9. Rai, R.D., Upadhyay, R.C. and Sharma, S.R. 2005. Frontiers in Mushroom Biotechnology. National Research Centre for Mushroom, Solan.
10. Suman, B.C. and Sharma, V.P. 2007. Mushroom Cultivation in India. Daya Publishing House.

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2. www.mushroomdays.com.cn
3. <https://www.mushroomcouncil.com>
4. <https://fungiforthepeople.org>
5. nrcmushroom.org

Journals

1. Mushroom Research – An International
2. Indian Journal of Mushroom Research
3. International Journal of Medicinal Mushrooms

**M.SC. (AG.) AGRICULTURAL MICROBIOLOGY
COURSE- WISE DISTRIBUTION**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	AGM 611	Principles of Microbiology	2+1
2.	AGM 612	Microbial Genetics	2+1
3.	AGM613	Food and fermentation Technology	2+1
4.	AGM 621	Microbial Physiology	2+1
5.	AGM 622	Soil Microbiology	2+1
6.	AGM 623	Environmental Microbiology	2+1
7.	AGM 624	Microbial Management of Organic waste	1+1
Total			13+7=20
Minor- 9 credits			
1.	OPC- GPB 621	Concepts of crop physiology	2+1
2.	OPC- AGM 711	Microbial Inoculant Production Technology	2+1
3.	OPC- AGM 712	Industrial Microbiology	2+1
Total			6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistical Methods and Design of Experiments	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
Total			3+2=5
Seminar + Research - 21 credits			
1.	AGM -032	Seminar	0+1
2.	AGM -011; 021;031;041	Research 011-0+1; , 021-0+2; , 031- 0+8; , 041- 0+9	0+20
Grand Total			22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0+1
4	PGS 624	Library and information services	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture	1+0
6	PGS 716 e-course	Disaster management	1+0
Total			2 + 4 = 6

**M.SC. (AG.) AGRICULTURAL MICROBIOLOGY
SEMESTER WISE DISTRIBUTION**

S.No.	Course No.	Courses	Credit Hours
FIRST SEMESTER			
1.	AGM 611	Principles of Microbiology	2+1
2.	AGM 612	Microbial Genetics	2+1
3.	AGM613	Food and fermentation Technology	2+1
4.	STA 611	Statistics	2+1
5.	AGM 011	Research	0+1
6.	COM 611	Computer Applications for Agricultural Research	1+1
7.	PGS 611	Agricultural Research Ethics & Methodology (0+1)	
8.	PGS 612	Technical writing and Communication Skills (0+1)	
		Total	9+6=15
SECOND SEMESTER			
1.	AGM 621	Microbial Physiology	2+1
2.	AGM 622	Soil Microbiology	2+1
3.	AGM 623	Environmental Microbiology	2+1
4.	AGM 624	Microbial Management of organic wastes	1+1
4.	AGM 021	Research	0+2
5.	OPC-GPB621	Concepts of crop physiology	2+1
6.	PGS 623	Basic concept in Laboratory Techniques(0+1)	
7.	PGS 624	Library and Information services (0+1)	
		Total	9 + 7 = 16
THIRD SEMESTER			
1.	OPC XXX 711	Minor Course - Related discipline	2+1
2.	OPC XXX 712	Minor Course - Related discipline	2+1
3.	AGM 031	Research	0+8
4.	AGM 032	Seminar	0+1
5.	PGS 715 e-course	Intellectual property and its management in agriculture (1+0)	-
6.	PGS 716 e-course	Disaster management (1+0)	-
		Total	4+11 =15
FOURTH SEMESTER			
1.	AGM 041	Research	0 + 9
		Total	0 + 9
		Grand Total	22+33 = 55

AGM 611- PRINCIPLES OF MICROBIOLOGY (2+1)

Objectives

To study the fundamentals and principles of microbiology, basic techniques of microbiology, to isolate, cultivate and identifying the microorganisms.

Theory

Unit-I- History and basic techniques of microbiology

Historical developments - contributions of Antony Van Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Fleming, S.A. Waksman, Edward Jenner and other recent innovations in the field of microbiology-Microscopy-light microscope-electron microscope-scanning probe microscopy- advances in microscopy - sterilization - principles and methods of sterilization-staining-principles and types of staining.

Unit-II- Structure of prokaryotic and eukaryotic cell

Prokaryotic and eukaryotic microorganisms-bacteria: morphology of bacteria-ultra structure of bacteria- Archaeal cell structure - Morphology, structure and general characteristics of Fungi, Algae, Protozoa, Viruses and Prions.

Unit-III- Culture techniques and microbial growth

Culture media- types of media- isolation and purification techniques-enrichment culture- preservation methods of microorganisms - growth- bacterial growth curve-nutrient requirement- nutritional types- measurement of microbial growth-influence of environmental factors on microbial growth.

Unit-IV- Microbial taxonomy

Microbial taxonomy-definition and systematics, nomenclature - classification-types-taxonomic hierarchy-major characteristics used in taxonomic classification - Phylogenetic trees-Whittaker's five kingdom concept - classification of bacteria according to Bergey's manual of systematic bacteriology-outline classification of fungi, algae, protozoa and viruses.

Unit-V- Microbial identification

Identification of microbes based on morphological and biochemical characteristics-Identification based on molecular and serological techniques.

Theory Schedule

1. Introduction – Microbiology -Historical developments - Pioneers in
2. Microbiology.
3. Contributions of Louis Pasteur and Robert Koch.
4. Contributions of Alexander Fleming, S.A.Waksman and others.
5. Microscopy- principle and optics, light microscope.
6. Electron microscope- transmission Electron Microscope, Scanning
7. Electron microscope and scanning probe microscope.
8. Sterilization principles and methods.
9. Principles of staining and types of staining.
10. Prokaryotic and eukaryotic microbes – their differentiation.
11. Bacterial morphology and ultra structure.
12. Cell wall composition - gram positive and gram negative.
13. Archaeal cell structure- bacterial cell vs archaeal cell.
14. Morphology, structure and characteristic of fungi and algae.
15. Morphology, structure and characteristic of protozoa and viruses.
16. Growth media-types of media.

17. Isolation, purification and enrichment culture technique.
18. Measurement of microbial growth and population.
19. Mid Semester Examination.
20. Preservation methods of microorganisms.
21. Bacterial growth curve.
22. Measurement of microbial population
23. Nutrient requirements.
24. Nutritional types.
25. Factors influencing microbial growth.
26. Microbial taxonomy-introduction-types of classification, taxonomic hierarchy.
27. Characteristics used in taxonomy-morphology, physiological,
28. Biochemical and Ecological.
29. Molecular characteristics-G+C content- nucleic acid hybridization-
30. NA sequence (16sr RNA).
31. Whittaker's five kingdom concept.
32. Bacterial classification- Bergey's Manual of Systematic Bacteriology.
33. Fungal and Algal classification.
34. Protozoa and Viral classification.
35. Microbial identification- morphological and biochemical.
36. Microbial identification- molecular techniques.
37. Microbial identification- serological techniques
38. Microbial identification -precipitation and agglutination

Practical Schedule

1. Preparation of different growth media for culturing microorganisms.
2. Enrichment, selective and differential media.
3. Examination of microorganisms- micrometry.
4. Staining techniques - simple staining.
5. Differential-gram staining.
6. Structural staining- flagella Staining.
7. Capsule staining.
8. Endospore staining.
9. Isolation and purification of bacteria.
10. Enumeration of bacteria
11. Measurement of Microbial growth
12. Effect of pH on growth of microorganism
13. Effect of temperature on growth of microorganism
14. Biochemical characters of bacteria.
15. Growth curve of bacteria.
16. Testing different carbon requirements.
17. Testing of nitrogen requirements and Antigen antibody reaction.

References Books

1. Ananthanarayanan and Panikar. 2017. Text book of Microbiology. 10th Edn. Universities press.

2. Atlas, R.M. 2000. Microorganisms in Our World, Mosby Year Book Inc., Wm. C. Brown Pub., Oxford.
3. H.C. Dube. A text book of fungi, bacteria and viruses. 2007. Student Edition.
4. Holt, JS. Kreig NR, Sneath P.H.A and Williams S.T. 1994. Bergey's Manual of Determinative Bacteriology (9th edition) Williams and Wilkins, Baltimore.
5. K.R. Aneja. 2008. A text book of basic and applied microbiology. New age International publishers.
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8. Prescott LM, Harley JP and Klein DA. 2010. Microbiology (5th Edition) McGraw Hill New York. 2017, 10th Edition
9. Schlegel. H.G. 2004 General Microbiology, (7th Edition) Cambridge University Press
10. Tortora, Funke & case. 2013. 12th Edn. Microbiology on introduction. Pearson publication.

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1. <https://microbiologyinfo.com/top-and-best-microbiology-books/>
2. <https://guides.ou.edu/microbiology/reference>
3. <https://www.jstor.org/stable/4442169>

AGM 612- MICROBIAL GENETICS (2+1)

Objective

The students be educated to understand the fundamental aspects of microbial genetics, nucleic acid structure, function, mutation and genetic recombination in prokaryotes and eukaryotes and fungal genetics.

Theory

Unit-I- Nucleic acids, genomic organization

Evolution of microbial genetics- Nucleic acids-DNA and RNA - arrangement of nucleotides in DNA - general concepts of DNA replication- salvage and *de novo* pathways of nucleotide synthesis - replicon model and replication operations- DNA synthesis *in vitro* - denaturation and renaturation of nucleic acids - gene and genome - Nucleotide sequencing - Genetic variability in prokaryotic and eukaryotic microorganisms - Reproduction in bacteria and fungi and segregation of genetic characters - gene expression and its regulation - process of transcription , translation and transcriptional regulation - prokaryotic and eukaryotic genome - functional genome and proteome - Molecular basis for genome evolution and concepts of phylogenetics.

Unit –II- Genetic variability - mutation

Genetic variability in microorganisms - Mutation and genetic recombination - Mutation in bacteria- spontaneous and induced mutations- Natural selection of mutants - Induction of mutation in microorganisms - Physical and chemical mutagenic agents - DNA damages and modifications in nucleotide sequences -

Photoreactivation - nucleotide excision and repair - Different types of mutants and their scoring.

Unit –III- Genetic recombination

Genetic recombination in prokaryotic microorganisms- *in vivo* and *in vitro* recombination - mechanism of recombination - Transformation - cellular competence and environmental conditions required for transformation. Conjugation in bacteria - intergeneric and intrageneric conjugation – chromosome mapping - transduction - general, restricted transductions and abortive transductions – Bacteriophage genetics – structure of the phage particle – Mutant phages – process of infection - Transposons and mechanism of transposition – site specific recombination.

Unit-IV- Genetic variability

Model systems in Genetic analysis: genetics of fungi - mutation in fungi - classical genetics of *Neurospora crassa* - variability through sexuality and Para sexuality. Yeast genetics.

Unit-V- Genetic engineering

Cloning and transformations - restriction endo nucleases – vectors – plasmids and cosmids – isolation of gene, cloning and transformation in prokaryotes and eukaryotes – *Ti* and *Ri* plasmids and their role in transgenics. Polymerase Chain Reaction – Genomic DNA and cDNA libraries. General account on application of genetic engineering in Industry, Agriculture and Medicine.

Practical

DNA isolation from bacteria and study of the plasmid profile - DNA sequencing - mutation studies in bacteria - Spontaneous mutation and induction of mutation by physical and chemical mutagenesis - Replica plating technique and isolation of auxotrophic and drug resistant mutants. Biological mutagenesis by transposons - Studying the frequency of mutation - Conjugation experiments in bacteria - Conjugative plasmids - intergeneric and intrageneric plasmid transfer - interrupted mating experiments and chromosome mapping in *E. coli*. Isolation of bacteriophages - titer value - Induction of mutation in *Neurospora crassa* with chemical mutagens and assessing the frequency of mutation - yeast genetics and recombination - Polymerase chain reaction.

Theory Schedule

1. Microbial genetics – definition – evolution – historical developments.
2. Advantageous in microbial genetics - basic genetic material - gene, genome, genotype and phenotype.
3. Studying the nucleic acid – biochemical structure – nucleotides arrangements in nucleic acids - general concepts of DNA replication.
4. Salvage and *de novo* pathways of nucleotide synthesis - replicon model and replication operations.
5. DNA synthesis *in vitro* - denaturation and renaturation of nucleic acids – gene and genome.
6. Genetic differences of prokaryotic and eukaryotic microorganisms.
7. Prokaryotic and eukaryotic gene expression and regulation.

8. Nucleotide sequencing in bacterial DNA - Chemical method and other rapid methods.
9. Studying *E.coli* and yeast genome.
10. Applications of genomic studies - functional genome and proteome.
11. Molecular basis for genome evolution and concepts of phylogenetic grouping of Microorganisms.
12. Genetic variability in microorganisms - Mutation and genetic recombination- mutation in bacteria- spontaneous and induced mutations.
13. Induction of mutation in microorganisms - Chemical and physical mutagens and Mutagenesis.
14. Different types of mutations and mutants and their characters.
15. DNA damages and modifications in nucleotide sequences - photo reactivation - nucleotide excision and repair.
16. Scoring the mutants and studying the rate of mutation.
17. Mid Semester Examination.
18. Genetic recombination in prokaryotic microorganisms- *in vivo* and *in vitro* recombinations - mechanism of recombination
19. Conjugation in bacteria - fertility factor - F⁺, F⁻ F' and Hfr cells and their mating Processes
20. Intergeneric and intrageneric recombination through conjugation - chromosome mapping by interrupted mapping.
21. Bacteriophage genetics - structure of the phage particle - lytic and lysogenic cycles transducing phages - process of infection.
22. Transduction - general, restricted transductions and abortive transductions
23. Transposons and mechanism of transposition - site specific recombination
24. Transformation - cellular competence and environmental conditions required for transformation - enhancing the competence of bacterial cell for the uptake of DNA.
25. *In vitro* recombination - principles of cloning and transformations to create genetic variability.
26. Genetics of fungi - basis for genetic variability in fungi - sexual reproduction in lower and higher fungi. Para sexuality in fungi - their importance in creation of genetic variability.
27. Extra nuclear DNA in fungi - 2 μ m circles - mitochondrial and chloroplast DNA.
28. Induction of mutation in fungi and their importance.
29. Genetics of *Neurospora crassa* - plasmids and plasmid like DNAs in *Neurospora* and their characters.
30. Genetics of yeast - mutation in yeast.
31. Importance of restriction endo nucleases and vectors in cloning - plasmids and cosmids as useful vectors.

32. Cloning and transformation in prokaryotes and eukaryotes - Ti and Ri plasmids and their role in transgenic transformation.
33. Polymerase chain reaction.1
34. Genomic DNA and cDNA libraries and Application of genetic engineering in industry, agriculture and medicine.

Practical Schedule

1. Genetic purity in bacterial strains – single colony isolation.
2. Genetic purity of *Neurospora crassa* – single hyphal tip isolation.
3. Evaluation of intrinsic antibiotic resistance characters in bacteria
4. Studying the maximum allowable concentration level in bacterial strains.
5. Spontaneous mutagenesis for antibiotic resistance in *E. coli*.
6. Chemical mutagenesis in bacteria for heavy metal tolerance.
7. Induction of mutation in bacteria by UV light
8. Induction of mutation in fungi for hyper pigmentation.
9. Conjugation in bacteria.
10. Isolation of bacteriophages and phage titration.
11. Genomic DNA isolation in bacteria.
12. Isolation of plasmid DNA in *E. coli*.
13. Plasmid curing in *E. coli* by Acridine orange.
14. Agarose gel electrophoresis of DNA from *E. coli*.
15. Restriction digestion and size determination of plasmid DNA.
16. Preparation of competent cell in *E. coli* and transformation studies.
17. Practical examination.

References Books

1. Brian W. Bainbridge 2013. Genetics of Microbes Tertiary Level Biology. Springer Science & Business Media.
2. Daniel L. Hartl. 2009. Essential Genetics. A genomics perspective, 5th edition, Jones and Barlett pub.
3. George M. Malacinski. Freifelder's 2015. Essentials of Molecular Biology. Jones & Barlett Pub, Boston.
4. Jeremy W. Dale and Simon F. Park. 2010. Molecular Genetics of Bacteria. Wiley – Blackwell.
5. Jianping Xu 2010. Microbial Population Genetics. Horizon Scientific Press.
6. Larry Snyder, Joseph E. Peters, Tina M. Henkin and Wendy Champness. Molecular Genetics of Bacteria.
7. Ldis N. Streips and Ronald E. Yazsbin. 2002. Modern Microbial Genetics. Wiley – Liss. John Wiley & sons, Inc., Publication
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9. Pierce, Benjamin A. 2012. Genetics; A conceptual approach. New York: W.H. Freeman.
10. Stanley R. Maloy, John E. Cronan, Jr., David Freifelder, 1994. Microbial Genetics. Jones & Barlett Pub, Boston.

11. Venetia A. Saunders 2013 Microbial genetics applied to biotechnology- Principles and techniques of gene transfer and manipulation. Springer Publications, USA.

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AGM 613- FOOD AND FERMENTATION TECHNOLOGY (2+1)

Objective

The emphasis of course will be on the basic principles and applied aspects of food and fermentation technology such as characteristics of food microflora, food preservation, spoilage of fermented foods and immobilization techniques.

Theory

Unit - I- Food microflora

Introduction and importance of food microbiology – Incidence and behaviour of microorganisms in food – sources of contamination in food.

Unit – II- Food preservation

Principles of food preservation – methods of preservation physical methods – high temperature, low temperature, drying, osmotic pressure, irradiation, chemical methods – class I and II chemicals. food manufacturing practices – HACCP – quality control in food processing industries. food quality control and standards - FAASI.

Unit – III- Fermented foods and food spoilage

Fermentation of pickles, sauerkraut, bread, vinegar, idli, beverages – alcohol production – beer, wine. single cell proteins – application microbial enzymes in food industries. microbial spoilage of different types of food – spoilage of cereals and cereal products, fruits and vegetables, meat, egg and poultry. sea food and canned foods. food poisoning – botulism – food borne infections and food pathogens – mycotoxins.

Unit – IV- Microbial fermentations and bioreactors

Concepts and scope of microbial fermentations – inoculum – screening and selection – strain improvement – fermentation medium- fermentation processes- dual and multiple fermentation – continuous fermentation, batch fermentation. bioreactors – types, designs and functional characteristics.

Unit – V- Immobilization and fermented dairy products

Principles of immobilization – different kinds of immobilization techniques and their importance – preservation of dairy products – pasteurization – fermented dairy products – diseases spread by microbes through milk.

Theory Schedule

1. Introduction and importance of food microbiology – Types of microorganisms in food.
2. Incidence and behaviour of microorganisms in food.
3. Sources of microorganisms found in food – Intrinsic and extrinsic parameters of food affecting microbial growth.
4. Food preservation techniques.
5. Food sanitation and food manufacturing practices.

6. Fermentation of pickles, sauerkraut, bread, vinegar and idly.
7. Fermentation of beverages.
8. Alcohol production.
9. Beer production.
10. Wine production.
11. Single cell production technique.
12. Application of microbial enzymes in food industries.
13. Microbial spoilage – Types of spoilage.
14. Microbial spoilage of cereal and cereal products.
15. Spoilage of fruits and vegetables.
16. Spoilage of meat.
17. Mid Semester Examination
18. Spoilage of egg and poultry.
19. Spoilage of sea foods.
20. Spoilage of canned foods.
21. Food poisoning – botulism.
22. Food borne infection – food pathogens.
23. Mycotoxins
24. Scope of fermentation technology.
25. Screening and selection of microorganisms.
26. Strain improvement of microorganisms.
27. Inoculum – fermentation medium.
28. Dual and multiple fermentation.
29. Bioreactors – types, designs and functional characteristics.
30. Principles of immobilization – techniques and importance.
31. Preservation of dairy products.
32. Pasteurization techniques.
33. Fermented dairy products.
34. Diseases spread by microbes through milk.

Practical

1. Microbiological examination of normal fruits and vegetables.
2. Microbiological examination of spoiled fruits and vegetables.
3. Microbiological examination of normal cereal and sugar products.
4. Microbiological examination of spoiled cereal and sugar products.
5. Microbiological examination of egg.
6. Microbiological examination of canned food.
7. Microbiological examination of spoiled meat and fish.
8. Microbiological survey of utensils and processing plants.
9. Assessing the load of coliform bacteria as indicator organisms.
10. Methylene blue reduction test.
11. Resazurin test.
12. Microbiological examination of milk.
13. Alcohol production from jaggery.
14. Wine production.

15. Bread making.
16. Ethanol production by immobilized yeast cells.
17. Enzyme production – amylase production and Visit to distillery unit / beer production unit.

Reference Books

1. Bibek Ray and Arun K. Bhunia. 2014. Fundamental Food Microbiology, Fifth Edition. CRC Press, Taylor & Francis Group, LLC. New Delhi.
2. Montville., Thomas J. Mattnews., Karl, R., Kniel and Kalmia, E. 2017. Food Microbiology an Introduction, Third Edition. ASM Press. California.
3. Neelima Garg., Garg, K.L and Mukerji, K.G. 2010. Laboratory Manual of Food Microbiology. I. K. International Publishing House Pvt. Ltd. New Delhi.
4. Peppler, H.J and Perlman, D. 2014. Microbial Technology and Fermentation Technology. Academic Press. New York.
5. Shikha Ojha,K and Brijesh, K. Tiwari. 2016. Novel Food Fermentation Technologies. Springer Science & Buisness Media. New York.
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8. Ramanathan, N. 2018. Food Microbiology. New India Publishing Agency, New Delhi.
9. Sivakumar, P.K. and M.M. Joe and Sukesh. 2013. Industrial Microbiology, S.chand Pvt Ltd., New Delhi.

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AGM 621- MICROBIAL PHYSIOLOGY (2+1)

Objective

The emphasis of course will be transport mechanism inter conversion of energy pathways glycolysis, oxygenic and anoxygenic photosynthesis.

Theory

Unit - I- Cell wall and transport mechanisms

Biosynthesis of peptidoglycon – outer membrane, techoicacid – Exopolysaccharides – cytoplasmic membrane. Pili, Fimbriae, S – layer, Transport mechanisms – Active, Passive facilitated diffusions – Uni, sym, Antiports – Chemiosmotic theory.

Unit – II- Reproduction and sporulation

Microbial differentiation – Sporulation – Endo and Exospores – Endospore formation in *Bacillus* sp. Exospore formation in *Streptomyces* – Reproduction in fungi – formation of specialized structure – akinetes, cysts and heterocysts.

Unit – III- Respiration and energy generation

Anaerobic respiration – Anabolic and Catabolic processes of lipids, Reproductive physiology of microorganisms. Generation of ATP, reducing power, Biosynthesis of ATP by ATP synthase.

Unit – IV- Catabolic metabolism

Glycolysis – Pentose phosphate pathway – Entner Doudroff pathway – Oxidation of pyruvate – TCA cycle – Gluconeogenesis – Autotrophs – Heterotrophs – Myxotrophs – Cyanobacteria. Photosynthetic bacteria and green algae – Photosynthesis – Oxygenic and anoxygenic Photosynthesis – Mechanisms of Carbon-dioxide fixation in prokaryotes.

Unit – V- Regulation of metabolism and sporulation

Regulation of metabolism control mechanisms operating at DNA level, transcriptional level, translation level, post translation level and regulation of protein activity – Feedback control Mechanisms. Microbial growth – Nature and expression of growth – Measurement of growth. Effect of environmental factors on microbial growth – Response of microorganisms to stress – Sporulation in bacteria.

Theory Schedule

1. Introduction and scope of microbial physiology.
2. Biosynthesis of peptidoglycon.
3. Outer membrane, teichoic acid and Exopolysaccharides.
4. Cytoplasmic membrane.
5. Cell wall appendages - Pili, and Fimbriae, S – layer.
6. Mechanisms of nutrient transport in bacteria – Passive & facilitated diffusions.
7. Primary active uptake – secondary active uptake, Chemiosmotic theory.
8. Microbial differentiation and sporulation.
9. Endospore formation in Bacteria.
10. Exospore formation in Fungi.
11. Reproduction in fungi.
12. Formation of specialized structure like akinetes, cysts and heterocysts.
13. Anaerobic respiration.
14. Anabolic and Catabolic processes of lipids.
15. Reproductive physiology of microorganisms.
16. Generation of ATP, reducing power.
17. Mid Semester Examination
18. Biosynthesis of ATP by ATP synthase.
19. Glycolysis – Oxidation of pyruvate – TCA cycle – Glyoxylate cycle.
20. Types of nutritional habits among microorganisms.
21. Photosynthesis - Oxygenic and anoxygenic Photosynthesis.
22. Alternate pathways of glucose metabolism – HMP – Pentose phosphate pathway – Entner Doudroff pathway.
23. Mechanisms of Carbon-dioxide fixation in prokaryotes.
24. Gluconeogenesis biosynthesis of storage compounds and energy reserves in bacteria.
25. Microbial growth – Nature and expression of growth.

26. Measurement of growth and growth curve, generation time.
27. Effect of environmental factors on microbial growth – Response of microorganisms to stress.
28. Sporulation in bacteria.
29. Regulation of metabolism.
30. Control Mechanisms operating at DNA level.
31. Transcriptional level, Translation level
32. Post translation level.
33. Regulation of protein activity.
34. Feed back control Mechanisms.

Practical Schedule

1. Determination of molar growth yield – YG and YATP.
2. Preparation of Liquid Media for cultivation of microorganisms.
3. Preparation of Solid Media (Nutrient agar) for cultivation of microorganisms.
4. Growth of selected species of bacteria on various Carbon sources.
5. Growth of selected species of bacteria on various Nitrogen sources.
6. & 7. Development of growth curve of bacteria based on colony forming units.
8. & 9. Development of growth curve of bacteria based on turbidity measurements.
10. Development of growth curve of bacteria based on protein content.
11. Effect of pH on growth and development of bacteria.
12. Effect of temperature on growth and development of bacteria.
13. Indole test.
14. Methyl red test.
15. Voges proskauer test.
16. Photosynthetic pigments in bacteria.
17. Practical examination.

References Books

1. Bernhard Schink. 2012. *Advances in Microbial Ecology*. Springer Science & Business Media, New York.
2. Cohen G.N. 2011. *Microbial Biochemistry*. Springer Science & Business Media, New York.
3. Gunsalus I.C and Roger Y. Stainer 2013. *The Physiology of Growth*. Academic Press, New York.
4. Michael J. Bazin and James I. Prosser. 2018. *Physiology Models in Microbiology*. CRC Press, Taylor & Francis group, New York.
5. Sokatch, J.R. 2014. *Bacterial Physiology and Metabolism*. Academic Press, Okimo State University, New York.
6. Albert, G., Moat, John W.Foster and Michael P.Spector. 2012. *Microbial Physiology*. Wiley-Liss, Inc.

7. Dubey. R.C. and D.K. Maheswari. 2012. A text of Microbiology, Revised edition, S.Chand and company Ltd., New Delhi.
8. Robert poole, 2017. Advances in Microbial Physiology, Volume 71, 1st edition. Academic press. New York.
9. Imrich Barak, M. Simon, cutting, Ezio Ricea, Neil Fair weather, Ivan MiJakovic. 2017. Spores and spore Formers. Frontiers Publication. South Africa.
10. David white. 2011. The Physiology and biochemistry of Prokaryotes. Oxford University Press. 4th edition.

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AGM 622- SOIL MICROBIOLOGY (2+1)

Objectives

To educate the students on different soil biological processes and its significance in the bio dissolution of various plant nutrients and commercial utilization of microorganisms.

Theory

Unit – I- Importance of microorganisms in soil

Historical developments in Soil Microbiology- Contributions of Beijerinck, Winogradsky, Alexander Fleming, Hiltner, and S.A.Waksman - Distribution of microorganisms in soil - quantitative and qualitative microflora of different soils - Role of microorganisms in soil fertility - Influence of soil and environmental factors on microflora - moisture, pH, temperature, organic matter, and agronomic practices etc.

Unit – II- Microorganisms in soil processes

Microorganisms in soil processes - carbon cycle - organic matter decomposition - humus formation - nitrogen cycle – proteolysis - ammonification - nitrification, denitrification reactions - organisms involved - factors affecting nitrogen transformation. nitrogen fixation - symbiotic, non-symbiotic, associative symbiotic and endophytic organisms- process of nitrogen fixation - root nodule formation, structure and functions of root nodule – mechanism and biochemistry of nitrogen fixation – *Frankia* - casuarina symbiosis.

Unit – III- Microbial transformation of nutrients

Microbial transformation of elements in soil - phosphorous cycle - phosphorous solubilization by phosphobacteria - Mycorrhiza - ecto and endomycorrhiza - AM fungi - sulphur cycle and sulphur bacteria - iron cycle and iron bacteria and their importance. Inter relationships between microbes and plant microbe interactions - Rhizosphere concept - quantitative and qualitative studies - R: S ratio - Rhizoplane- Spherosphere - Phyllosphere microorganisms and their importance in plant growth

Unit – IV- Microbial inoculant production technology

Mass production of bacterial biofertilizers, azolla and algal biofertilizers - AM fungi - PGPR organisms - use of soil microorganisms for pest and diseases control – Biopesticide production.

Unit –V- Pesticides degradation and plant microbe interactions

Pesticide and soil microflora - microbial decomposition of chemicals applied to soil - effect of pesticides on soil microorganisms - xenobiotics in soil – Molecular plant microbes interaction - cell signaling, quorum sensing and biofilm formation.

Practical

Enumeration of microbial population in soil - qualitative and quantitative distribution. Isolation of symbiotic nitrogen fixing bacteria – non- symbiotic and associative symbiotic bacteria - nitrification - denitrification. organic matter decomposition - CO₂ evolution. Isolation of Phosphobacteria - Isolation of sulphur and iron bacteria. Rhizosphere - Spherosphere - Phyllosphere microorganisms. AM fungi - root infection - Ectomycorrhizae - Associative and antagonistic relationships among soil microorganisms - microbial degradation of pesticides and herbicides- molecular plant microbe interactions.

Theory Schedule

1. Introduction to soil microbiology.
2. Historical developments in soil microbiology.
3. Contributions of Beijerinck, Winogradsky, Alexander Fleming, Hiltner, and Waksman.
4. Distribution of microorganisms in soil - quantitative and qualitative nature of microflora on different soils.
5. Role of microorganisms in soil fertility.
6. Influence of soil and environmental factors on microflora - moisture, pH, temperature, organic matter, agronomic practices etc.
7. Carbon cycle.
8. Organic matter decomposition - humus formation.
9. Nitrogen cycle, Proteolysis, Ammonification , Nitrification, Denitrification reactions organisms involved.
10. Factors affecting nitrogen transformation.
11. Nitrogen fixation, symbiotic and non -symbiotic.
12. Associative symbiotic and endophytic organisms.
13. Root nodule formation in legume plants,its structure and functions.
14. Mechanism and biochemistry of nitrogen fixation.
15. *Frankia* - casuarina symbiosis.
16. Phosphorous cycle phosphorous solubilization by phosphobacteria.
17. Mid Semester Examination
18. Mycorrhiza - ecto and endomycorrhiza.
19. Sulphur cycle and sulphur bacteria.
20. Iron cycle and iron bacteria and their importance.
21. Inter relationships between microbes.
22. Plant microbe interactions - Rhizosphere concept - R: S ratio.

23. Rhizoplane, Spherosphere, Phyllosphere microorganisms and their importance in plant growth.
24. Bacterial biofertilizer production.
25. Azolla, Algal and AM fungal biofertilizer production.
26. Plant Growth Promoting Rhizobacteria (PGPR).
27. Role of soil microorganisms in pest and diseases control.
28. Biopesticide production.
29. Pesticide degradation by soil microflora.
30. Microbial decomposition of chemicals applied to soil.
31. Effect of pesticides on soil microorganisms xenobiotics in soil.
32. Plant microbe interaction.
33. Cell signaling, Quorum sensing
34. Biofilm formation.

Practical

1. Enumeration of microbial population from soil – Standard plate count method.
2. Enumeration of microbial population from soil – Conn's direct microscopic count method.
3. Enumeration of cyanobacteria from low land rice ecosystem by MPN method
4. Isolation of symbiotic nitrogen fixing bacterium – *Rhizobium*.
5. Isolation of non-symbiotic Nitrogen fixing bacterium – *Azotobacter*.
6. Isolation of *Azospirillum*.
7. Isolation of endophytic symbiotic nitrogen fixer *Gluconacetobacter diazotrophicus*
8. Isolation of phosphobacteria
9. Isolation of *Blue green Algae*
10. Isolation of phyllosphere and spherosphere microorganisms.
11. Isolation and identification of endomycorrhizal fruting bodies from soil.
12. Percentage colonization of AM fungi from root samples.
13. Organic matter decomposition - CO₂ evolution
14. Calculation of R:S ratio.
15. Mass production of Bacterial biofertilizers and Quality control
16. Mass production of Algal biofertilizers and method of applications
17. Mass production of mycorrhizal biofertilizers and methods of applications

Reference Books

1. Adhya, T.K., Lal, B., Mohapatra, B., Paul, D. and Das, S. Advances in Soil Microbiology; Recent Trends and Future Prospects. Springer Publi., UK.
2. Barabara. E., Schulz Christein J.C. Boyle Thomas N. Sieber (Eds.) 2006. Microbial Root Endophytes. Springer publications, germany.
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4. Dixon, G.R., Tilston, Emma L.(Eds.) 2010 Soil Microbiology and Sustainable Crop Production, Springer publisher.
5. Eldor paul, 2015. Soil Microbiology, Ecology and Biochemistry, fourth edition, acadmic press, wyman St., Waltham.

6. Mukerji, K.G., C. Manoharachary and J.Singh(Eds.) 2006. Microbial Activity in the Rhizosphere Series: Soil Biology, Vol. 7XVI, 349 p. 35 illus, UK.
7. Paul E.A and F.E. Clark 1996. Soil Microbiology and Biochemistry, Academic Press. California.
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9. Subba Rao, N.S 2001. Soil Microbiology, Oxford and IBH publishing House. India
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AGM 623- ENVIRONMENTAL MICROBIOLOGY (2+1)

Objectives

This course will express to understand the applications of microorganisms in the environmental protection, Understanding current trends in environmental microbiology and critically appraising the issues related to environment.

Theory

Unit I- Microbial communities and ecosystems

Microbial community dynamics, structure of microbial communities. Ecosystems – concept and ecological pyramid. structure and functions of some microbial communities in nature. Microbes in extreme environments: Habitat, biodiversity, adaptive strategies and biotechnological potential of thermophiles and hyperthermophiles, psychrophiles and psychrotrophs, halophiles, acidophiles and alkalophiles.

Unit II- Water pollution

Sources and types, physical, chemical and biological pollution of water, eutrophication and its control. Waste water treatment – methods and recent developments in developing countries – waste stabilization ponds – aerated lagoons, oxidation ditches, bio-methanation.

Unit III- Solid waste

Types and Classification. Municipal refuse composition – landfill sites and refuse emplacement strategies – refuse degradation – landfill products and site exploitation – toxic and hazardous wastes. Composting- types and methods. probiotic organisms – role of the lactic acid bacteria in silage additives.

Unit IV- Global environmental problems

Global warming, Ozone depletion, acid rain. Environmental monitoring: environmental impacts and their assessments using bioindicators, biomarkers, biosensors and toxicity testing, rDNA technology. Conservation strategies.

Unit V- Indian environmental laws

State and Central government acts and governing bodies. World perspectives of environmental issues- status and scope of biotechnology in environmental protection. Impact of GMO on environment.

Theory Schedule

1. Microbial communities and ecosystems.
2. Ecosystems concept and ecological pyramid.
3. Microbes in extreme environment
4. Biotechnological potential of extremophiles.
5. Potential of hyperthermophiles, psychrophiles and psychrotrophs,
6. Potential of halophiles
7. Potential acidophiles
8. Potential of alkalophiles
9. Water pollution – measurement of pollution and its control.
10. Waste water treatment concepts
11. waste stabilization ponds
12. Aerated lagoons types and oxidation ditches
13. Concept of bio-methanation.
14. Solid waste – Types and classification.
15. Municipal solid waste management.
16. Landfill sites and refuse emplacement strategies.
17. Midsemester
18. Toxic and hazardous wastes exploitation strategies.
19. Composting methods
20. Types of composting.
21. Probiotic organisms – role of the lactic acid bacteria in silage additives.
22. Global environmental problems: air pollution.
23. Air pollution types and remedial measures.
24. Global warming phenomenon.
25. Ozone depletion issues and how to minimize& Acid rain- problems and control measures.
26. Environmental monitoring: environmental impacts and their assessments.
27. Bioindicators, biomarkers, biosensors and toxicity testin.
28. rDNA technology for environmental pollution abatement.
29. Conservation strategies for environment.
30. National and state environmental laws and governing bodies.
31. World perspectives of environmental issues.
32. Status and scope of biotechnology in environmental protection. Review of lectures.
33. Impact of GMO on environment.
34. Review of Lectures.

Practical Schedule

1. Studies on microbial communities in soil – Succession
2. Isolation of microorganisms from extreme environment
3. Characterization of waste water
4. Estimation of biochemical oxygen demand
5. Estimation of chemical oxygen demand
6. Estimation of organic carbon

7. Estimation of ammonia and hydrogen sulfide
8. Estimation of *E.coli.* and total bacteria
9. Activated sludge systems
10. Decolorization of waste water
11. Biofilters and bioaccumulation
12. Solid waste treatment; composting determination of compost maturity
13. Vermicompost
14. Isolation of lactic acid bacteria
15. Isolation for cellulose degrading enzymes
16. Assessment of microorganisms in air
17. Impact of air pollution on Phyllosphere & Spherosphere.

Reference Books

1. Aalecia M. Spooner 2012. Environmental Science. John Wiley and Sons, Inc, New Jersey.
2. Arne Vesilind 2013. Environmental Pollution and control. 3rd Ed. Butterworth-Heinemann.
3. Alan H. Varnam and Malcolm G. Evans. 2000. Environmental Microbiology. Manson Publishing Ltd; 1 edition
4. Bhatia, S.C., 2008. Hand book of Environmental Microbiology: Vol. 1.
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6. Garima Kaushik 2015. Applied Environmental Biotechnology. Springer Publication.
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AGM 624- MICROBIAL MANAGEMENT OF ORGANIC WASTE (1+1)

Objectives

To enable the students to learn the different types of organic wastes generated and their management techniques by employing microbes.

Theory

Unit-I- Concept of organic waste

Characteristics and classification of waste- potential availability of agro industrial waste-collection handling and processing of waste – microbial decomposition of organic material-aerobic and anaerobic processes - factors affecting degradation.

Unit-II- Solid waste management

Solid waste management- Principle and methods of composting - aerobic and anaerobic composting techniques - windrow composting- Vermicomposting - advantages and disadvantages nutritive value - improved techniques in composting- factors affecting composting.

Unit-III- Role of microbes on enriched compost

Microbial inoculant for composting - microbial consortium for enriched compost – quality standard and maturity test for compost - handling-storage - Method of application - Effect on soil fertility and crop productivity.

Unit-IV- Liquid waste management

Liquid waste management- impact on environment - characterization of liquid waste- waste water treatment- primary: sedimentation, coagulation and flocculation - secondary: trickling filter, activated sludge process, oxidation ponds - tertiary treatments: disinfection, chlorination - safe disposal of treated effluents.

Unit-V- Utilization of organic waste

Anaerobic digester – types - microbiology of anaerobic digestion - feedstock for anaerobic digesters-aquatic plants, organic waste and energy crops for biogas - factors influencing biogas production.

Theory Schedule

1. Wastes-classification and characteristics.
2. Various Agro Industrial waste- collections, handling, processing.
3. Decomposition of organic material.
4. Factors affecting degradation.
5. Principles of composting.
6. Methods of aerobic and anaerobic composting.
7. Windrow and vermicomposting - special techniques.
8. Factors affecting composting.
9. Mid semester Examination.
10. Microbial inoculant for composting - selection and preparation.
11. Microbes for enriched composting.
12. Quality standard - method of application.
13. Effect on soil fertility and crop growth.
14. Characteristics and impact of liquid waste on environment.
15. Primary and secondary treatment.
16. Tertiary treatment and safe disposal.
17. Anaerobic digester - types - microbiology of biogas production.

Practical Schedule

1. Qualitative and quantitative enumeration of microorganisms from organic waste.
2. Degradation of cellulose.
3. Determination of CO₂ evaluation.
4. Quantification of methane from organic wastes.
5. Isolation of methane producing microorganisms from the wastes.
6. Methods of composting.
7. Preparation of enriched compost.
8. Vermicomposting.
9. Studying the coir pith degradation.
10. Testing the maturity and quality of compost.
11. Characterization of waste water.
12. Determination of BOD in organic wastes.
13. Determination of COD in organic wastes
14. Enumeration of coliform bacteria.
15. Anaerobic digester- utilization of aquatic weeds.
16. Single cell protein production using wastes.
17. Visit to sewage farm.

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OPC AGM 711- MICROBIAL INOCULANT PRODUCTION TECHNOLOGY (2+1)

Objective

To study the basic principles and application methodologies of different microbial inoculants in order to improve the soil fertility and productivity.

Theory

Unit – I- Concepts of microbial inoculants

Biofertilizers – Definition - types, importance of biofertilizers in agriculture – *Rhizobium* - characters and classification – *Rhizobium* - legume symbiosis - nodule formation - Factors affecting nodulation and nitrogen fixation.

Unit-II- Nitrogen fixing biofertilizer

Characteristics and classification of *Azospirillum*, *Azotobacter*, *Gluconacetobacter*.- Actinorhizal plants (*Frankia*) and Algal biofertilizers - Blue green algae – *Azolla*.

Unit –III- Phosphate solubilizing/mobilizing biofertilizer

Problems of phosphorus uptake - fixation of phosphorus - microbial transformation of phosphorus- Phosphate solubilizing microorganisms, K, Zn and silicate solubilizing microorganisms – factors affecting phosphate solubilization– AM fungi – characteristics and types of mycorrhizae - Plant Growth Promoting Rhizobacteria (PGPR) – *Pseudomonas*.

Unit –IV- Formulations of biofertilizer

Different formulations of biofertilizers – Types and characters - carrier – beads – pellets and liquid formulation – preservatives and additives-shelf life of different formulations- quality control of different formulations - BIS.

Unit-V- Production technology

Mass Production technology of bacterial biofertilizers, *Azolla* , Algal biofertilizers and AM fungi – problem and constrains in production- method of application – Marketing and monitoring field performance-Economics of microbial inoculants.

Practical

Isolation, screening for efficiency and strain improvement of different types of inoculants-*Rhizobium*, *Azospirillum*, *Azotobacter*, *Gluconacetobacter*, BGA and Phosphobacteria,. Mass multiplication techniques of *Rhizobium*, *Azotobacter*, *Gluconacetobacter*, *Azospirillum*, BGA and Phosphobacteria- AM fungi – Spore count and infection percentage- Fermentor-fermentation requirements-Types of carriers- preparation of carrier based inoculants-shelf life- methods of applications- Quality control of inoculants.

Theory Schedule

1. Microbial inoculants in Agriculture.
2. Biofertilizers-definition-Development of the concept-
3. Contribution and importance of microorganisms to soil fertility.
4. Different groups of biofertilizers-bacterial,
5. Different groups of algal
6. Different groups of fungal biofertilizers etc.
7. Nitrogen fixing microorganisms-Phosphate solubilising microorganisms etc.
8. Symbiotic nitrogen fixing bacteria-*Rhizobium* classification-Cross inoculation groups- characteristics.
9. Infection-root nodule formation-leghaemoglobin-nitrogen fixation.

10. Assay of nitrogen fixation-Nitrogen assimilation.
11. Transfer of fixed nitrogen in symbiotic systems.
12. Associative symbiosis-*Azospirillum*-species distribution-Characterization.
13. Importance of *Glucoacetobacter* and its distribution.
14. Non-symbiotic nitrogen fixation-*Azotobacter*- Characterization.
15. Actinorhizal association-*Frankia*-Importance-location, biochemistry and physiology of actinorhizal nodules.
16. Phosphate solubilization by microorganisms-bacteria and fungi involved general characters and importance.
17. Algal biofertilizers - Blue green algae-distribution-occurrence.
18. Morphological variation-Characteristics.
19. *Azolla-Anabaena* symbiosis-Importance- *Azolla* growth behavior-multiplication- sporulation etc.
20. Mid Semester Examination
21. Mycorrhiza- types -Ectomycorrhiza –
22. Mycorrhiza- types -Endomycorrhiza.
23. Role of mycorrhiza in crop production.
24. Microbial inoculants for solubilization of potassium sulphur and trace elements.
25. Carrier materials-Types and quality characteristics of an ideal carrier, preparation of inoculant packets.
26. Different formulations of inoculants- carrier, gel, liquid formulations etc.
27. Principles of mass production-Large scale production of bacterial biofertilizers-growth characteristics.
28. Fermentation-Principles and techniques-inoculum preparation.
29. Shelf life-quality control of biofertilizers-BIS specifications.
30. Field performance of biofertilizers.
31. Method of application –Economics.
32. Algal multiplication-large scale production-application methods
33. *Azolla*-Mass multiplication and method of application etc.
34. Mycorrhizae-VAM-Mass scale production-field performance-problems and prospects of biofertilizers.

Practical Schedule

1. Isolation of *Rhizobium* from legume root nodules; purification and characterization of *Rhizobium*
2. Testing the efficiency-Leonard jar technique and plant infection test.
3. *Rhizobium* strain identification by immunological methods.
4. Isolation of *Azospirillum* from roots Rhizosphere.
5. Identification and characterization of *Azospirillum*.
6. Isolation and identification of *Azotobacter* and *Gluconacetobacter*.
7. Isolation of phosphobacteria from soil.
8. Quantitative determination of P-solubilization by phosphobacteria.
9. Mass multiplication of bacterial biofertilizers-Fermentor
10. Carrier material-preparation of inoculant packets
11. Quality control-assessment of shelf life and storage methods
12. Methods of application of bacterial biofertilizers- seed, soil
13. Isolation, enumeration and identification of Blue green algae

14. Blue green algae-large scale production and method of application
15. Azolla-large scale production and inoculation methods.
16. Liquid and gel formulations biofertilizers.
17. Different genera of VA mycorrhizae and Mass multiplication of AM fungal-application methods.

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OPC AGM 712- INDUSTRIAL MICROBIOLOGY (2+1)

Objectives

To teach the students about different fermentations, industrial important microorganisms and the mass production techniques .

Theory

Unit- I- Introduction of fermentation

History of industrial microbiology – Isolation and screening methods – strain development strategies – fermentation media – raw materials used in media production and antifoam agents – fermentation process- dual and multiple fermentation process - batch and continuous fermentation, soild state and submerged fermentation.

Unit-II- Bioreactors and its types

Bioreactors – basic functions - types, designs and functional characteristics-upstream and downstream processing – automation of bioreactors.

Unit -III- Production of organic solvents organic acids , amino acids and Beverages

Production of organic solvents such as ethyl alcohol and glycerol. organic acids production – butyric acid, citric acid and lactic acid . Amino acid production – lysine and glutamic acid. Beverages production – beer and wine. – Alcohol production

Unit- IV- Production of Antibiotic Vitamin and Enzymes

Industrial production of antibiotics – penicillin , streptomycin and tetracycline production of vitamin B2 (Riboflavin), vitamin B12 and vitamin C. production of enzymes – amylase, protease, cellulase, pectinase and lipase immobilization and its type.

Unit- V- Fermented food products, biofertilizers and biopesticides production techniques

Milk and dairy product production – yoghurt, buttermilk, cultured milk and cheese - mass production of bacterial biofertilizers – *Azospirillum*, *Rhizobium* and phosphobacteria. mass production of Bio insecticides – *Bacillus thuringiensis*, *Beauveria bassiana* and *Metarhizium anisopilae*. Mass production of *Pseudomonas fluorescens* and *Trichoderma viridae*.

Practical

Isolation and screening of industrial important microorganisms- preparation of inoculums – bioreactors – fermentation of alcohol , wine making – production of penicillin – antibiotics sensitivity test of penicillin , streptomycin and tetracycline organic acids , enzymes, production of curd , mass production of bacterial biofertilizers and bio control agents.

Theory Schedule

1. History of industrial microbiology
2. Screening methods
3. Strain improvement of microorganisms
4. Methods of strain improvement
5. Fermentation media and their raw materials
6. Fermentation process of its Types
7. Bioreactors , design and functional characteristics
8. Types of bioreactors
9. Upstream processing
10. Downstream processing- introduction
11. Details of down steam processing
12. Production of organic solvents –ethyl alcohol and glycerol
13. Production of organic acid – Butyric, citric and Lactic acid
14. Production of Amino acid - Lysine and glutamic acid
15. Production of Beverages - Beer and wine alcohol production
16. Production of pencillin , streptomycine and tetracycline
17. Mid semester Examination
18. Production of amylase and protease
19. Production of pectinase , cellulose
20. Production of Lipase
21. Immobilization and its types
22. Milk product – Butter milk and culture milk
23. Yoghurt production
24. Cheese production
25. Bacterial bio fertilizer production – *Azospirillum*
26. *Rhizobium* mass production
27. Phosphobacteria mass production
28. Quality control and method of application
29. Production of bioinsecticides – *Bacillus thuringiensis*
30. Mass production of *Beavria bassiana*
31. Mass production of *Metarhizum anisopliae*
32. Mass production of *Pseudomonas fluoresceus*
33. Mass production of *Trichoderma Viridae*
34. Review of Lectures

Practical Schedule

1. Isolation of industrial important microorganisms from soil and buttermilk/ curd.
2. Strain improvement – Induced mutation of bacteria.
3. Preparation of Inoculum
4. Bioreactors and its functional characteristics
5. Alcohol production from Jaggery
6. Wine making
7. Amylase production
8. Citric acid production by solid waste fermentation
9. Antibiotic sensitivity test – penicillin streptomycin and tetracycline
10. Extra – cellular amylase production
11. Production of penicillin
12. Production of enzymes using immobilization techniques
13. Mass production of *Rhizobium* biofertilizer
14. Mass production of phosphobacteria
15. Mass production of Bioinsecticide *Bacillus thuringiensis* (or) *Beauveria bassiana* (or) *Metarhium anisopilae*
16. Mass production of *Pseudomonas fluorescens* and *Trichoderma viride*
17. Practical Examination

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2. Casida LE. 1999. Industrial Microbiology. New age International Publishers.
3. Crueger W and Crueger A. 2000. Biotechnology: A text Book of Industrial Microbiology, 2nd edition. Panima Publishing Corporation.
4. Cruger W and Crueger A. 2017. Biotechnology- A text book of Industrial microbiology (Third edition) Sinaue Associates International USA.
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6. Karthikeyan, B. and R.Elango 2010. Fermentation Technology, Srivelan Pathipagam Chidambaram.
7. Casida LE. 2016. (Revised) Industrial Microbiology , New age international publisher New Delhi
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**M.SC. (AG) SOIL SCIENCE AND AGRICULTURAL CHEMISTRY DEGREE PROGRAMME
DISTRIBUTION OF COURSES**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	SAC 611	Soil genesis, taxonomy and survey	2+1
2.	SAC 612	Analytical techniques in soil and plant analysis and isotopes in agricultural research	2+1
3.	SAC 613	Soil Physics	1+1
4.	SAC 621	Soil fertility, fertilizer technology and use	2+1
5.	SAC 622	Soil chemistry	2+1
6.	SAC 623	Remote sensing and GIS application in soil and crop studies	2+1
7.	SAC 624	Soil degradation, problem soils and water	2+1
Total			13+7=20
Minor- 9 credits			
1.	OPC- GPB 621	Concepts of crop physiology	2+1
2.	OPC- SAC 711	Soil, water and air pollution	2+1
3.	OPC SAC 712	Soil health management	2+1
Total			6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistical Methods and Design of Experiments	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
Total			3+2=5
Seminar + Research - 21 credits			
1.	SAC -032	Seminar	0+1
2.	SAC -011; 021;031;041	Research 011- 0+1 ; , 021- 0+2 ; , 031- 0+8 ; , 041- 0+9	0+20
Grand Total			22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0 + 1
4	PGS 624	Library and information services	0 + 1
5	PGS 715 e-course	Intellectual property and its management in agriculture	1 + 0
6	PGS 716 e-course	Disaster management	1 + 0
Total			2 + 4=6

**M.SC. (AG) SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
SEMESTER-WISE DISTRIBUTION (REGULAR)**

S.No.	Course No.	Courses	Credit Hours
FIRST SEMESTER			
1.	SAC 611	Soil genesis, taxonomy and survey	2+1
2.	SAC 612	Analytical techniques in soil and plant analysis and isotopes in agricultural research (2 + 1)	2+1
3.	SAC 613	Soil Physics	1+1
4.	STA 611	Statistical Methods and Design of Experiments	2+1
5.	COM 611	Computer Programming and its Applications	1+1
6.	SAC 011	Research	0+1
7.	PGS 611	Agricultural Research Ethics & Methodology (0+1)	-
8.	PGS 612	Technical Writing and Communication Skills (0+1)	-
		Total	8+6=14
SECOND SEMESTER			
1.	SAC 621	Soil fertility, fertilizer technology and use(2+1)	2+1
2.	SAC 622	Soil chemistry(2+1)	2+1
3.	SAC 623	Remote sensing and GIS techniques for soil and crop studies(2+1)	2+1
4.	SAC 624	Soil degradation, problem soils and water (2+1)	2+1
4.	OPC GPB 621	Concepts of crop Physiology	2 +1
5.	SAC 021	Research	0+2
6.	PGS 623	Basic Concepts in Laboratory Techniques (0+1)	-
7.	PGS 624	Library and Information Services (0+1)	-
		Total	10+7=17
THIRD SEMESTER			
1.	OPC XXX 711	Minor Course - Related discipline	2+1
2.	OPC XXX 712	Minor Course - Related discipline	2+1
3.	SAC 031	Research	0+8
4.	SAC 032	Seminar	0+1
5.	PGS 715 e-course	Intellectual property and its management in agriculture (1+0)	-
6.	PGS 716 e-course	Disaster management (1+0)	-
		Total	4+11 =15
FOURTH SEMESTER			
1.	SAC 041	Research	0 + 9
		Total	0 + 9
		Grand Total	22+33 = 55

SAC 611. SOIL GENESIS, TAXONOMY AND SURVEY (2+1)

Objective

The aim of this course is to impart knowledge to students on soil genesis in terms of factors and processes of soil formation, classification of soils and to enable students to conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory

Unit I- Rocks and minerals

Rocks – formation, classification and properties. Minerals – formation, classification and characteristics of silicate and non-silicate clay minerals , Techniques in identification of minerals . Clay minerals in Indian soils.

Unit II- Weathering and soil formation

Soil formation – concepts and views, Weathering of rocks and mineral transformations – types of weathering – agencies of weathering – weathering stability, sequence and indices, Soil profile and description .

Unit III- Soil formation – factors and processes

Factors of soil formation – Types of soil forming factors- Active and passive . Different soil forming processes – Fundamental and specific, soil forming processes responsible for the development of different soil orders (USDA system).

Unit IV- Soil taxonomy

Soil classification – objectives ; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, Soil orders (USDA system). Soils of India and Tamil Nadu

Unit V -Soil survey and land evaluation

Soil survey concepts objectives and types; Soil survey techniques - conventional and modern; soil survey interpretations; soil maps – usefulness : cartography - thematic soil maps, , mapping units, techniques for generation of soil maps.

Land use evaluation-Land capability classification and land irrigability classification, storie index, soil productivity rating, Fertility capability classification ; Different approaches for managing soils and landscapes in the framework of agro-ecosystem.

Practicals

Identification and characterization of different rocks and minerals.– total chemical analysis of soils – determination of molar ratios – study of selected soil profiles and laboratory analysis for classification purposes. Exercises on classification of soils under Soil Taxonomy (USDA system) .Survey and study of profiles in selected areas Exercises on land capability classification, storie index rating, productivity rating, land irrigability classification and crop suitability classification.

Lecture schedule

Theory

1. Rocks – formation and classification
2. Minerals – classification and properties
3. Identification techniques of crystalline and non crystalline clay minerals
4. Clay minerals in Indian soils.

5. Soil formation – concepts and views
6. Pedology – concepts of pedogenesis , Pedology and Edaphology – their relationships
7. Weathering of rocks and minerals – types of weathering – physical
8. Weathering of rocks and minerals- - chemical and biological
9. Weathering sequence and indices
10. Factors of soil formation – active
11. Factors of soil formation – passive
12. Fundamental soil forming processes
13. Specific soil forming processes
14. Soil forming processes responsible for development of different soil orders – A
15. Soil forming processes responsible for development of different soil orders – B
16. Soil profile development and description
17. Midsemester Examination
18. Soil classification – concepts and principles
19. Types of soil classification – early and recent
20. Soil taxonomy– salient features and recent trends and Hierarchy of soil taxonomy
21. Differentiating characteristics of taxa, criticism and appreciation of soil taxonomy
22. Description of soil orders – Entisol, Inceptisol
23. Description of soil orders – Alfisol, Aridisol, Vertisol
24. Description of soil orders – Mollisol, Histosol, Spodosol
25. Description of soil orders – Oxisol, Ultisol
26. Description of soil orders – Andosol and Gelisol
27. Soils of India
28. Soils of Tamil Nadu
29. Methods of soil survey
30. Types of soil survey, soil mapping unit
31. Cartography
32. Soil survey report Preparation and Soil survey interpretation
33. Land evaluation, land capability classification and land irrigability Classification
34. Storie index, soil productivity rating, Fertility capability classification

Practical schedule

1. Identification and characterization of rocks
2. Identification and characterization of minerals
3. Study of Morphological properties soil profile- I
4. Study of Morphological properties soil profile -II
5. Preparation of HCl extract
6. Estimation of acid insolubles
7. Estimation of iron and aluminium
8. Estimation of calcium and magnesium
9. Estimation of sodium and potassium
10. Estimation of phosphorus

11. Estimation of nitrogen
12. Estimation of total micronutrients
13. Determination of molar ratios and weathering indices
14. Orientation on keys to Soil Taxonomy
15. Exercises on land capability classification, land irrigability classification
16. Exercises on storie index rating, productivity rating, and crop suitability classification
17. Record certification

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2. Das, P.C. 2002. Soils of India. Kalyani Publishers, Ludhiana.
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5. Dipak Sarkar. 2003. Fundamentals and Applications of Pedology. Kalyani Publishers, New Delhi.
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**SAC 612: ANALYTICAL TECHNIQUES IN SOIL AND PLANT ANALYSIS AND
ISOTOPES IN AGRICULTURAL RESEARCH (2 + 1)**

Objective

To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples, besides imparting knowledge on the application of isotopes in soil plant research

Theory

Unit I - Analytical Chemistry

General principles of Analytical chemistry-introduction to volumetric analysis-Acidimetry-Alkalimetry-Redox reactions-Complexometry-Precipitation reactions – types of indicators and theory of indicators- Gravimetry- Principles

Unit II - Instrumentation Techniques

Introduction to instrumental methods of analysis – Electrochemical methods- Potentiometry- -pH measurement – Potentiometric titration. Conductometry-conductivity measurement- conductometric titration- theory and principles

X ray diffraction- Differential thermal analysis-Chromatography-partition, column, paper, Thin, Gas, Gas-Liquid, HPLC- Principles and instrumentation

Unit III - Optical Methods

Spectral methods of Analysis- Nature of electromagnetic radiation- Interaction of EMR with matter – Colorimetry / Spectrophotometry- turbidimetry /Nephelometry- Principles and Theory

Unit IV - Flame spectroscopy (Emission/ Absorption)

Emission spectroscopy-Flame photometry-Plasma emission spectroscopy Atomic absorption spectrophotometry- Nuclear magnetic resonance spectroscopy (NMR) - Theory and Principles

Unit IV - Isotopes in Agriculture

Isotopes- stable and radioisotopes- Nuclear Fission and fusion- Principles and use of radiation monitoring instruments - proportional, Geiger Muller counter, solid and liquid scintillation counters; neutron moisture meter, mass spectrometry, auto radiography. Isotopic dilution techniques used in soil and plant research; use of stable isotopes; application of isotopes in studies on organic matter, nutrient transformations, ion transport, rooting pattern and fertilizer use efficiency and BNF Doses of radiation exposure, radiation safety aspects regulatory aspects, collection, storage and disposal of radioactive wastes

Theory Schedule

1. General principles of Analytical chemistry- introduction to volumetric analysis
2. Types of titration - Acidimetry- Alkalimetry - Redox reactions- Complexometry - Precipitation reactions
3. Types of indicators and theory of indicators
4. Gravimetry- Theory and Principles
5. Introduction to instrumental methods of analysis – Electrochemical methods- Potentiometry- -pH measurement
6. Potentiometric titration- definition - principle – types – advantage and disadvantage

7. Conductometry- conductivity measurement-theory and principles
8. Conductometric titration- theory and principles
9. X ray diffraction- Differential thermal analysis -theory and principle and Application
10. Chromatography- Introduction- definition- types - partition, column, paper, Thin- theory and principle – advantage and disadvantage
11. Gas-Liquid chromatography - Principles and instrumentation
12. HPLC- Principles and instrumentation
13. Spectral methods of Analysis- Nature of electromagnetic radiation- Interaction of EMR with matter – Colorimetry / Spectrophotometry- Theory and principle-I
14. Colorimetry / Spectrophotometry- Theory and principle-II
15. Turbidimetry /Nephelometry- Principles and Theory
16. Emission spectroscopy-Flame photometry- Theory and principle
17. Mid Semester examination
18. Plasma emission spectroscopy - Theory and principle
19. Atomic absorption spectrophotometry- Theory and principle
20. Nuclear magnetic resonance spectroscopy (NMR) - Theory and Principles
21. Atomic structure, Isotope- types- Stable and radioisotopes radioactivity and units;
22. Nuclide stability, properties and decay principles
23. Nature and properties of nuclear radiations
24. Interaction of nuclear radiations with matter
25. Nuclear Fission and fusion
26. Principles and use of radiation monitoring instruments – Ionization chamber and proportional counter, Geiger Muller counter, solid and liquid scintillation counters;
27. Principle and use of Neutron moisture meter and auto radiography
28. Principle and use of mass spectrometry
29. Isotopic dilution techniques used in soil and plant research;
30. Use of stable isotopes; application of isotopes in studies on organic matter, nutrient transformations,
31. Application of isotopes in soil chemistry- ion transport, rooting pattern
32. Application of isotopes on fertilizer use efficiency and BNF
33. Doses of radiation exposure, radiation safety aspects regulatory aspects
34. Collection, storage and disposal of radioactive wastes

Practical schedule

1. Preparation of, analytical reagents, qualitative reagents, Indicators and standard solutions for acid-base, oxidation reduction and complexometric titration
2. Soil, water and plant sampling techniques, their processing and handling.
3. Potentiometric titration
4. Conductometric titration
5. Spectrophotometric analysis r available phosphorus estimation
6. Flame photometric analysis for Potassium estimation
7. Atomic absorption spectroscopy analysis for micronutrients
8. Nephelometry analysis for available sulfur in soils

9. Chromatography technique- paper, thin and GLC
10. Studies on atomic structure, half-life, activity and rate constant
11. Studies on types of radioactivity decay
12. Understanding about types of radioisotope laboratories , their design and feature, Storage and handling of radioactive materials
13. Setting up of experiment on fertilizer use efficiency and Preparation of soil and plant samples for radioactive measurements
14. Calculation on fertilizer use efficiency and biological nitrogen fixation
15. Sample preparation and measurement of ^{15}N enrichment by mass spectrophotometry/ emission spectrometry
16. Calculate A, E and L values of soil using ^{32}P / ^{65}Zn - calculation
17. Record submission

Reference Books

1. Douglas A Skoog and James Holler. 2014. Principles of Instrumental Analysis. 6TH Edition Cengage Learning India Private Limited New Delhi
2. James Holler F., Stanley R Crouch , Donald M. West and Douglas A. Skoog 2012. Fundamentals of Analytical Chemistry 9th Edition. Cengage Learning India Private Limited New Delhi
3. Gary D. Christian 2007. Analytical Chemistry. 6th edition. John Wiley & Sons, Inc New York
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10. IAEA 2001. Use of isotope and radiation methods in soil and water management and crop nutrition. Joint FAO/IAEA Publication, Vienna, Austria

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1. www.adichemistry.com/analytical/analytical-chemistry.html
2. www.federica.unina.it/agraria/analytical-chemistry/analytical-chemistry/
3. <https://www.crcpress.com/Soil-and...Instrumental-Techniques/.../9780824709914>
4. web.uni-louvain.be/.../Handbook%20of%20Analytical%20Techniques,%202%20Vol..
5. https://www.iaea.org/sites/default/files/publications/magazines/.../212_305482935.pdf
6. www.gutenberg.org › 56,364 free ebooks
7. large.stanford.edu/courses/2017/ph241/white-m2/docs/singh.pdf

SAC 613 - SOIL PHYSICS (1+1)**Objectives**

- The aim of this subject is to impart knowledge to the students on the various concepts of soil physics. It also aims to discuss the various phases of soil physics and their practical application to overcome the physical constraints of the soil.

Theory**Unit I – Mechanical composition of soils**

Soil physical properties – Importance – composition of soil – minerals and organic constituents – determinations – mass volume relationship. Soil texture – textural classes – classification of different systems – influence on soil properties.

Unit II – Soil structure and consistency

Soil structure – soil aggregation – genesis and classification – factors affecting– influence on soil properties and plant growth. Soil consistency – factors influencing – soil plasticity – Atterberg's constants.

Unit III – Soil colour and soil moisture

Soil colour – significance – soil moisture – forms – methods of estimation – energy concepts – potentials – constants – characteristic curves – hysteresis – soil water movement – Hydraulic conductivity – measurement of HC in saturated and unsaturated soils.

Unit IV – Soil air and soil temperature

Soil air – composition – significance – renewal – factors influencing – diffusion – mass flow - indices – ODR – effect on plant growth – Soil air management. Soil temperature – importance – factors influencing thermal properties of the soil – effect on plant growth – Soil temperature management.

Unit V – Importance of soil physical conditions for sustained production

Soil physical fertility and productivity – role of soil organic matter and micro organisms in modifying soil physical conditions and improving plant growth. Physical constraints in soil - occurrence – characteristics and impact on plant growth – management of soil physical conditions for sustained production.

Practical

Soil sampling techniques – textural analysis – determination of physical properties – structure – colour – density and porosity – hydraulic conductivity – infiltration rate – aggregate stability – soil moisture characteristic curve – soil temperature measurement .

Lecture schedule**Theory**

1. Soil physical properties – importance – soil composition
2. Mineral and organic constituents – determination – mass volume relationship
3. Soil texture – classes – classification – influence on soil properties
4. Soil structure – soil aggregation – genesis – classification
5. Factors affecting soil structure – impact of soil structure on soil properties and plant growth
6. Soil consistency – factors affecting– soil plasticity – Atterberg's constants

7. Soil colour – significance – soil moisture – forms – methods of estimation
8. Energy concepts – potentials – constants - Soil moisture characteristic curves – hysteresis
9. Mid - Semester Examination
10. Soil water movement - Hydraulic conductivity – measurement of HC in saturated and unsaturated soils
11. Soil air – composition –renewal – factors influencing renewal
12. Diffusion – mass flow – indices – ODR – effect on plant growth - soil air management
13. Soil temperature – importance – conduction, convection and radiation – factors influencing soil temperature - thermal properties of soil – effect on plant growth – Soil temperature management
14. Soil physical fertility and productivity
15. Physical constraints – occurrence- characteristics of physical constraints – impact on plant growth
16. Role of organic matter in modifying the physical conditions of the soil
17. Management of soil physical conditions for sustained production

Practical

1. Collection of soil samples for physical analysis
2. Textural analysis of soil by international pipette method
3. Determination of soil texture (Mechanical analysis) by hydrometer method
4. Determination of bulk density by core sampler method
5. Determination of bulk density by wax coating method
6. Determination of particle density – Pycnometer method
7. Determination of bulk density, particle density and pore space by measuring cylinder and Keen Roetzkowski box method
8. Determination of soil colour
9. Determination of water holding capacity
10. Determination of infiltration rate
11. Determination of hydraulic conductivity
12. Determination of soil moisture constants
13. Determination of soil consistency
14. Aggregate analysis – dry sieving and wet sieving method
15. Determination of soil temperature
16. Preparation of soil moisture characteristic curves
17. Practical Orientation.

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1. Arun Kumar Saha. 2008. A textbook of Soil Physics, Kalyani Publishers, Ludhiana.
2. Ghildyal, B.P. and Tripathi, R.P. 2017. Soil Physics. New Age International (P) Limited, Chennai
3. Majumdar, S.P. and Singh, R.A. 2002. Analysis of soil physical properties. Agrobios (India), Jodhpur.

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6. Singh, R.A. 1997. Soil physical analysis. Kalyani Publishers, Ludhiana
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8. Daniel Hillel 1982 Fundamentals of Soil Physics, Academic press , New York
9. Pradeep K. Sharma 2017. Introduction to Soil Physics. Westville Publishing House, New Delhi
10. Rattan Lal and Manoj K. Shukla 2004. Principles of Soil Physics. CRC Press;. London

E-Books:

1. Daniel Hallal ISSN:9780080918709,2013 – Fundamentals of Soil Physics – Ist Edition-Elsevier. Academic Press. <https://www.elsevier.com>
2. Rathan Lal and Manoj k shukla, 2004.Principles of Soil Physics. (RC Press books. <https://www.crcpress.com>)
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4. Jeet Daniel Hillal -2013. Introduction to Soil Physics – Ist Ediction elseveir. Academic Press.<https://www.elseveir.com>
5. Kezdi A. Soil Physics Ist Edition.Elsevier. Academic Press.<https://www.elsevier.com>

SAC.621 SOIL FERTILITY, FERTILIZER TECHNOLOGY AND USE (2+1)

Objectives

- The main objective is to impart knowledge about soil fertility, fertilizers technology and the role of fertilizers and manures in supplying nutrients to plants for sustainable agriculture. By the end of the course, the students will be able to understand the techniques of fertilizer production, mechanism of nutrient absorption by plants and dynamics of soil nutrients.

Unit I - Soil fertility and Plant nutrition

Soil fertility –problems and prospects – Elements in plant nutrition-sources – functions and deficiency symptoms- Nutrient mobility in soils and plants- Mechanism of nutrient uptake and transport in plants

Unit II - Transformation of N in soil

Soil nitrogen – sources, forms and transformation, fixation and release in arable and submerged soils; biological nitrogen fixation. Nitrogenous fertilizers production techniques- Nitrogenous fertilizers and their fate in soils- management of fertilizer nitrogen in lowland and upland conditions for higher use efficiency.

Unit III - Transformation of P and K in soil

Soil phosphorus – forms, transformation, fixation and release in arable and submerged soils; factors affecting - quantity – intensity relationships- phosphorus availability in soils - Phosphatic fertilizers production techniques – Phosphatic

fertilizers behavior in soils- management of phosphatic fertilizers for higher use efficiency- Potassium – forms, equilibrium in soils and agricultural significance- potassium fixation- mechanism-factors affecting fixation- quantity – intensity relationships – Production techniques of potassic fertilizers - management of potash fertilizers for higher use efficiency.

Unit IV - Behavior of secondary and micronutrients in soil

Sulphur – source, forms, fertilizers and their behavior in arable and submerged soils; calcium and magnesium – factors affecting their availability in soils; Secondary nutrient fertilizers and their behavior in soils. Micronutrients – critical limits in soils and plants- factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability. Fertilizer use efficiency- soil fertility management - Balanced fertilization- INM - site-specific nutrient management--soil quality in relation to sustainable agriculture.

Unit V - Soil fertility evaluation and fertilizer recommendations

Soil fertility evaluation – concepts, approaches – Biological and chemical methods - soil test crop response correlations and response functions- DRIS. Modern approaches in fertilizer recommendation, Soil testing, Long term fertilizer experiment and its significance

Practical

Chemical analysis of soil for available nutrients – Major, secondary and micro nutrients- interpretation-Analysis of plants for essential elements- Major, secondary and micro nutrients

Theory Lecture Schedule

1. Introduction – importance of soil fertility in crop production – Problems and Prospects
2. Functions of nutrients in plants
3. Nutrient elements – Arnon's criteria of essentiality – classification of essential nutrients –Ionic forms of plant nutrients in soil
4. Deficiency and toxicity symptoms – corrective and management measures
5. Nutrient mobility –concepts- soils and plants
6. Mechanism of nutrient uptake and transport in plants
7. Nitrogen cycle – sources, forms – factors influencing content of nitrogen in soil
8. Transformation in soils – mineralization (aminisation and ammonification) – Nitrification – factors affecting nitrification –fate of released ammonium and nitrate nitrogen.
9. Ammonium fixation- factors affecting, Nitrogen loss mechanism in soil– methods to minimize N losses
10. Biological nitrogen fixation– symbiotic and non symbiotic microorganisms
11. Transformation in submerged soils
12. Commercial N fertilizers – classification – production techniques
13. Management of fertilizer nitrogen in upland and submerged conditions for increased fertilizer use efficiency
14. Phosphorus cycle – Sources, forms and transformation in arable and submerged soils
15. P fixation – mechanism and release- methods to reduce phosphate fixation

16. Factors affecting phosphorus availability in soils- QI relationship
17. Phosphatic fertilizers- - classification - Production techniques of Phosphatic fertilizers
18. Mid- semester examination
19. Crop response to P fertilizer- P use efficiency
20. P management under upland and lowland conditions
21. Potassium – content in soil – source – forms of soil potassium – Equilibrium in soils and its agricultural significance
22. Potassium fixation-release- factors affecting-Potassium availability- K buffering- QI relationship
23. Potassium fertilizers- Production techniques of potassic fertilizers - management under upland and lowland conditions
24. Sulphur – sources , forms - transformation in arable and submerged soil- crop response-Commercial sources of sulphur
25. Calcium and Magnesium – sources, forms– Secondary nutrient fertilizers
26. Micronutrients – Dynamics and reactions of Fe, Mn, Cu and Zn in soil and crop response
27. Dynamics and reactions of B, Mo, and Cl in soil and crop response
28. Micronutrient fertilizers for crop production- method of application
29. Fertilizer use efficiency- soil fertility management - Balanced fertilization
30. INM - Site-Specific Nutrient Management--soil quality in relation to sustainable agriculture.
31. Soil fertility evaluation concepts– approaches
32. Evaluation techniques- chemical and biological methods- rating- interpretation
33. STCR-Diagnosis Recommendation Integrated System (DRIS) approaches
34. Soil testing, Long term fertilizer experiment -significance Modern approaches in fertilizer recommendation.

Practical Schedule

1. Available N estimation – KMnO_4 method
2. Available P estimation – Olsen – P and Bray – P
3. Available K estimation – $1\text{N NH}_4\text{OAC}$ - K and 0.1N HNO_3 – K
4. Exchangeable Ca and Mg – Versenate titration method
5. Available S- 0.15% CaCl_2 extraction
6. Estimation of DTPA - Fe, Mn, Cu, Zn
7. Estimation of N in nitrogenous fertilizers
8. Estimation of water soluble, citrate soluble and total P in Phosphatic fertilizers.
9. Estimation of K in potassic fertilizers- Direct and indirect method
10. Estimation of Ca, Mg and S in secondary nutrient fertilizers
11. Estimation of Fe, Mn, Zn and Cu in micro nutrient fertilizers
12. Analysis of total N in plant
13. Analysis of total P and S in plant
14. Analysis of K, Ca and Mg in plants
15. Analysis of total Fe, Mn, Zn and Cu in plant
16. Analysis of total B in plant
17. Fertilizer prescription based on STCR approach

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1. Brady, N.C. and Weil, R.R 2002. *The Nature and Properties of Soils*. 13th Edition. Pearson Education, New Delhi.
2. Epstein, E. and Bloom, A. 2005. *Mineral Nutrition of Plants: Principles and Perspectives*. Second Edition. Sinauer Associates.
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4. John Havlin, James Beaten, Samuel Tisdale and Werner Nelson, 2005. *Soil Fertility and Fertilizers - An Introduction to Nutrient Management*. 7th Edition, Prentice Hall. Upper Saddle River, NJ.
5. Mengel.K. 2006. *Principles of Plant Nutrition*, 5th Edn. Atlas Books and Periodicals, New Delhi.
6. Miller, C.E. 2004. *Soil Fertility*. International Books and Periodical supply services, New Delhi.
7. Mortvedt, J.J., Shuman, L.M., Cox, F.R., and Welch.R.M. 1991. *Micronutrients in Agriculture*, 2nd Ed. SSSA, Madison.
8. Pierzynski, G.W., Sims, J.T. and Vance, G.F. 2002. *Soils and Environmental Quality*, Second Edition. CRC Press, Boca Raton.
9. Stevenson, F.J. and Cole M.A.1999. *Cycles of Soil: Carbon, Nitrogen , Phosphorus, Sulphur, micronutrients*. John Wiley and Sons, Newyork.
10. Sumner, A.M.E. (Editor) 2000. *Handbook of Soil Science*. CRC Press, Boca Raton, USA.

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SAC 622. SOIL CHEMISTRY (2+1)

Objectives

- To impart knowledge on the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to use of soils as a medium for plant growth.

Theory

Unit I - Soil chemical composition and soil colloids

Chemical (elemental) composition of the earth's crust- mineral and organic constituents of soil – clay minerals – structure – properties – nomenclature and classification. Effect of clay minerals on fertility of soil and plant growth

Unit II - Electrochemistry and chemical kinetics.

Elements of equilibrium thermodynamics, chemical equilibria, electro chemistry and chemical kinetics. Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids.

Unit III - Ion exchange processes

Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr- Vanselow, Krishnamurthy & Overstreet equation Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity. measurement, thermodynamics, statistical mechanics; anion and ligand exchange – inner sphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition. Buffering capacity of soils

Unit IV - Soil organic matter

Soil organic matter – sources, composition, carbon cycle - bio-degradation of organic matter. Fractionation of soil organic matter. Humus formation – role of humus, clay humus complex and chelation – significance of chelation in soil. Metal – organic complex reactions. Significance of organic matter in soil fertility. Carbon sequestration in different ecosystem and its significance on soils and environment.

Unit V - Nutrient fixation and chemistry of submerged soils

Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects. Chemistry of submerged soils – Chemical changes – development of aerobic and anaerobic soil layers – changes in redox potential, pH – sequential reduction of oxidation–reduction system – change in specific conductance – ion exchange – sorption and desorption – reduction of Fe (III) to Fe (II) – reduction of Mn (IV) to Mn (II) – effect of chemical and electrochemical changes on rice growth – mineral equilibria in submerged soils.

Practicals

Determination of CEC and AEC of soil using different extractants; Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter; Point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method; Organic matter content in soil-wet digestion method; Fractionation of humic substances., Potentiometric and conductometric titration of soil humic and fulvic acids, (E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies on Δ (E4/E6) values at two pH values; Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm; Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved; Determination of P and K buffering capacity of soil; Determination of P and K fixing capacity of soils; Measurement of redox potential of soil;

Lecture schedule**Theory**

1. Chemical (elemental) composition of the earth's crust and soil
2. Mineral constituents of soil.
3. Clay minerals – classification, structure and properties I
4. Clay minerals – classification, structure and properties II
5. Genesis of clay minerals and importance of clay minerals in relation to fertility of soil and plant growth
6. Elements of equilibrium thermodynamics
7. Soil colloids: origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge.
8. Surface charge characteristics of soils
9. Diffuse double layer theories of soil colloids, zeta potential,
10. Coagulation/flocculation and peptization of soil colloids
11. Electrometric properties of soil colloids
12. Sorption properties of soil colloids
13. Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept).
14. Adsorption isotherms, donnan-membrane equilibrium concept
15. Membrane electrodes and ionic activity measurement
16. Thermodynamics- statistical mechanics
17. Anion and ligand exchange – innersphere and outer-sphere surface complex formation
18. Mid semester examination
19. Fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions.
20. Shift of PZC on ligand exchange, AEC and CEC
21. Experimental methods to study ion exchange phenomena and practical implications in plant nutrition.
22. Soil reaction and buffering capacity of soils
23. Soil organic matter – sources, chemical composition of organic wastes
24. Carbon cycle and Fractionations of soil organic matter
25. Biodegradation of organic matter under anaerobic and aerobic conditions
26. Humus formation in soils – nature and characteristics of humus – role and functions of humus in soil
27. Clay humus complex and chelation – significance of chelation in soil, metal – organic complex reactions in relation to soil fertility
28. Carbon sequestration in different ecosystem and its significance on soils and environment.
29. Ammonium and Potassium fixation in soil and N and K management
30. Phosphorus fixation in soil and P management
31. Redox chemistry of soil involving organic constituents
32. Redox chemistry of soil involving inorganic constituents

33. Chemistry of submerged soil - Chemical and electrochemical changes in submerged soils – development of aerobic and anaerobic soil layers. Changes in redox potential.
34. Changes in pH – sequential reduction of nutrients. Changes in specific conductance – ion exchange – sorption and desorption Cation exchange reactions involving iron. Cation exchange reactions involving manganese. Mineral equilibria in submerged soils

Practicals

1. Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter
2. Determination of CEC of soil using different extractants
3. Determination of AEC of soils
4. Determination of point of zero-charge and associated surface charge characteristics by the serial Potentiometric titration method
5. Estimation of organic matter content in soil-wet digestion method
6. Fractionation of humic substances
7. Potentiometric and conductometric titration of soil humic and fulvic acids
8. (E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and Δ (E4/E6) values at two pH values
9. Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm
10. Construction of adsorption envelope of soils by using phosphate/ fluoride/ sulphate and ascertaining the mechanism of the ligand exchange process involved
11. Determination of Ammonium fixing capacity of soil
12. Determination of P buffering capacity of soil
13. Determination of P fixing capacity of soils
14. Determination of K buffering capacity of soil
15. Determination of K fixing capacity of soils
16. Measurement of redox potential of soil
17. Practical orientation

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2. <http://www.eolss.net/sample-chapters/c06/e6-13-03-00.pdf>
3. <http://www.norcoag.com/ag-and-soil-chemistry/>
4. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.431.331&rep=rep1&type=pdf>

SAC- 623 REMOTE SENSING AND GIS APPLICATION IN SOIL AND CROP STUDIES (2+1)

Objective

To impart knowledge about the basic concepts of remote sensing ,aerial photographs and imageries and their interpretation ,application of remote sensing in general and with special reference to soil, plants and yield forecasting : to impart and applications in agriculture.

Theory

Unit I - REMOTE SENSING CONCEPTS

Introduction and history of remote sensing, principles and types- Multispectral and hyperspectral remote sensing ,characteristics of electro-magnetic radiation – interaction of electromagnetic radiation , laws of radiation ,Electro- magnetic spectrum.

Unit II - SENSORS AND PLATFORMS

Sensor system and platforms, cameras ,microwave radiometers and scanner – aerial photography – visual image interpretation and digital image processing.

Unit III - GEOGRAPHIC INFORMATION SYSTEM

Geographic information system- principles and concepts –components of GIS – application for spatial,- non-spatial and land attributes.

Unit IV - GEOGRAPHIC POSITION SYSTEM-SATELLITE DATA

Global positioning system –principles and concepts –use of satellites data in soil resource inventory –soil information system (SIS) concepts-Application of SIS- Land evaluation –soil quality –pedo transfer functions.

Unit V - Application of remote sensing - GPS and GIS on soil and crop studies .

Yield monitoring system, field mapping and soil survey, precision agriculture crop stress detection ,crop health analysis ,crop modelling for yield estimation ,land suitability assessment for agriculture.

Lecture schedule

1. Introduction –principles and types

2. Multispectral and hyperspectral remote sensing
3. Characteristics of electromagnetic radiation –electromagnetic spectrum
4. Interaction of electromagnetic radiation –Laws of radiation
5. Remote sensor platforms-ground ,airborne and space borne platform
6. Sensor systems- framing system- scanning system
7. Microwave radiometer-aerial photo image interpretation- digital image processing.
8. Principles of GIS –spatial data representation spatial objects –raster data.
9. Mid semester
10. Components of GIS data output functions.
11. Application of land attributes –GIS
12. GPS-Functional segments of GPS-Basics of GPS Functioning-application of GPS
13. Satellite data products –use of satellites data in soil.
14. Soil resource inventory –soil information system –soil fertility
15. Application of geo information in soil resources studies.
16. Yield monitoring system, field mapping and soil survey, precision agriculture
17. Crop stress detection –crop health analysis ,crop modelling for yield estimation –land suitability assessment

Practical schedule

1. Land capability classification
2. Land irrigability classification
3. Soil index rating
4. Soil productivity index
5. Land suitability classification
6. Fertility capability classification
7. Spectral signature
8. Satellite data products
9. Aerial photograph interpretation for soils
10. Visual image interpretation
11. Preparation of land use classes
12. Level / scale of mapping
13. Digital image classification
14. Derivation of vegetation indices
15. Generation of thematic maps using GIS and land using planning using GIS
16. Ground truth radiometer
17. Record certification.

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2. Panda, B.C. (2006) Remote sensing principles and applications. *Viva Books Private Limited*, New Delhi.
3. George Joseph. (2005) Fundamentals of remote sensing second edition. Universities press (India) *Private limited* ,Hyderabad .
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5. FAO (1993) *Guide line for land use planning* .FAO Development series 1,food and agriculture organisation of the united nations,Rome.

e books

1. Principles of remote sensing – An introductory text book –GDMC (PDF) www.gdmc.nl> POR SHyperlinked.
2. Fundamentals of remote sensing and its application in GIS (PDF) gis.win.geo.tsukuba.ac.jp>remote
3. Principle of remote sensing –ITC (pdf)-[https:// www.itc.nl](https://www.itc.nl) >papers-2009
4. Fundamentals of remote sensing (pdf) www.ideo.columbia.edu>fundamental.
5. Remote sensing –GIS-Lab (pdf) –gis-lab.info>books> aerial mapping.
6. Principles of remote sensing (pdf) www.Wamis.org.>pubs>agm8
7. GEOG3051 principle and practice of remote sensing (PPRS)[pdf] WWW.geog.ucl.ac.uk>PPRS-1
8. Remote sensing and geographical information –university of delhi (pdf)ags.geography.edu.ac.in
9. Anji reddy – GIS resources (pdf)<http://www.gisresources.com>>20
10. Fundamentals of remote sensing- A Canada center for remote sensing remote sensing tutorial.

SAC 624. SOIL DEGRADATION, PROBLEM SOILS AND WATER (2+1)

Objectives

To educate students about soil erosion, soil physical constraints, water shed, basic concepts of problem soils and saline water and their management..

Unit I - Soil erosion and conservation

History, distribution, identification and description of soil erosion problems in India. Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; factors affecting water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation. Wind erosion-types, mechanism and factors affecting; extent of problem in the country. Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures

Unit II - Land degradation and water shed

Characterization and evaluation of soil and land quality indicators; Causes of land degradation; Management of soil physical properties for prevention/restoration of land degradation; Identification, monitoring and management of waste lands; Concept of watershed – its characterization and management.

Unit III - Physically degraded soils

Soil physical constraints affecting crop production- Physically degraded soils – surface crusting and hardening subsoil hardpan, fluffy soil, slowly and highly

permeable soils - characteristics and management. Management principles for sandy, clayey, red lateritic and dry land soils.

Unit IV - Acid soils

Acid soils – area, distribution, nature and sources of soil acidity. Effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management. Acid sulphate soil – genesis – characteristics and management

Unit V - Salt affected soils and quality of Irrigation water

Nature, properties and development of saline and alkali Soils; salinity and alkalinity appraisal, Management of salt affected soil-Leaching, gypsum requirements of alkal soils. Calcareous soil-genesis, characteristics and management Irrigation water quality - EC, SAR, RSC and specifications.

Practical

Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio. Visits to a watersheds.

Characterization of acid, acid sulphate, salt-affected and calcareous soils. Determination of cations (Na^+ , K^+ , Ca^{++} and Mg^{++}) in ground water and soil samples. Determination of anions (Cl^- , SO_4^{2-} , CO_3^{2-} and HCO_3^{-1}) in ground waters and soil samples. Lime and gypsum requirements of acid and sodic soils

Lecture schedule

Theory

1. History, distribution, identification and description of soil erosion problems in India
2. Forms of soil erosion; effects of soil erosion and factors affecting soil erosion
3. Types and mechanisms of water erosion; raindrops and soil erosion; factors affecting water erosion
4. Methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation
5. Wind erosion- types, mechanism and factors affecting; extent of problem
6. Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures
7. Characterization and evaluation of soil and land quality indicators
8. Causes of land degradation and Management of soil physical properties for prevention/restoration of land degradation
9. Concept of watershed – its characterization and management.
10. Surface crusting and hardening and its management
11. Hard pan formation and its management
12. Slowly permeable, highly permeable soil and their management
13. Waterlogged soils, poorly drained soils and their management
14. Fluffy paddy soils and its management
15. Management principles for sandy and clayey soils
16. Management principles for red lateritic and dry land soils.

17. Mid – Semester Examination
18. Acid soils - nature of soil acidity, sources of soil acidity
19. Effect of acidity on plant growth
20. Lime requirement of acid soils, liming material and effect of over liming
21. Management of acid soils
22. Acid sulphate soil – genesis – characteristics and management
23. Biological sickness of soils and its management.
24. Origin and basic concept of problematic soils.
25. Morphological features of saline, sodic and saline-sodic soils;
26. Characterization of salt-affected soils - soluble salts, ESP, pH
27. Physical, chemical and microbiological properties.
28. Management of salt-affected soils; salt tolerance of crops - mechanisms
29. Calcareous soil-Genesis, characteristics and management
30. Quality of irrigation water - quality parameters- indices and classification
31. Characteristics and management of brackish water for irrigation
32. Salt balance under irrigation
33. Agronomic practices in relation to problematic soils
34. Cropping pattern for utilizing poor quality ground waters.

Practical Schedule

1. Determination of suspension percentage and dispersion ratio
2. Determination of erosion ratio and clay ratio
3. Determination of clay/moisture equivalent ratio and percolation ratio.
4. Visits to a watersheds.
5. Analysis of chemical properties – pH and EC
6. Determination of active acidity in soil
7. Determination of reserve acidity ion soil
8. Determination of lime requirement
9. Determination of water soluble cations in soil
10. Determination of water soluble anions in soil
11. Determination of Gypsum requirement of soils
12. Leaching requirement of soil
13. Determination of CEC and ESP
14. Determination of cations in irrigation water
15. Determination of anions in irrigation water
16. Irrigation water quality assessment
17. Practical orientation

Reference

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3. Gholamreza Asadollahfardi, 2014 Water Quality Management: Assessment and Interpretation, Springer-Verlag Berlin Heidelberg
4. Gupta S.K and Gupta I.G 2017, Genesis and management of sodic(Alkali) soils ,Scientific publishers, Jodpur

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7. Isobel W. Heathcote 2009 Integrated Watershed Management: Principles and Practice, 2nd Edition,, John Wiley and Sons, New Jersey, USA
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9. Norman Hudson, 2016 Soil Conservation, IOWA state university press, Ames, USA
10. Somani L.L 2017 Sodic soils-Their reclamation and management, Agrotech publishing Academy, Udaipur
11. Osman, Khan Towhid 2014 Soil Degradation, Conservation and Remediation, Springer
12. Sarkar, K. (ed.). 2014, Acid Soils: Their Chemistry and Management, New India Publishing Agency, New Delhi

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2. Arora, Sanjay, Singh, Atul K., Singh, Y.P. (Eds.) 2017 Bioremediation of Salt Affected Soils: An Indian Perspective www.springer.com/in/book/9783319482569
3. Nesreen Houssein Ahmen Abou-Baker, Ebtisam Abdelmohsen El-Dardiry (Autoren) Integrated Management of Salt Affected Soils in Agriculture <https://www.lehmanns.de/.../33403541-9780128041680->
4. L.L. Somani and K.L. Totawat 2013 Management of Salt Affected Soils and Waters www.vedamsbooks.com/product_detail_print.htm
5. I.P. Abrol, J.S.P. Yadav and F.I. Massoud 1988 FAO Soils Bulletin 39 Food and Agriculture Organization of the United Nations, Rome www.fao.org/docrep/x5871e/x5871e00.htm

OPC-SAC 711. SOIL, WATER AND AIR POLLUTION (2+1)

Objectives

To make the students aware of soil, water and air pollution and their remediation for the use of agriculture, environment and human health.

Theory

Unit I - Types of pollution

Pollution- pollutants – introduction, definition- types of pollution - classification of pollution based on the environment - soil, water and air pollution - classification of pollution based on the sources of pollutants – agricultural pollution, automobile pollution and industrial pollution - classification of pollution

based on the nature of pollutants – pollution due to fertilizer, pesticides, herbicides, fungicides, weedicides and other agro – chemicals, Plastic pollution, heavy metal pollution, radiation pollution, oil pollution, sewage pollution and etc.,

Unit II - Soil pollution

Soil pollution – definition- sources – extent – solid waste as pollutants cause soil pollution in agriculture and environment. Land application of waste and mechanism of interaction of waste with soil. Soil contamination – introduction - definition- causes – its effect on soil microorganisms. CPC standards in soil and its effect on plant.

Soil as sink for waste disposal - Industrial effluents – distillery, papermill, tannery, textiles and metal finishing effluents – their composition. Its effect on soil properties, plant growth and human health. Toxic elements or heavy metals – sources, behaviors in soil, its effect on soil nutrient availability, plant growth and human health.

Unit III - Water pollution

Pure water, contaminated water, polluted water- definitions, quality parameters used to monitor water pollution. Pollution of water resources due to leaching of nutrients and its impact on aquatic eco - system, water pollution due to use of pesticides in agriculture and its impact on aquatic eco-system. Sewage – sludge- sewerage – definition –sewage treatment- eutrophication – important water borne diseases for crops and human beings.

Unit IV - Air pollution

Air pollution – introduction – airborne microbes- classification of air pollutants - global warming, ozone layer depletion and acid rain – emission of green house gaseous- sources - carbon-dioxide , carbon monoxide, methane, CFC, HFC, carbon tetra chloride, nitrous oxide and etc.,

Unit V - Management of pollutions and preventive measures

Reclamation - soil, water and air pollution, biological transformation of heavy metals, bio-mining of metals- solid waste management -bio-remediation. Application of remote sensing in monitoring and management of soil, water and air pollution for the benefit of agriculture, environment and human health.

Practicals

Sampling of sewage water, sewage sludge, sampling of solid and liquid industrial wastes, sampling of polluted soil and polluted plant. Estimation of ammoniacal nitrogen, nitrate nitrogen and phosphorus in polluted soil and plant. Estimation of heavy metals content in polluted soil, plant, water and effluent. Estimation of chemical oxygen demand (COD) and biological oxygen demand (BOD) in polluted water and effluent. Management of contaminants in soil and plants for safeguard of food safety. Air sampling. Determination of particulate matter and oxides of sulphur. Visit to various industrial sites to study the impact of pollutants on soil, water, plant and environment.

Theory lecture schedule

1. Pollution- pollutants – Introduction, definition- different types of pollution
2. Classification of pollution based on the environment- soil, water and air pollutions

3. Classification of pollution based on sources – agricultural, automobile pollution and industrial pollutions
4. Classification of pollution based on the nature of pollutants – pollution due to fertiliser, pesticides, herbicides, fungicides, weedicides and other agro – chemicals
5. Classification of pollution based on the nature of pollutants – Plastic, heavy metal, radiation, oil pollution, sewage pollution and etc.,
6. Sources and extent of pollution, problems in agriculture, environment and human health due to type pollutions
7. Solid wastes – definition, land application of wastes
8. Mechanism of interaction of waste with soil
9. Agricultural, industrial and urban wastes
10. Soil contamination – introduction - definition- in relation with soil microorganisms
11. Soil contamination due to fertilizers, pesticides, fungicides, weedicides, acid rain, oil spills, plastics and etc.,
12. Industrial effluents – distillery, papermill, tannery effluents – their composition
13. Industrial effluents – textiles and metal finishing industrial effluents – their composition
14. Effects of industrial effluents on soil properties, plant growth and human health
15. Soil as sink for waste disposal
16. Toxic elements – sources, behaviors, nutrient availability, plant growth and human health
17. Mid – semester examination
18. Pure water , contaminated water, polluted water- introduction, definitions
19. Quality parameters used to monitor water pollution
20. Pollution of water resources due to leaching of nutrients and its impact on aquatic eco system
21. Water pollution due to use of pesticides in agriculture and its impact on aquatic eco-system
22. Sewage – sludge- sewerage – definitions –sewage treatment- eutrophication – important water borne diseases
23. Air pollution – introduction – airborne microbes- classification of air pollutants
24. Global warming , ozone layer depletion and acid rain –
25. Emission of green house gaseous- sources - carbon-dioxide , carbon monoxide, methane, CFC, HFC, carbon tetra chloride and nitrous oxide
26. Reclamation of soil contamination for the use of agriculture and
27. Remediation of water pollution
28. Amelioration of air pollution

29. Heavy metal pollution, its effect on human health , biological transformation of heavy metals
30. Bio - mining of metals, bio-remediation of heavy metals
31. solid waste – definition- objectives - classification
32. Solid waste treatment, solid waste management
33. Application of remote sensing in monitoring and management of soil for the benefit of agriculture, environment and human health
34. Application of remote sensing in monitoring and management of water and air pollution for the benefit of agriculture, environment and human health

Practical schedule

1. Sampling of polluted soil /plant/water/effluent/ sewage for analysis
2. Estimation of ammoniacal nitrogen in polluted soil or plant
3. Estimation of nitrate nitrogen in polluted soil or plant
4. Estimation of phosphorus in polluted soil or plant
5. Estimation of ammoniacal nitrogen in polluted water of effluent
6. Estimation of nitrate nitrogen in polluted water or effluent
7. Estimation of phosphorus in polluted water or effluent
8. Visit to various industrial sites to study the impact of pollutants on soil, water, plant and environment.
9. Estimation of heavy metals in polluted soil or plant
10. Estimation of heavy metals in polluted water or effluent
11. Estimation of chemical oxygen demand (COD) in polluted water or effluent
12. Estimation of biological oxygen demand (BOD) in polluted water or effluent.
13. Assessment of microorganisms in air
14. Management of contaminants in soil and plants for safeguard of food safety
15. Practical examination

Reference Books

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4. Frank Den Hond, Peter Groenewegen, Nico van Straalen. 2008. Pesticides Problems, Improvements, Alternatives. Wiley.
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8. Methods in environmental analysis water, soil and air.2nd edition. 2007. Agrobios. Jodhpur.

9. Peter A. Victor. 2017. Pollution. Economy and Environment. Taylor and Francis.
10. Ramanathan,N. and Muthukkaruppan, S.M.. 2012. A text book of environmental microbiology. Om shakthi pathippagam. Annamalainagar.
11. Singh,K.K,Juwarkar Asha, Singh,A.K. Tomer Alka. 2016. Air, Water and Soil pollution.
12. Kalyani publishers.New delhi.
13. Suresh T.Nesaratnam.2014. Water Pollution Control.
14. Tushar Kanti Sen.2017. Air, Gas, and Water Pollution Control Using Industrial and Agricultural Solid Wastes Adsorbents. CRC Press.

E- Books

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2. <https://www.ebooks.com/180494/environmental-modelling-with-gis-and-remote-sensing/skidmore-andrew/>.
3. <https://www.ebooks.com/95881311/soil-pollution/duarte-armando-c-cachada-anabela-rocha-santos-tere/>.
4. <https://www.ebooks.com/214163/pesticides/den-hond-frank-groenewegen-peter-van-straalen-nico/>.
5. <https://www.ebooks.com/95889867/pollution/victor-peter-a/>.
6. <https://www.ebooks.com/2642553/air-pollution/scorer-r-s-scoring-r-s/>.

OPC-SAC 712. SOIL -HEALTH MANAGEMENT (2+1)

Objectives

The main objectives of this course is to impart practical knowledge on soil related constraints, irrigation water quality appraisal guidelines and their efficient management, soil quality and soil quality test kits-soil health card

Theory-

Unit I - Soil related constraints and their management

Soil resources of India; distribution of wasteland and problematic soils with special reference to Tamil Nadu ; soil tith management; soil crusting and its management; management of soil moisture under different climates. Reclamation and management of acidic, saline and sodic soils, constraints and management of highly and slowly permeable soils; soil erosion, extent, type and effects.

Unit II - Irrigation water quality appraisal and its management

Effect of water quality on soils and plants; soil aeration problems and management; soil thermal regimes in relation to crops and their optimization. Recycling of agricultural and industrial wastes, waste land and their management.

Unit III - Soil organicmatter

Management practices-Sustainability and soil health management-history and importance of organic matter management- Soil organic carbon conservation and sequestration-Characterisation of soil carbon pools under different land use management systems-Soil quality and resilience in relation to SOC pools

Unit IV - Soil nutrient management

Tools and techniques to build soil health- Biological methods of improving nutrient use efficiency-Biological nitrogen fixation- Biological phosphorus.

Mobilization/ immobilisation-microbial inoculants for plant growth promotion- Biofertilizer technology- green manures, green leaf manures- Composting vermicomposting- nutrient enriched manures- quality standards for organic manures large scale compost production-Scope of land use management on carbon trading- Soil bioremediation- Nutrient management –Organic farming and soil health.

Unit V - Soil quality management

Soil quality characters-Indicators of soil quality-Non Quantitative-quantitative- Chemical –Physical Biological –Assessment of soil health- Assessment as a monitoring tool-Lab based assessments –Concept of minimum data set – indicator selection interpreting indicators-multifactor sustainability-sustainability index-Indexing soil quality-Soil quality test kits-Soil health card

Practical

Determination of saturated hydraulic conductivity, bulk density measurement of soil measurement of water holding and field capacities of soil, measurement of infiltration rate and moisture retention characteristics curve in normal, problematic and reclaimed soils. Preparation of saturation paste and saturation extracts of salt affected soils. Determination of pH, EC, cations and anions in saturation extract. Determination of CaCO₃ equivalent of liming material. Estimation of lime requirement of acid soils and gypsum requirement of sodic soils. Measurement of ODR of soil. Estimation of water stable aggregate in soil and field trip to study the areas of problematic soils.

Lecture schedule- Theory

1. Soil resources of India; distribution of wasteland and problem soils
2. Soil tillage management, soil crusting and their management
3. Soil water: classification, and its measurement, forces of soil water retention, moisture retention curve
4. Management of soil moisture under different climates
5. Quality of irrigation water: Criteria and classification of poor quality water,
6. Effect of poor quality of water on soil and crop growth, management of poor quality water.
7. Soil air: Composition of soil air, gaseous exchange in soil.
8. Management of soil aeration in relation to plant growth.
9. Soil temperature and thermal regimes in relation to crop growth.
10. Factors affecting soil temperature and optimization of soil thermal regimes.
11. Recycling of Agricultural and industrial organic waste.
12. Acid soils: Extent, reclamation and management in India and Tamilnadu.
13. Nomenclature, classification and formation of salt affected soils in India and Tamilnadu,
14. Visual and chemical methods of diagnosing salt affected soils.
15. Reclamation and management of salt affected soils
16. Highly and low permeable soils: constraints and their management
17. Mid Semester Examination

18. Management practices-sustainability and soil health management.
19. History and importance of organic matter management.
20. Soil organic carbon conservation and sequestration.
21. Characterisation of soil carbon pools under different land use management systems-Soil quality and resilience in relation to SOC pools
22. Tools and techniques to build soil health
23. Biological methods of improving nutrient use efficiency
24. Biological nitrogen fixation-Biological phosphorus mobilization/ immobilisation
25. Microbial inoculants for plant growth promotion
26. Biofertilizer technology; green manures, green leaf manures
27. Composting vermicomposting; nutrient enriched manures
28. Quality standards for organic manures large scale compost production
29. Scope of land use management on carbon trading
30. Soil quality characters-Indicators of soil quality-Non Quantitative- quantitative
31. Chemical –Physical Biological –Assessment of soil health
32. Assessment as a monitoring tool-Lab based assessments
33. Concept of minimum data set –indicator selection interpreting indicators-multifactor sustainability-sustainability index.
34. Indexing soil quality and soil quality test kits-Soil health card

Lecture schedule- Practical

1. Techniques of reclamation / management of problematic soils
2. Determination of saturated hydraulic conductivity of normal, problematic and reclaimed soil.
3. Determination of bulk density of soil by core sampler method in normal, problematic and reclaimed soil.
4. Determination of soil moisture at 1/3 and 15 bar by pressure plate method in normal, problematic and reclaimed soil.
5. Measurement of water holding capacity and field capacity of soil
6. Measurement of infiltration rate of soil by double ring infiltrometer in normal, problematic and reclaimed soil.
7. Preparation and analysis of saturation extract and determination of EC, pH
8. Determination of Ca + Mg and Na in saturation extract and computation of SAR
9. Determination of CO₃, HCO₃ and Cl in saturated extract.
10. Determination of CaCO₃ equivalent of liming material
11. Estimation of lime requirement of acid soils
12. Estimation of gypsum requirement of sodic soils
13. Measurement of ODR of soil in normal, problematic and reclaimed soil
14. Estimation of water stable soil aggregates in normal, problematic and reclaimed soil
15. Soil Health assessment- Determination of Soil Quality indices
16. Preparation of Soil Health card
17. Practical Examination

Reference books

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Reference-E -books

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3. https://en.wikipedia.org/wiki/Soil_Health_Card
4. www.soilhealth.com/soil-health/management
5. <https://casfs.ucsc.edu/about/publications/Teaching-Organic>
6. <https://link.springer.com>
7. <https://www.noble.org/news/publications/ag.../management-of-salt-affected-soils>

**M.SC. (HORT.) - FRUIT SCIENCE
COURSE-WISE DISTRIBUTION**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	FSC 611	Breeding of fruit crops	2+1
2.	FSC 612	Tropical and dryland fruit production	2+1
3.	FSC 613	Biodiversity and conservation of fruit crops	2+1
4.	HOR 621 HOR 622	Growth regulation and stress management in horticultural crops (or) Protected and precision horticulture	2+1
5.	FSC 621	Subtropical and temperate fruit production	2+1
6	FSC 622 FSC 623	Biotechnology of fruit crops (or) Organic fruit production	1+1
7	FSC 624	Post harvest technology of fruit crops	2+1
			13+7=20
Minor- 9 credits			
1.	OPC- GPB 611	Concepts of crop physiology	2+1
2.	OPC- HOR 711	Propagation and nursery management for horticultural crops	2+1
3.	OPC FSC 712	Genetic resources and conservation of fruit crops	2+1
		Total	6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistical Methods and Design of Experiments	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
		Total	3+2=5
Seminar + Research - 21 credits			
1.	FSC -032	Seminar	0+1
2.	FSC -011; 021; 031 041	Research 011- 0+1 ; , 021- 0+2 ; , 031- 0+8 ; , 041- 0+9	0+20
		Grand Total	22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0+1
4	PGS 624	Library and information services	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture	1+0
6	PGS 716 e-course	Disaster management	1+0
			2 + 4=6

M.SC. (HORT.) - FRUIT SCIENCE
SEMESTER WISE DISTRIBUTION OF COURSES

S.No.	Course No.	Courses	Credit Hours
FIRST SEMESTER			
1.	FSC 611	Breeding of fruit crops	2+1
2.	FSC 612	Tropical and dryland fruit production	2+1
3.	FSC 613	Biodiversity and conservation of fruit crops	2+1
4.	STA 611	Statistical Methods and Design of Experiments	2+1
5.	COM 611	Computer Programming and its Applications	1+1
6.	FSC 011	Research	0+1
7.	PGS 611	Agricultural Research Ethics & Methodology (0+1)	-
8.	PGS 612	Technical Writing and Communication Skills (0+1)	-
		Total	9+6=15
SECOND SEMESTER			
1.	HOR 621 HOR 622	Growth regulation and stress management in horticultural crops (or) Protected and precision horticulture	2+1
2.	FSC 621	Subtropical and temperate fruit production	2+1
3.	FSC 622 FSC 623	Biotechnology of fruit crops (or) Organic fruit production	1+1
4.	FSC 624	Post harvest technology of fruit crops	2+1
4.	OPC GPB 621	Concepts of crop Physiology	2 + 1
5.	FSC 021	Research	0+2
6.	PGS 623	Basic Concepts in Laboratory Techniques (0+1)	-
7.	PGS 624	Library and Information Services (0+1)	-
		Total	9+7=16
THIRD SEMESTER			
1.	OPC XXX 711	Minor Course - Related discipline	2+1
2.	OPC XXX 712	Minor Course - Related discipline	2+1
3.	FSC 031	Research	0+8
4.	FSC 032	Seminar	0+1
5.	PGS 715 e-course	Intellectual property and its management in agriculture (1+0)	-
6.	PGS 716 e-course	Disaster management (1+0)	-
		Total	4+11 =15
FOURTH SEMESTER			
1.	FSC 041	Research	0 + 9
		Total	0 + 9
		Grand Total	22+33 = 55

FSC 611 BREEDING OF FRUIT CROPS (2+1)

Objectives

To impart comprehensive knowledge about different methods of breeding techniques employed, achievements made so far and problems encountered in the breeding of fruit crops.

Theory

Origin and distribution- taxonomical status, species and cultivars, cytogenetics, genetic resources- blossom biology- genetic resources- breeding objectives- breeding systems- ideotypes- approaches for crop improvement- introduction- selection- hybridization- mutation breeding- polyploidy breeding- rootstock breeding- improvement of quality traits- resistance breeding for biotic and abiotic stresses- biotechnological interventions- achievements and future thrust in the following selected fruit crops.

Unit I - Breeding of tropical fruit crops - I

Mango, banana and papaya

Unit II - Breeding of tropical fruit crops -II

Guava, sapota and grapes

Unit III - Breeding of sub-tropical fruit crops -I

Citrus, pineapple, jack fruit and avocado

Unit IV - Breeding of sub- tropical fruit crops -II

Litchi, annona, ber and pomegranate

Unit V - Breeding of temperate fruit crops

Apple, pear, plum, peach, apricot and strawberry

Practical

Characterization of germplasm- blossom biology- estimating fertility status- practices in hybridization- ploidy breeding- mutation breeding- evaluation based on biometrical traits and quality traits- screening for resistance against biotic and abiotic stress- developing breeding programme for specific traits- visit to research stations working on tropical- subtropical and temperate fruit improvement.

Lecture schedule

1. Need and status of fruit breeding in India, study of institutes working on fruit crop improvement
2. Constraints of breeding of fruit crops, sterility, incompatibility, heterozygosity and methods suggested to overcome the hurdles in breeding Scope for breeding against production constraints , yield and quality enhancement
3. Pollination problems in relevance to fruit set in the given fruit crops.
4. Origin and distribution, taxonomic status, related genus, species and cultivars, ideotypes, cytogenetics, genetic resources for improvement, breeding objectives, breeding systems- introduction, selection, hybridization, mutation breeding, polyploidy breeding, rootstock breeding, quality and resistance breeding, biotechnological interventions, achievements and future thrust for the following crops:
5. & 6. Mango
7. & 8. Banana

9. & 10. Papaya
11. & 12. Guava
13. & 14. Citrus
15. & 16. Grapes
17. Mid-semester examination
18. Sapota
19. Pineapple
20. Jack
21. Avocado
22. Litchi
23. Annona
24. Ber
25. Pomegranate
26. & 27. Apple
28. Pear
29. Plum
30. Peach
31. Apricot
32. Strawberry
33. Walnut
34. Almond

Practical schedule

1. Scoring techniques for genomic status in banana.
2. Characterization of germplasm of banana.
3. Characterization of germplasm of papaya.
4. Study of blossom biology in mango, banana and papaya.
5. Study of blossom biology of guava, sapota, grapes.
6. Study of blossom biology of mandarin, pineapple, jackfruit, avocado and litchi.
7. Study of blossom biology of apple, pear, plum, peach, apricot and strawberry.
8. Estimation of pollen output, viability and germinability in fruit crops.
9. Practices in hybridization, ploidy breeding, mutation breeding of mango and banana.
10. Practices in hybridization, ploidy breeding, mutation breeding of papaya and sapota.
11. Practices in hybridization, ploidy breeding, mutation breeding of grapes and guava.
12. Criteria for evaluation based on biometric and quality traits in fruit crops.
13. Screening and scoring techniques for resistance against biotic stress such as viral diseases and fusarium wilt in banana and PRSV in papaya.
14. Screening techniques for resistance against abiotic stresses like salt and drought tolerance in fruit crops.

15. - 17. Visit to research institutes working on improvement of fruit crops and visit to sub-tropical research stations for studying breeding programmes.

Reference books

1. Bose, T.K., S.K. Mitra and D. Sanyal. (Eds.). 2002. Fruits of India – Tropical and Sub-tropical. 3rd Ed. Vols. I, II. Naya Udyog, Kolkata
2. Chadha, K.L. and O.P. Pareek. (Eds.). 1996. Advances in Horticulture. Vol. I. Malhotra Publ. House., New Delhi.
3. Chadha, K.L. and S.D. Shikhamany. 1999. The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House, New Delhi
4. Janick, J. and J.N. Moore. 1996. Fruit Breeding. Vols. I-III. John Wiley and Sons, USA.
5. Nijjar, G.S. (Eds.). 1977. Fruit Breeding in India. Oxford & IBH Publishing CO, New Delhi.
6. Radha, T. and L. Mathew. 2007. Fruit Crops. New India Publ. Agency.
7. Shukla, A.N. and Vashishtha. 2004. Fruit Breeding: Approaches and Achievements. International Book Distributing Co., Lucknow, UP.

FSC 612 TROPICAL AND DRY LAND FRUIT PRODUCTION (2+1)

Objectives

To impart knowledge on the importance, scientific management practices, problems associated, postharvest management and marketing potential of tropical and dry land fruit crops grown in India.

Theory

Commercial varieties of regional- national and international importance- eco-physiological requirements- recent trends in propagation- rootstock influence- cropping systems- planting systems- hdp- root zone and canopy management- nutrient management- water management- fertigation- role of bio regulators- abiotic factors limiting fruit production- physiology of flowering- pollination- fruit set and development- physiological disorders- causes and remedies- organic production technologies- quality improvement by management practices; maturity indices- harvesting- grading- packing- storage and ripening techniques- mechanisation in fruit production- industrial and export potential- agri-export zones (aez)- industrial supports and research advancements made in the following fruit crops.

Unit I Tropical fruit crops-I

Mango and banana

Unit II Tropical fruit crops-II

Citrus, sapota and guava

Unit III Tropical fruit crops -III

Papaya, jackfruit and pomegranate

Unit IV Arid zone fruit crops -I

Aonla, ber, jamun and annona

Unit V Arid zone fruit crops -II

Wood apple, bael, karonda, manila tamarind and phalsa

Practical

Identification of important cultivars- observations on growth and development- practices in growth regulation- malady diagnosis- analysis of quality attributes- visit to tropical and arid zone orchards- analyzing stress management practices- project preparation for establishing commercial orchards.

Lecture schedule

1. Scope and current status of area- production and export of tropical and dry land fruit crops in India- scope for cultivation and area expansion- industrial and export potential.
Commercial varieties of regional- national and international importance- ecophysiological requirements- recent trends in propagation- rootstock influence- planting systems- cropping systems- root zone and canopy management- nutrient management- water management- fertigation- role of bio-regulators- abiotic factors limiting fruit production- physiology of flowering- pollination- fruit set and development- honeybees in cross pollination- physiological disorders- causes and remedies- major biotic stresses and their management quality improvement by management practices- maturity indices- harvesting- grading- packing- storage and ripening techniques- mechanisation in fruit production- industrial and export potential- Agri. Export Zones (AEZ) and industrial supports for the following crops:
2. - 4. Mango.
5. - 7. Banana
8. - 9. Sweet orange
10. - 11. Acid lime
12. - 13. Lemons
14. Sapota
15. - 16. Guava
17. Mid- semester examination
18. - 19. Papaya
20. Jack fruit
21. - 22. Pomegranate
23. - 24. Annona
25. - 26. Ber
27. Jamun
28. - 29. Aonla
30. Wood apple and bael
31. Karonda
32. Manila tamarind
33. Phalsa
34. Processing industries for tropical and arid zone fruit crops

Practical schedule

1. Identification of important cultivars, observations on growth and development in mango.
2. Practices in growth regulation and malady diagnosis in mango.
3. Identification of important cultivars, observations on growth and development in banana.
4. Special practices, growth regulation and malady diagnosis in banana
5. Identification of important cultivars, observations on growth and development in citrus.
6. Practices in growth regulation and malady diagnosis in citrus.
7. Identification of important cultivars, observations on growth and development, practices in growth regulation, papain extraction and malady diagnosis in papaya.
8. Identification of important cultivars, observations on growth and development, growth regulation, and malady diagnosis in sapota.
9. Identification of important cultivars, observations on growth and development, practices in growth regulation and malady diagnosis in guava.
10. Identification of important cultivars, observations on growth and development, practices in growth regulation and malady diagnosis in pomegranate.
11. Identification of important cultivars, observations on growth and development, practices in growth regulation and malady diagnosis in jackfruit.
12. Analysis of quality attributes in fruit crops- TSS, acidity and ascorbic acid.
13. Analysis of quality attributes in fruit crops – sugars and carotenoids.
14. Project preparation for establishing commercial orchards.
15. - 16. Visit to commercial tropical orchards.
17. Visit to arid zone orchards.

Reference books

1. Bose, T.K., S.K. Mitra. and D. Sanyal. (Eds.). 2001. Fruits – Tropical and Subtropical. Naya Udyog, Kolkatta.
2. Chanda, K.L. and O.P. Pareek. (Eds.).1996. Advances in Horticulture. Vols II to IV. Malhotra Publ. House, India.
3. Nakasone, H.Y. and R.E. Paul. 1998. Tropical Fruits. CABI. UK
4. Peter, K.V. 2008. Basics of Horticulture. New India Publ. Agency, New Delhi.
5. Pradeepkumar, T., B. Suma, Jyothibhaskar and K.N. Sathhesan. 2008. Mangement of Horticultural Crops. Parts I, II. New India Publ. Agency, New Delhi.
6. Radha, T. and L. Mathew. 2007. Fruit Crops. New India Publ. Agency, New Delhi.

7. Singh, H.P., J.P. Negi and J.C. Samuel. (Eds.). 2002. Approaches for Sustainable Development of Horticulture. National Horticultural Board, India.
8. Singh, H.P., G. Singh, J.C. Samuel and R.K. Pathak. (Eds.). 2003. Precision Farming in Horticulture. NCPAH, DAC/PFDC, CISH, Lucknow.

FSC 613 BIODIVERSITY AND CONSERVATION OF FRUIT CROPS (2+1)

Objectives

Understanding the principles of biodiversity, strategies in conservation and utilization of fruit crop biodiversity and learning about under exploited fruits in india.

Theory

Unit I Importance of biodiversity and methods of conservation

Biodiversity and conservation- issues and goals- centres of origin of cultivated fruits- primary and secondary centres of genetic diversity- present status of gene centres- exploration and collection of germplasm- conservation of genetic resources- *in situ* and *ex situ* germplasm conservation- problem of recalcitrancy- cold storage of scions- tissue culture- cryopreservation- pollen and seed storage- inventory of germplasm.

Unit II Role of National institutes in conservation and plant quarantine

Introduction of germplasm- plant quarantine- role of national institutes in conservation- TBGRI- NBPGR-etc- intellectual property rights- regulatory horticulture- plant variety protection authority- maintenance of core group using traditional knowledge for plant conservation.

Unit III Bio diversity of tropical fruit crops

Biodiversity of major tropical fruit crops - mango- banana- sweet orange- lime-lemon- sapota- papaya- guava- pomegranate- pineapple- annona and avocado.

Unit IV Bio diversity of sub tropical and temperate fruit crops

Biodiversity of major sub tropical- temperate fruit and nut crops - grapes- mandarin- mangosteen- litchi- fig- apple- pear- plum- peach- strawberry- almond- apricot and walnut.

Unit V Bio diversity of under exploited minor fruit crops

Under exploited minor fruits -present status and scope- their origin- distribution- biodiversity- conservation and utilization of minor fruits.

Practical

Documentation of germplasm- maintenance of passport data and other records of accessions- field exploration trips- exercise on *ex situ* conservation- cold storage- pollen/seed storage- cryopreservation- visits to national gene bank and other centres of pgr activities- core sampling- germplasm characterization using molecular techniques.

Lecture schedule

1. Bio diversity – introduction , principles, goals and issues in conservation.
2. Genetic diversity- occurrence and distribution.
3. Exploration, collection, characterization, documentation and cataloguing of germplasm.
4. Present status of national and international gene banks.

5. Role of national institutes in conservation-TBGRI, NBPGR.etc.
6. Germplasm exchange, Material Transfer Agreement and current quarantine protocols.
7. Methods for *ex situ* conservation of germplasm and *in situ* conservation of germplasm .
8. Use of GIS and documentation of local biodiversity.
9. Horticultural cropping systems and implication on biodiversity.
10. Impact of climate change on biodiversity.
11. Advances and issues in conservation of biodiversity though recalcitrant and orthodox seeds.
12. Advances and issues in conservation of biodiversity through vegetative propagation .
13. Intellectual Property Rights, Plant Variety Protection Authority.
14. Status of biodiversity of mango.
15. Status of biodiversity of banana.
16. Status of biodiversity of sweet orange, lime and lemon.
17. Mid-semester examination
18. Status of biodiversity of sapota and papaya.
19. Status of biodiversity of guava and pomegranate.
20. Status of biodiversity of pineapple and annona.
21. Status of biodiversity of avocado and mangosteen.
22. Status of biodiversity of grapes.
23. Status of biodiversity of mandarin.
24. Status of biodiversity of litchi and fig.
25. Status of biodiversity of apple and pear.
26. Status of biodiversity of plum and peach.
27. Status of biodiversity of strawberry .
28. Status of biodiversity of almond and apricot.
29. Status of biodiversity of walnut.
30. Under exploited minor fruit crops - present status and scope.
31. - 34.Minor fruits - origin, distribution - biodiversity, propagation, conservation and utilization.

Practical schedule

1. Field exploration trips- exercise in collection and characterization.
2. Visit to field germplasm unit and documentation of germplasm.
3. Practices in maintenance of passport data.
4. Practical study of *ex situ* conservation methods.
5. Practical study of *in situ* conservation methods.
6. Methods of seed storage for short and long term conservation.
7. Methods of conservation using vegetative propagules.
8. *In vitro* conservation protocols.
9. Study of species diversity in horticultural cropping system.
10. Visit to regional conservation centres.
11. Visit to subtropical and temperate zone orchards.

12. Characterization of banana germplasm.
13. Characterization of papaya germplasm.
14. Characterization of mango germplasm.
15. Identification of minor fruit crops and their description.
16. Use of molecular tools for characterizing species diversity.
17. Estimating extent of diversity through collection and analysis of data.

Reference books

1. Frankel, O.H and J.G. Hawkes. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.UK.
2. Peter, K.V and Z. Abraham. (Eds). 2007. Biodiversity in Horticultural Crops.Vol.1 Daya Publishers, New Delhi.
3. Peter, K.V. (Ed). 2008. Biodiversity in Horticultural Crops.Vol.2 Daya Publishers, New Delhi.
4. Peter, K.V. (Ed). 2010. Biodiversity in Horticultural Crops.Vol.3 Daya Publishers, New Delhi.

HOR 621 GROWTH REGULATION AND STRESS MANAGEMENT IN HORTICULTURAL CROPS (2+1)

Objectives

To study the physiology of vegetative and reproductive growth in horticultural crops, to understand the growth regulation concepts in relation to productivity of crops and their environment and to study the physiological stresses in crop production and strategies to overcome them.

Theory

Unit I Concepts of crop growth analysis

Growth and development: definition- parameters of growth and development- growth dynamics- morphogenesis - different stages of growth- growth curves: sigmoid- polynomial and asymptotic - growth analysis in horticultural crops- CGR- RGR- NAR- LAI- LAR- HI in horticultural crops- canopy development- plant density and crop productivity - solar radiation concept and techniques for harvesting solar radiation for crop productivity.

Unit II Plant growth regulators

Plant growth regulators: auxins- gibberellins- cytokinins- ethylene- brassinosteroids- morphactins- inhibitors and retardants- bioassay- biosynthesis- translocation/movement- physiological role in cell level and their basic functions - mechanism of action of pgrs and theories - role of bio stimulants in crop growth and development - seaweed extract- humic acid- fulvic acid- chitosan and growth promoting microorganisms.

Unit III Developmental physiology of horticultural crops

Developmental physiology and biochemistry of seed germination- dormancy- bud break- methods of overcoming dormancy in horticultural crops - juvenility- vegetative to reproductive interphase and flowering - effect of light- photosynthesis- photoperiodism- vernalisation- temperature- heat units and thermoperiodism on developmental physiology - physiology of flowering : factors affecting flowering - floral induction theories/models: abc model- photoperiodism- vernalisation- florigen

and anti-florigen concepts – stages of flowering: floral induction- initiation and organ primordial identification.

Unit IV Physiology of growth regulation in horticultural crops

Physiology of source and sink relationship- translocation of assimilates - physiological basis of training and pruning - physiology of fruit & seed development and maturation - physiological basis of unfruitfulness- fruit drop and fruit thinning -physiology of ripening - climacterics in ripening - post harvest physiology of horticultural crops - physiology of tuber and bulb formation – growth regulation for tuber and bulb yield.

Unit V Physiology of senescence and stress management in Horticultural crops

Senescence: Physiology- biochemistry- molecular and genetic approaches in plant senescence - longevity of leaves in perennial and annual crops - stress physiology concepts: stress and strain terminology- eustress- distress- stress tolerance- resistance- avoidance - stress responses of plants: cellular and molecular level- causes- effects and methods of overcoming stress - heat- low temperature- water deficit- flooding and salinity stresses.

Practical

Mechanism of dormancy- stratification -PGR experiments on seeds- tubers and bulbs -visit to arid- subtropical and temperate horticultural zones to identify growth and development patterns- to perform growth analysis and to evaluate photosynthetic efficiency under different environments - experiment on growth regulator functions- hormone assays and ripening phenomenon in horticultural crops - experiment on impact of physical and chemical manipulations on growth and development of horticultural crops - growing of plants in sand culture under salt stress for biochemical and physiological studies - experiment on effect of osmotic and ionic stress on seed germination and seedling growth-measurement of low/high temperature injury under field conditions.

Lecture schedule

1. Growth and development: definitions and parameters of growth and development.
2. Principles of growth dynamics and morphogenesis.
3. Growth curves:stages and different pattern of growth curves of horticultural crops.
4. Growth analysis in horticultural crops (CGR, RGR, NAR, LAI, LAR, HI in horticultural crops).
5. Canopy development and plant density with respect to crop productivity.
6. Solar radiation concept and techniques for harvesting solar radiation for crop productivity.
7. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of auxin.
8. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of gibberellins.
9. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of cytokinins.

10. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of ethylene.
11. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of brassinosteroids and morphactins
12. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of inhibitors and retardants
13. Role of bio stimulants in crop growth and development: seaweed extract, humic acid, fulvic acid, chitosan and growth promoting microorganisms.
14. Physiology and biochemistry of seed germination
15. Physiology and biochemistry of dormancy : seed and bud dormancy
16. Physiology of bud breaking and methods of overcoming dormancy in horticultural crops
17. Mid -semester examination.
18. Effect of light, photosynthesis and photoperiodism on developmental physiology.
19. Effect of vernalisation, temperature, heat units and thermoperiodism on developmental physiology.
20. Physiology of flowering : factors affecting flowering and different stages of flowering
21. Physiology of flowering: floral induction theories/models: ABC model, photoperiodism and vernalisation.
22. Physiology of flowering : florigen and anti-florigen concepts with special reference to horticultural crops.
23. Source and sink relationship and concepts (carbon partitioning, sucrose synthesis, phloem loading and transportation).
24. Physiological and biochemical basis of training and pruning.
25. Physiology of fruit set and development with a special reference to chemical regulation of fruit set.
26. Physiological basis of unfruitfulness, fruit drop and fruit thinning
27. Physiological and biochemical basis of ripening and post harvest physiology of horticultural crops
28. Physiological and biochemical basis of tuber and bulb formation with special reference to growth regulation for tuber and bulb yield.
29. Physiological and biochemical basis of senescence with special reference to molecular and genetic approaches in plant senescence
30. Concepts of stress physiology: stress, eustress, distress, stress tolerance, resistance, avoidance
31. Stress responses of plants at cellular and molecular level.
32. Causes, effects and methods of overcoming heat and low temperature stress.
33. Causes, effects and methods of overcoming water deficit and flooding stress.
34. Causes, effects and methods of overcoming salinity stress.

Practical schedule

1. Estimation of growth parameters for analyzing the growth - estimation of leaf area index.
2. Estimation of growth parameters for analyzing the growth – DMP and growth rates.
3. Evaluation of photosynthetic efficiency of horticultural crops under different environments.
4. Visit to arid, subtropical and temperate horticultural zones to identify growth and development pattern of different horticultural crops.
5. Studies on mechanism breaking of dormancy by stratification in seeds.
6. PGR experiments on seeds, tubers and bulbs breaking of dormancy.
7. Hormone assays (Auxin)
8. Experiments on growth regulator functions - rooting of cuttings and herbicidal effect.
9. Experiments on growth regulator functions - fruit ripening in climacteric and non-climacteric fruits.
10. Experiments on growth regulator functions – senescence.
11. Experiments on growth regulation by pruning, pinching, defoliation and disbudding in horticultural crops .
12. Experiments on growth regulator functions – fruit thinning, overcoming fruit drop and unfruitfulness.
13. Experiments on growth regulator functions – post harvest losses in horticultural crops and post harvest treatments for shelf life.
14. Growing of plants in sand culture to study the effect of drought stress.
15. Growing of plants in artificially salinized soil in pots to study the effect of salt stress.
16. Effect of osmotic and ionic stress on seed germination and seedling growth
17. Estimation of proline content in stress and normal condition in crops.

Reference books

1. Helgi, O., Pik and A. Stephen. Rolfe. 2005. The Physiology of Flowering Plants. Fourth Edition (Arthur J. Willis, Ed.) Cambridge University Press The Edinburgh Building, Cambridge, UK.
2. Leopold, A.C. and P.E. Kriedermann. 1985. Plant Growth and Development. 3rd Ed. Mc Graw-Hill, UK.
3. Peter, K.V. (Ed.). 2008. Basics of Horticulture. New India Publ. Agency, New Delhi.
4. Roberto L. Benech-Arnold and A. Rodolfo. 2014. Handbook of seed physiology: Applications to Agriculture. CRC press, Boca Raton.
5. Roberts, J., S. Downs. and P. Parker. 2002. Plant Growth and Development in Plants. (I. Ridge, Ed.), Oxford University Press.UK.
6. Salisbury, F.B. and C.W. Ross. 1992. Plant Physiology. 4th Ed. Wadsworth Publ. UK.

HOR 622 PROTECTED AND PRECISION HORTICULTURE (2+1)

Objectives

This course aims to impart knowledge on various modes of protected cultivation and their technology components. It highlights various measures to control light- temperature- relative humidity and CO₂ and recent advances in control of substrate factors like pH- EC and soil microbes. It elaborates the production system so as to acquire knowledge on the cost of establishment and procedures for commencing hi-tech projects on protected and precision cultivation of horticultural crops.

Theory

Unit I Scope, importance and principles of protected cultivation

Profile of crop production systems - protected cultivation systems: overview- importance- scope and constraints under Indian conditions - comparison with conventional crop production system – microclimatological principles of protected cultivation: effect of light- temperature- relative humidity and CO₂ on crop growth and productivity- modes of protected cultivation types of protected structures: greenhouse- polyhouses/ walk in tunnels- plastic tunnels shade houses- cold frames- rain shelters- etc.

Unit II Structure and components of green house

Site selection and planning of green house structure - types/styles of green house- orientation- design- frames- civil work requirement- drainage and gutter - green house components - environment control systems: green house covering materials- ventilation systems- temperature control by cooling/heating system- shade and light systems- photoperiod manipulation - green house growing media - beds- green house benches- grow containers for different systems/crops – components of different growing media – media preparation.

Unit III Irrigation systems for green house

Green house irrigation systems: different types and components- planning- lay out- designing- installation- operation and maintenance – water requirement and irrigation scheduling for different crops – fogging systems- fertilizer sources – fertigation systems- water soluble fertilizers and their compatibility– application methods – fertilizer programmes for important vegetables and flowers.

Unit IV Green house automation (smart green house)

Green house automation – commercial smart green house systems – sensor based signalling and monitoring for environment control- irrigation and fertigation scheduling- automation components for plug production- modular containers- media mixers and fillers- mechanical seeder- seed pelleting- priming- root trainers- insects and disease control system- smoke generator- thermal fogging for insect and disease control - automatic green house logistical system and internet of things – multi-level growing and vertical farming.

Unit V Precision horticulture and hydroponics

Precision horticulture- principles and concepts- enabling technologies of precision farming- GPS- GIS- remote sensing- sensors- variability management in precision farming- mapping- variable rate technology- precision equipments- computers and robotics in precision farming- precision farming displays- software- expert systems and application – hydroponics: principles and system designs-

system components – materials- growing media and methods of establishment – management of hydroponic growing systems – aquaponics.

Practical

Green house designing- site analysis and lay out - parts of green house and structural components- glazing/cladding materials - growing media and sterilization - beds- specification for benches- construction and lay out- plant growing containers - environment control systems: ventilation- cooling- heating- lighting- irrigation and fertigation systems - IPM- special horticultural practices- cost economics of different greenhouse production systems - visit to hi-tech units - GPS- GIS- remote sensing facility- designing of prototype hydroponic system.

Lecture schedule

1. Protected cultivation systems: overview and importance in comparison with conventional crop production system.
2. Current scenario of green house cultivation in India: focus on constraints and scope.
3. Microclimatological principles of protected cultivation: effect of light, temperature and relative humidity on crop growth and productivity.
4. Microclimatological principles of protected cultivation: effect of elevated CO₂ on crop growth and productivity.
5. Modes and types of protected structures: greenhouse, polyhouses/ walk in tunnels and plastic tunnels
6. Modes and types of protected structures: shade houses, cold frames, rain shelters etc.
7. Types/styles of green house structure, site selection and planning
8. Structural designing and specifications of frames, gutter and fittings for different types of green houses.
9. Civil work requirement and specifications for green house erection.
10. Components of green house for environment control : green house covering materials, accessories and ventilation systems
11. Components of green house for environment control : temperature control by cooling/heating system and photoperiod manipulation by shade and light systems,
12. Grow beds, benches and grow containers for different green house systems and crops.
13. Components of different growing media and media preparation for different greenhouse crops.
14. Different types and designing principles of green house irrigation systems.
15. Installation, operation and maintenance of green house irrigation systems.
16. Water requirement and irrigation scheduling for different green house crops.
17. Mid -semester examination.
18. Fogging systems for green house: principles, designing and components.
19. Advantages of fertigation systems in green house and working principles and design of different fertigation systems.

20. Sources of water soluble fertilizers and their compatibility in fertigation systems.
21. Fertilizer programmes for important vegetables and flowers under green house growing.
22. Green house automation : scope and advantages of commercial smart green house systems
23. Sensor based signalling and monitoring for environment control and scheduling of irrigation and fertigation in smart green house.
24. Automation components: plug production, modular containers, media mixers and fillers.
25. Mechanical seeding, seed pelleting, priming and root training practices in green house automation.
26. Automated insects and disease control system: smoke generator, thermal fogging for insect and disease control.
27. Automatic green house logistical systems and internet of things.
28. Vertical farming and multi-level growing: principles, design and practices.
29. Precision horticulture: principles, concepts and role of GPS, GIS, Remote sensing and sensors.
30. Variability management in precision farming, mapping- variable rate technology.
31. Precision equipments, computers and robotics in precision farming.
32. Precision farming displays, software, expert systems and applications
33. Hydroponics: principles, system designs, components and management of hydroponic growing systems.
34. Aquaponics: Integration of hydroponic system with domestic aquaculture.

Practical schedule

1. Study on components of greenhouse, polyhouses/ walk in tunnels and plastic tunnels
2. Study on site analysis and lay out designing for green house.
3. Estimating the cost of low cost green house of IARI model.
4. Designing covering material.
5. Designing of ventilation – passive and active systems.
6. Designing of cooling systems.
7. Designing an irrigation system.
8. Designing of fogging systems
9. Estimation of light requirement for various purposes.
10. Working out the space use efficiency of beds and benches.
11. Study of fertigation methods.
12. Fertilizer calculation.
13. Economics of green house cultivation of cut flowers.
14. Economics of green house cultivation of vegetables.
15. Visit to export oriented floriculture units and precision farming units.
16. Visit to GPS, GIS and remote sensing facility.
17. Designing of prototype hydroponic system.

Reference books

1. Aldrich R.A and J.W. Bartok. 1994. Green House Engineering. NRAES (Natural Resource, Agriculture, and Engineering Service), Ithaca, New York.
2. James, Lr. Boodley. 1981. The Commercial Green House. Ball Publishing, USA.
3. Paul, V. Nelson. 1991. Green House Operation and Management. Ball Publishing, USA.
4. Pranab Hazra, A., Chattopadhyay, K., Karmakar S. Dutta. 2011. Modern Technology in vegetable production. New India publishing agency, New Delhi
5. Prasad, S. and U. Kumar. 2005. Greenhouse Management for Horticultural Crops. 2nd Ed. Agrobios India, Jodhpur.
6. Prasad, S. and V. Kumar. 1999. Green House Management for Horticultural Crops. Agrobios India, Jodhpur.
7. Premjit Sharma, 2007. Precision Farming, Gene-Tech Books, New Delhi.
8. Reddy, S., B. Janakiram., T. Balaji, S. Kulkarni. and R.L .Misra. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.
9. Robert, A., Aldrich. and W. John. Bartok, Jr. 1990. Green House Engineering. Ball publishing, USA.
10. Tiwari, G.N. 2003. Green House Technology for Controlled Environment. Narosa publishing house, New Delhi.

FSC 621 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION (2+1)

Objectives

To impart knowledge on the importance, scientific management practices, problems associated- postharvest management and marketing potential of subtropical and temperate fruits grown in India.

Theory

Commercial subtropical fruits and temperate fruits and nuts- eco physiological requirements- important varieties- latest propagation techniques followed- rootstocks- stock/scion relationships- planting systems- hdp- cropping systems- root zone and canopy management- modern irrigation and nutrient management- factors (abiotic and biotic) limiting fruit production and their management- gap- physiology of flowering and fruit set and development- off season and year round production- management practices for quality improvement- organic production technologies- maturity indices- harvesting- grading- packing- pre- cooling- storage- transportation and ripening techniques- mechanisation in fruit crops- local and export market potential- AEZs and industrial support- research advances made in the following fruit crops:

Unit I Sub tropical fruit production -I

Hill banana, grapes, mandarin and pineapple

Unit II Sub tropical fruit production -II

Mangosteen, durian, passion fruit, fig and avocado

Unit III Sub tropical fruit production -III

Persimmon, loquat, litchi, rambutan, carambola and bilimbi

Unit IV Temperate fruit crop production

Apple, pear, plum, peach, strawberry

Unit V Nut crop production

Kiwi, apricot, walnut, almond, pistachio, pecan and hazelnut.

Practical

Identification of important cultivars- designing hdp system for optimum production- growth regulation and off season production using pruning methods and use of growth regulators - diagnosis and correction of physiological disorders- identification of nutrient and micronutrient deficiencies and their correction- identification of storage disorders and following preventive methods- visit to subtropical and temperate orchards and fruit processing and package industries- project preparation for establishing commercial orchards.

Lecture schedule

1. Importance- area and production of subtropical and temperate fruit crops in Tamilnadu and India.
Important varieties- latest propagation techniques followed- rootstocks-stock/scion relationships- modern hdp systems for tropical and subtropical fruit crops- pruning methods and machineries used in HDP and off season production- growth regulation using growth regulators for off-season fruit production- good agricultural practices- mechanisation in fruit crops local and export market potential for the following subtropical and temperate fruit crops:
2. Hill banana
3. - 5. Grapes
6. Mandarin
7. - 8. Pineapple
9. Mangosteen
10. Durian
11. Passion fruit and Kokam
12. Fig
13. Avocado
14. Persimmon
15. Loquat
16. Litchi
17. Mid-semester examination
18. Rambutan
19. Carambola and Bilimbi
20. Unique climatic requirements for temperate fruit crops
21. - 22. Apple
23. Pear
24. Plum
25. Peach
26. Strawberry
27. Apricot

28. Cherries
29. Kiwi fruit
30. Commercial temperate nuts and their economic importance
31. Walnut
32. Almond
33. Pistachio, pecan and hazelnut
34. Processing industries for subtropical and temperate fruit crops

Practical schedule

1. Description of commercial subtropical fruits.
2. Propagation techniques for subtropical fruits.
3. Designing HDP for subtropical fruits.
4. Pruning and growth regulation of grapes for year round production.
5. Preparation of growth regulator solutions for propagation and flower induction in subtropical fruits.
6. Visit to grape gardens.
7. Identification of nutrient and physiological disorders in citrus sp.
8. Preparation of micronutrient mixtures for alleviating nutrient deficiency of citrus.
9. Visit to temperate orchards – HRS, Kodaikanal and study of mandarin at HRS Thadiyankudisai, identification of important cultivars and survey of existing cropping systems.
10. Visit to cold storage unit - study of stored temperate fruits for quality and diseases.
11. Development of a model fruit cropping system suitable for southern (Tamilnadu) subtropical areas.
12. Development of a model fruit cropping system for southern (Tamilnadu) temperate areas
13. Nutrition management in subtropical fruits.
14. Nutrition management in temperate fruits.
15. Identification of maturity indices for subtropical and temperate fruit crops.
16. Project Preparation for commercial orchard establishment.
17. Visit to Kallar and Burliar State Horticultural Farms .

Reference books

1. Bose, T.K., S.K. Mitra. and D.S. Rathore. (Eds.). 1988. Temperate Fruits - Horticulture. Allied Publ. New Delhi.
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3. Chadha, K. L. and O.P. Pareek. (Eds.). 1996. Advances in Horticulture. Vols. III-V. Malhotra Publ. House, India
4. Nakasone, H. Y. and R.E. Paul. 1998. Tropical Fruits. CAB International, Wallingford, England.
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8. Singh, H.P., J.P.Negi. and J.C. Samuel. 2002 (Eds.). Approaches for Sustainable Development of Horticulture. National Horticulture Board, Gurgaon.
9. Singh, H.P., G. Singh., J.C. Samuel and R.K. Pathak. (Eds.). 2003. Precision Farming in Horticulture. NCPAH, DAC/PFDC, CISH, Lucknow

FSC 622 BIOTECHNOLOGY OF FRUIT CROPS (1+1)

Objectives

Understanding the principles of biotechnology, learning about the various developments in biotechnology and its potential applications.

Theory

Unit I Importance of biotechnology and factors affecting tissue cultures

Harnessing biotechnology in fruit crops- influence of plant materials- physical-chemical factors and growth regulators on growth and development of plant cell-tissue and organ cultures.

Unit II Techniques in biotechnology -I

Callus culture- types- cell division- differentiation- organogenesis-embryogenesis- organ culture- meristem- embryo- endosperm-anther- ovule culture- embryo rescue- rapid clonal propagation- somaclonal variations.

Unit III Techniques in biotechnology-II

Hardening and field transfer- use of bioreactors and *in vitro* methods for production of secondary metabolites- suspension cultures- regeneration of tissues.

Unit IV Techniques in biotechnology -III

Protoplast culture and fusion- construction and identification of somatic hybrids and cybrids- *in vitro* pollination and fertilization- *in vitro* mutation- artificial seeds.

Unit V Techniques in biotechnology -IV

Cryopreservation- genetic engineering in horticulture crops- use of molecular markers- *in vitro* selection for biotic and abiotic stress- achievements of biotechnology in fruit crops.

Practical

An exposure to tissue culture laboratories- media preparation- inoculation of explants for clonal propagation- callus induction and culture- regeneration of plantlets from callus- sub-culturing- techniques on anther- embryo culture- somaclonal variation- *in vitro* mutant selection against abiotic stress- development of protocols for mass multiplication- project development for establishment of commercial tissue culture laboratory.

Lecture schedule

1. Role of biotechnology in fruit crops.
2. Influence of plant materials, physical and chemical factors on growth and development of plant cell tissues and organs.
3. Callus cultures, differentiation, organogenesis and somatic organogenesis.
4. Meristem culture for disease elimination.

5. Production of haploids and dihaploids through anther, pollen and ovule culture.
6. Embryo culture and endosperm culture techniques
7. Rapid *in vitro* clonal propagation through direct organogenesis.
8. Hardening and establishment of tissue cultured plantlets in primary, secondary nursery and field.
9. Mid – semester examination
10. Somaclonal variations and its applications.
11. *In vitro* production of secondary metabolites
12. Protoplast culture and regeneration and protoplast fusion.
13. Techniques of *in vitro* pollination and fertilization and *in-vitro* mutation
14. Synthetic seed production techniques
15. *In vitro* conservation and cryopreservation techniques.
16. Genetic engineering and transgenics.
17. Vectors and methods of transformation.

Practical schedule

1. Components of tissue culture laboratory.
2. Laboratory equipments-uses and methods of operation.
3. Nutrient stock and growth regulator stock preparation.
4. Culture media preparation.
5. Sterilization techniques for glassware and media.
6. Inoculation of explants for direct organogenesis.
7. Inoculation of explants for callus culture.
8. Clonal propagation through meristem culture.
9. Anther, pollen and ovule culture.
10. Sub-culturing techniques for regeneration.
11. Induction of multiple shoots and roots.
12. *In vitro* screening of cell lines for abiotic stress.
13. *In vitro* mutation for abiotic stress.
14. Synthetic seed production.
15. Hardening techniques.
16. Visit to leading commercial tissue culture units.
17. Project preparation for establishment of tissue culture labs.

Reference books

1. Alex Mathew. 2010. Principles of Biotechnology. Adhayan Pub. New Delhi.
2. Balasubramanian, D., C.F.A. Bryce., K. Dharmalingam., J.Green. And K. Jayamaran. 2004. Concepts in Biotechnology. Universities Press, India.
3. Bhojwani, S.S. and M.K. Razdan. 2006. Plant Tissue Culture Studies – Theory and Practice. Elsevier Publication.
4. Brown T.A. 2001. Gene Cloning and DNA Analysis- an Introduction. 6th Edn. Wiley-Blackwell, U.K.
5. Endress, R. & E. Rudolf. 2004. Plant Cell Biotechnology. Springer – Verlag Publication, London.

6. Keshavachandran, R., P.A. Nazeem, D. Girija, P. S. John and K. V. Peter.(Ed).2007. Recent trends in biotechnology of Horticultural Crops, Vol-2. New India Publishing Agency, New Delhi.
7. Manoj, V., Parakhia .2010. Molecular Biology and Biotechnology: Microbials methods, New India. Publ.,New Delhi.
8. Prakash S.Lohar.2012. Text Book of Biotechnology,MJP Publ., New Delhi.
9. Sambrook, J., T. Fritsch. & T. Maniatis 2001. Molecular Cloning – A Laboratory Manual. 2nd Ed. Cold Spring Harbour Laboratory Press, UK.

FSC 623 ORGANIC FRUIT PRODUCTION (1+1)

Objectives

To educate the students with the principles and concept of organic farming in the production of fruit crops

Theory

Unit I Importance of organic Horticulture

Organic Horticulture definition – synonyms and misnomers – principles – methods – merits and demerits – present status- rationale back ground of organic fruit production in India and in the world.

Unit II Bio inputs in organic Horticulture

Different organic inputs – their role in organic fruit production – bulky organic manures – green manures – bio fertilizers – bio dynamics – em technology and its impact in organic fruit production

Unit III Biological management in organic Horticulture

Indigenous practices in organic horticulture – sustainable soil fertility management – weed management practices in organic fruit production- biological/natural control of pests and diseases- quality improvement

Unit IV Certification in organic Horticulture

GAP- Principles and management – HACCP exercise – certification of organic products and systems – agencies involved at National and International level – standards evolved by different agencies.

Unit V Post harvest management and sustainability in organic Horticulture

Constraints in certification – organic fruit production and export – IFOAM and global scenario of organic movement – post harvest management of organic fruit produce -sustainability and input management system in organic fruit production.

Practical

Estimation of soil physical, chemical and biological parameters – composting of farm wastes and agro industrial wastes -recycling of crop wastes through vermiculture- preparation of panchakavya -activated em solution nutritive analysis for estimating the potential of organics- mulching -nursery bed soil solarisation- bio agents for crop protection and their preparation-working out indices for organic fruit production- economic evaluation of organic fruit production system -visit to farmers field under organic fruit production .

Lecture schedule

1. Organic horticulture, definition, synonyms and misnomers.
2. Scope, principles of organic horticulture and merits and demerits.
3. Present status, rationale and back ground of organic fruit production in India and the world.

4. Different organic inputs and its role in organic fruit production.
5. Bulky organic green manures and biofertilizers.
6. Biodynamic farming, EM technology and its impact.
7. Indigenous practices in organic horticulture.
8. Sustainable soil fertility management.
9. Mid – semester examination
10. Weed management practices in organic fruit production.
11. Biological/natural pest management.
12. Biological/natural disease management with respect to quality.
13. GAP principles and management.
14. Certification of organic produce and agencies at national and international levels.
15. Standards for different agencies .
16. Constraints in certification.
17. Post harvest management of organic produce and sustainability and input management.

Practical schedule

1. Soil physical parameters with relevance to organic fruit production.
2. Estimate of soil chemical parameters (pH, EC and ESP).
3. Estimation of soil biological parameters.
4. Estimation of farm wastes / agro industrial waste.
5. Agro techniques for composting farm wastes and agro industrial wastes.
6. Recycling of crop wastes through vermin culture.
7. Preparation of Panchakavya .
8. Preparation of activated EM solution.
9. Nutritive analysis for estimating the potential of organics.
10. Application of various mulch materials to horticultural crops.
11. Nursery bed soil solarization.
12. Study of bio agents for crop protection.
13. Preparation of organic formulations for pest control.
14. Preparation of organic formulations for disease control.
15. Working out indices for organic fruit production.
16. Economic evaluation of organic fruit production system.
17. Visit to farmers field under organic fruit production.

Reference books

1. Dahama, A.K. 2018. Organic farming for sustainable Agriculture. 2 nd Ed. Agrobios, Jodhpur.
2. Gehlot, G. 2005. Organic farming. Standards, Accreditation, Certification and inspection. Agrobios, Jodhpur.
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5. Shiv shankar, K (Ed.). 1997. 3rd IFOAM – ASIA science conference and general assembly “Food security in harmony with nature” held at UAS, Bangalore.
6. Stella Cubison. 2015. Organic fruit production and viticulture – A complete guide Timber press , USA.

FSC 624 POST HARVEST TECHNOLOGY OF FRUIT CROPS (2+1)

Objectives

To understand the basics and principles of post harvest technology and recent innovations in processing- packaging- storage and transport of fruit crops.

Theory

Unit I Importance of post harvest technology and factors leading to post harvest losses

Post harvest technology- scenario in fruit crops - harvest indices - harvesting methods in fruit crops - harvesting practices for specific market requirements - influence of pre - harvest factors on post harvest quality and shelf life of fruit crops - factors leading to post harvest losses.

Unit II Physiology of ripening and post harvest treatments

Ripening of fruits - physiology and biochemistry of fruit ripening - ethylene action on ripening of fruits and ethylene management - pre-cooling - treatments prior to transport - chlorination- waxing- chemicals- bio control agents and natural plant products.

Unit III Storage methods

Storage methods- ventilated – refrigerated – MAS – CAS - physical injuries and disorders during storage

Unit IV Methods of preservation

Principles and methods of preservation - minimal processing of fruits – pretreatment- blanching - canning and irradiation - value addition of fruits - fruit juices – beverages - pickles - jam- jellies- marmalades- candies- glazed- crystallized fruits- dried and dehydrated products-nutritionally enriched- fortified products encapsulated fruit flavours.

Unit V Packing technologies and quality control standards

Packaging-technologies - packaging materials and transport- by -products from processing and its management- quality control and regulation of fresh and processed products- food safety standards.

Practical

Experiments on extension of shelf life - experiments on methods of preservation - changes occurring during preservation- various methods of preserving products- experiments to curtail spoilage- visit to food processing units.

Lecture schedule

1. Post harvest technology scenario of fruit crops.
2. Harvest indices, physiological and horticultural maturity of important fruits, harvesting practices for specific market requirements.
3. Harvest indices, physiological and horticultural maturity of important sub tropical fruit crops *viz.*, pineapple, mandarins, jack, strawberry, grapes – harvesting practices for specific market requirements.
4. Harvest indices, physiological and horticultural maturity of important temperate fruit crops *viz.*, apple, pear, peach, plum – harvesting practices for specific market requirements .
5. Harvest indices, physiological and horticultural maturity of arid zone and minor fruit crops, *viz.*, pomegranate, annona, ber, date aonla, bael, woodapple, karonda, jamun, gambodge- harvesting practices for specific market requirements.

6. Influence of pre- harvest practices on post harvest quality and shelf life of fruits.
7. Influence of pre- harvest practices on post harvest quality and shelf life of vegetables.
8. Influence of pre- harvest practices on post harvest quality and shelf life of flowers.
9. Influence of pre- harvest practices on post harvest quality and shelf life of spices and plantation crops.
10. Influence of pre- harvest practices on post harvest quality and shelf life of medicinal plants.
11. Major factors leading to post harvest losses.
12. Fruit ripening – climacteric and non- climacteric ripening.
13. Bio chemical and physiological changes during ripening.
14. Respiration, transpiration, ethylene evolution and ethylene management of fresh produce.
15. Pre- cooling treatments prior to transport, chlorination, waxing, chemicals, bio control agents and natural plant products.
16. Storage methods for fresh produces (ventilated, cold storage).
17. Mid - semester examination
18. Modified atmospheric and controlled atmospheric storage (MAS, CAS)
19. Disorders and injuries during storage.
20. Packaging technology and packaging materials – characteristics and selection.
21. Refrigerated transport system for fresh produce.
22. Minimal processing merits and demerits.
23. Cold chain in maintenance and supply chain management.
24. Principles and methods of preservation and processing
25. Pre- treatments – blanching and canning.
26. Value added products from horticultural crops – fruit juices and beverages.
27. Pickles.
28. Jam, jellies, marmalades.
29. Dried and dehydrated products
30. Nutritionally enriched or fortified products, encapsulated fruit flavours.
31. Packaging technology for processed products.
32. General principles and quality standards and control.
33. Food safety standards.
34. By-products from processing and its management (Briquetting, Kernel powder).

Practical schedule

1. Exercise on harvesting of fruits based on maturity indices.
2. Pre-cooling, grading, washing and waxing treatments.
3. Collection and practicing usage of various packaging materials.
4. Experiments to hasten ripening of fruits.
5. Experiments to delay ripening of fruits.
6. Exercise on storage of fruits.
7. Preparation of jams and jellies.
8. Preparation of squashes and RTS.
9. Preparation of marmalade.

10. Preparation of sauce.
11. Preparation of brine and syrup for preservation.
12. Preparation of pickles.
13. Practices in lye peeling and scalding.
14. Experiment on dehydration of fruits.
15. Preparation of candies and crystallized fruits.
16. Visit to commercial processing industries.
17. Project preparation for establishment of fruit processing industry.

Reference books

1. Ashwani, K. Goel. 2007. Post harvest management and value addition. Daya publishing House. New Delhi.
2. Cruesss, W.V. 2000. Commercial Fruit and Vegetable Products. Agrobios (India), Jodhpur
3. Jacob John. 2008. A Hand Book on Post Harvest Management of Fruits and Vegetables. Daya Publishing House. New Delhi.
4. Loasecke, H. W.V. 2001. Drying and Dehydration of Foods. Agrobios (India), Jodhpur
5. Manorajan Kalia. 2006. Post Harvest Technology of Vegetables. Agrotech Publishing Academy, Udaipur.
6. Sumanbhatti and Uma Varma. 1995. Fruit and Vegetable Processing. CBS Publishers and Distributors, New Delhi.
7. Thompson, A. K. 1996. Post Harvest Technology of Fruits and Vegetables. Blackwell Science, Inc. U.K.
8. Verma, L.R and V.K. Joshi 2000. Post Harvest Technology of Fruits and Vegetables (Vol I & II). Indus Publishing Company, New Delhi.

OPC- HOR 711 PROPAGATION AND NURSERY MANAGEMENT OF HORTICULTURAL CROPS (2+1)

Objectives

This course deals with different methods of plant propagation and strategies for nursery management of various fruit crops. Knowledge of tools and implements is essential to carry out all scientific horticultural operations and also nursery management practices. The above themes are discussed elaborately in this course and the basic knowledge gained will be useful for the career development of students in commercial nursery business.

Theory

Unit I Principles of plant propagation

Sexual and asexual methods of propagation - principles and factors influencing seed germination-dormancy- hormonal regulation of germination and seedling growth- seed quality- packing- storage- certification and testing.

Unit II Anatomical and physiological aspects of plant propagation

Techniques of cottage - layerage- graftage and budding- compatibility-dwarfing rootstocks of important fruit trees.

Unit III Plant growth regulators and plant tissue culture

Role of PGR'S in plant propagation- role of nucellar embryony- apomixes-tissue culture techniques- hardening techniques .

Unit IV Planning of a nursery unit and modern propagation structures

Raising of nursery plants- selection- certification maintenance of mother plants and bud wood and root stock nurseries- use of modern structures- mist chambers- low cost poly houses- tunnel houses.

Unit V Marketing methods of nursery plants and economics

Media/soil mixtures- containers- use of machinaries- lifting- packing- transport- marketing- economics of raising nursery and management in different fruit crops.

Practical

Media/soil mixture- containers and soil sterilisation- use of chemicals for seed treatment and sowing- preparation of nursery beds- polybags- seedpans- thumb rule for raising seedlings- stratification and scarification of seeds and use of tetrazolium salts for germination tests-identification of nucellar seedlings- practice of different asexual methods of propagation- viz.-cottage- layering- budding- approach- veneer and softwood grafting-use of plant growth regulators in propagation of plants -use of mist chambers- modern propagation structures- low cost polyhouses- low tunnels and bottom heating techniques- selection- lifting- packing- transportation and marketing of nursery plants- economics of raising nurseries- visit to local commercial/private nurseries.

Lecture schedule

1. Scope and importance of plant propagation.
2. Study of sexual and asexual methods of propagation.
3. Advantages and disadvantages of seed and vegetative propagation.
4. Factors influencing seed germination of Horticultural crops.
5. Studies on dormancy, hormonal regulation of germination and seedling growth.
6. Study of seed quality, packing, storage, certification and testing.
7. Study of anatomical and physiological aspects of asexual propagation.
8. Studies on graft compatibility on fruit crops.
9. Dwarfing rootstocks of commercial importance in fruit crops.
10. Role of PGR's in raising seedlings and rooting of cuttings and layers.
11. Role of nucellar embryony and apomixis.
12. Studies on tissue culture techniques.
13. Micro grafting (STG).
14. Techniques of cuttings and layering.
15. Techniques of budding and grafting.
16. Planning of nursery unit.
17. Mid-semester examination
18. Study of raising of nursery plants and their after care- role of prostrate nursery and their after care.
19. Study of modern propagation structures.
20. Role of mist chambers in plant propagation.
21. Study of bottom heating techniques.
22. Hardening techniques in nursery.

23. Progeny orchard and scion bank.
24. Establishment of bud wood bank.
25. Media -soil mixture preparation for nursery plants.
26. Study of containers used for nursery.
27. Use of machineries in nurseries.
28. Soil sterilization techniques.
29. Irrigation systems in nursery plants.
30. Lifting and packing of nursery plants.
31. Transportation and marketing of nursery plants.
32. Nursery planning and layout .
33. Economics of raising nursery and management of different fruit crops.
34. Nursery acts.

Practical schedule

1. Media/soil mixture, containers and soil sterilization.
2. Use of chemicals for seed treatment and sowing.
3. Preparation of nursery beds, polybags, seedpans, thumbrule for raising seedlings.
4. Stratification and scarification of seeds and use of tetrazolium salts for germination.
5. Identification of nucellar seedlings.
6. Practice of different asexual methods of propagation, viz.,cuttage, layering.
7. Buddingmethods.
8. Grafting- methods.
9. Use of plant growth regulators in propagation.
10. Role of mist chambers in plant propagation.
11. Other protected structures uses for plant propagation.
12. Low cost polyhouses, low tunnels.
13. Bottom heating techniques and soil sterilization.
14. Selection, lifting, packing of nursery plants.
15. Transportation and marketing of nursery plants.
16. Economics of raising nurseries.
17. Visit to local commercial/private nurseries.

Reference books

1. Adams, C.R., K.M. Bandford and M.P. Early. 1996. Principles of Horticulture CBS Publishes and Distributors, New Delhi.
2. Bose, T.K., S.K. Mitra., M.K. Sadhu and B. Mitra. 1991. Propagation of Tropical and subtropical Horticultural Crops, Naya Prokash, Calcutta. India.
3. Edmond, J.B., T.L. Senna., F.S. Andrews and R.R. Halfacre. 1990. Fundamentals of Horticulture. Tata McGraw Hill Publishing Co. Ltd.
4. Hartmann, H.T., D.E. Kester., F.T. Davies. and R.L. Greneve. 1997. Plant propagation – Principles and Practices, Prentice Hall of India Private Ltd., New Delhi.
5. Prasad, S. and V. Kumar. 1999. Green House Management of Horticultural Crops, AgroBios India, Jodhpur.
6. Reddy, Y.T.N., T. Janakiram. and D. Satyanarayana Reddy. 2001. Scientific Nursery Management, The House of Sarpan (Media), Bangalore.

OPC - FSC 712 GENETIC RESOURCES AND CONSERVATION OF FRUIT CROPS (2+1)

Objectives

Understanding the principles of biodiversity, strategies in conservation and utilization of fruit crop biodiversity and learning about under exploited fruits in India.

Theory

Unit I Importance of biodiversity and methods of conservation

Biodiversity and conservation- issues and goals- centers of origin of cultivated fruits- primary and secondary centers of genetic diversity- present status of gene centers- exploration and collection of germplasm- conservation of genetic resources- *in situ* and *ex situ* germplasm conservation- problem of recalcitrancy- cold storage of scions- tissue culture- cryopreservation- pollen and seed storage- inventory of germplasm.

Unit II Role of National institutes in conservation and plant quarantine

Introduction of germplasm- plant quarantine- role of National institutes in conservation- TBGRI- NBPGR.etc- Intellectual property rights- regulatory horticulture- plant variety protection authority- maintenance of core group using traditional knowledge for plant conservation.

Unit III Bio diversity of tropical fruit crops

Biodiversity of major tropical fruit crops - Mango- banana- sweet orange- lime-lemon- sapota- papaya- guava- pomegranate- pineapple- annona and avocado.

Unit IV Bio diversity of sub tropical and temperate fruit crops

Biodiversity of major sub tropical- temperate fruit and nut crops - grapes-mandarin- mangosteen- litchi- fig- apple- pear- plum- peach- strawberry- almond-apricot and walnut.

Unit V Bio diversity of under exploited minor fruit crops

Under exploited minor fruits -present status and scope- their origin-distribution- biodiversity- conservation and utilization of minor fruits.

Practical

Documentation of germplasm maintenance of passport data and other records of accessions; field exploration trips- exercise on *ex situ* conservation cold storage-pollen/seed storage- cryopreservation- visits to National Gene Bank and other centers of PGR activities.

Lecture schedule

1. Bio diversity – introduction, principles, goals and issues in conservation.
2. Genetic diversity- occurrence and distribution.
3. Exploration, collection, characterization, documentation and cataloguing of germplasm.
4. Present status of National and International gene banks.
5. Role of national institutes in conservation-TBGRI, NBPGR.etc.
6. Germplasm exchange, Material Transfer Agreement and current quarantine protocols.
7. Methods for *ex situ* conservation of germplasm and *in situ* conservation of germplasm.
8. Use of GIS and documentation of local biodiversity.
9. Horticultural cropping systems and implication on biodiversity .
10. Impact of climate change on biodiversity.
11. Advances and issues in conservation of biodiversity though recalcitrant and orthodox seeds.

12. Advances and issues in conservation of biodiversity through vegetative propagation.
13. Intellectual Property Rights, Plant Variety Protection Authority .
14. Status of biodiversity of mango.
15. Status of biodiversity of banana.
16. Status of biodiversity of sweet orange, lime and lemon.
17. Mid-semester examination
18. Status of biodiversity of sapota and papaya.
19. Status of biodiversity of guava and pomegranate.
20. Status of biodiversity of pineapple and annona.
21. Status of biodiversity of avocado and mangosteen.
22. Status of biodiversity of grapes.
23. Status of biodiversity of mandarin .
24. Status of biodiversity of litchi and fig.
25. Status of biodiversity of apple and pear.
26. Status of biodiversity of plum and peach.
27. Status of biodiversity of strawberry .
28. Status of biodiversity of almond and apricot.
29. Status of biodiversity of walnut.
30. Under exploited minor fruit crops - present status and scope
31. - 34. Minor fruits - origin, distribution - biodiversity, propagation, conservation and utilization.

Practical schedule

1. Field exploration trips- exercise in collection and characterization
2. Visit to field germplasm unit and documentation of germplasm
3. Practices in maintenance of passport data
4. Practical study of *ex situ* conservation methods
5. Practical study of *in situ* conservation methods
6. Methods of seed storage for short and long term conservation
7. Methods of conservation using vegetative propagules
8. *In vitro* conservation protocols
9. Study of species diversity in horticultural cropping system
10. Visit to regional conservation centres
11. Visit to subtropical and temperate zone orchards
12. Characterization of banana germplasm
13. Characterization of papaya germplasm
14. Characterization of mango germplasm
15. Identification of minor fruit crops and their description.
16. Use of molecular tools for characterizing species diversity
17. Estimating extent of diversity through collection and analysis of data

Reference books

1. Frankel, O.H. and J.G. Hawkes. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.UK
2. Peter, K.V. and Z. Abraham. (Eds). 2007. Biodiversity in Horticultural Crops.Vol.1 Daya Publishers, New Delhi
3. Peter, K.V. (Ed).2008. Biodiversity in Horticultural Crops.Vol.2 Daya Publishers, New Delhi
4. Peter, K.V (Ed).2010. Biodiversity in Horticultural Crops.Vol.3 Daya Publishers, New Delhi

**M.SC. (HORT.) VEGETABLE SCIENCE
COURSE-WISE DISTRIBUTION**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	VSC 611	Breeding of Vegetable crops	2+1
2.	VSC 612	Production technology of warm season vegetable crops	2+1
3.	VSC 613	Systematics of vegetable crops	2+1
4.	HOR 621 HOR 622	Growth regulation and stress management in horticultural crops (or) Protected and precision horticulture	2+1
5.	VSC 621	Production technology of cool season vegetable crops	2+1
6	VSC 622 VSC 623	Biotechnology of vegetable crops (or) Organic vegetable production	1+1
7	VSC 624	Principles and processing of vegetable crops	2+1
			13+7=20
Minor- 9 credits			
1.	OPC- GPB 621	Concepts of crop physiology	2+1
2.	OPC- HOR 711	Propagation and nursery management for horticultural crops	2+1
3.	OPC VSC 712	Hightech vegetable production	2+1
		Total	6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistical Methods and Design of Experiments	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
		Total	3+2=5
Seminar + Research - 21 credits			
1.	VSC -032	Seminar	0+1
2.	VSC -011; 021;031;041	Research 011-0+1; , 021-0+2; , 031- 0+8; , 041- 0+9	0+20
		Grand Total	22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0+1
4	PGS 624	Library and information services	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture	1+0
6	PGS 716 e-course	Disaster management	1+0
			2 + 4=6

**M.SC. (HORT.) VEGETABLE SCIENCE
SEMESTER WISE DISTRIBUTION**

S.No.	Course No.	Courses	Credit Hours
FIRST SEMESTER			
1.	VSC 611	Breeding of Vegetable crops	2+1
2.	VSC 612	Production technology of warm season vegetable crops	2+1
3.	VSC 613	Systematics of vegetable crops	2+1
4.	STA 611	Statistical Methods and Design of Experiments	2+1
5.	COM 611	Computer Programming and its Applications	1+1
6.	VSC 011	Research	0+1
7.	PGS 611	Agricultural Research Ethics & Methodology (0+1)	-
8.	PGS 612	Technical Writing and Communication Skills (0+1)	-
		Total	9+6=15
SECOND SEMESTER			
1.	HOR 621 HOR 622	Growth regulation and stress management in horticultural crops (or) Protected and precision horticulture	2+1
2.	VSC 621	Production technology of cool season vegetable crops	2+1
3.	VSC 622 VSC 623	Biotechnology of vegetable crops (or) Organic vegetable production	1+1
4.	VSC 624	Principles and processing of vegetable crops	2+1
4.	OPC GPB 621	Concepts of crop Physiology	2 + 1
5.	VSC 021	Research	0+2
6.	PGS 623	Basic Concepts in Laboratory Techniques (0+1)	-
7.	PGS 624	Library and Information Services (0+1)	-
		Total	9+7=16
THIRD SEMESTER			
1.	OPC XXX 711	Minor Course - Related discipline	2+1
2.	OPC XXX 712	Minor Course - Related discipline	2+1
3.	VSC 031	Research	0+8
4.	VSC 032	Seminar	0+1
5.	PGS 715 e-course	Intellectual property and its management in agriculture (1+0)	-
6.	PGS 716 e-course	Disaster management (1+0)	-
		Total	4+11 =15
FOURTH SEMESTER			
1.	VSC 041	Research	0 + 9
		Total	0 + 9
		Grand Total	22+33 = 55

VSC 611 BREEDING OF VEGETABLE CROPS (2+1)

Objectives

To impart knowledge on principles and practices of breeding of vegetable crops.

Theory

Origin- botany- taxonomy- cytogenetics- genetics- breeding objectives- breeding methods (introduction- selection- hybridization- mutation)- varieties and varietal characterization- resistance breeding for biotic and abiotic stress- quality improvement- molecular markers- genomics- marker assisted breeding and QTLs- biotechnology and their use in breeding in vegetable crops- issue of patenting- PPVFR act of the following crops:.

Unit I Breeding of solanaceous vegetables

Tomato, brinjal, chilli and sweet pepper.

Unit II Breeding of cucurbitaceous vegetables

Cucurbitaceous vegetables.

Unit III Cool season vegetables

Cabbage, cauliflower, carrot, beet root and radish.

Unit IV Bulb and tuber crops

Onion, garlic, potato, tapioca and sweet potato.

Unit V Greens and beans

Okra, moringa, peas, beans and amaranthus.

Practical

Modes of pollination and reproduction- pollen morphology and viability- palanological studies- selfing and crossing techniques in vegetable crops- assessment of variability- estimation of genetic distance- techniques of hybridization in vegetable crops- emasculation and hybridization- techniques of handling segregating progenies- D² analysis- heterosis and combining ability- diallel and line x tester analysis- assessment of character association- path analysis- study of superior varieties and hybrids in vegetable crops- visit to vegetable crops breeding centers and research institutes.

Lecture schedule

Origin- botany and taxonomy- genetics- cytogenetics- plant genetic resources- anthesis- pollination- fertilization mechanism- sterility and incompatibility- constraints- breeding objectives- methods and achievements of the following crops:

1. - 2. Tomato.
3. - 4. Brinjal.
5. - 6. Chilli.
7. Sweet pepper.
8. Bitter gourd.
9. Ridge gourd.
10. Pumpkin.
11. Ash gourd.
12. Watermelon.
13. Muskmelon.
14. Cabbage.

15. Cauliflower.
16. Carrot.
17. Mid -semester examination
18. Beet root.
19. Radish .
20. - 21. Onion.
22. Garlic .
23. - 24. Potato.
25. Tapioca.
26. Sweetpotato.
27. - 28. Okra.
29. Moringa.
30. Peas.
31. Beans.
32. Amaranthus.
33. Issue of patenting, PPVFR act.
34. Marker assisted breeding and QTL.

Practical schedule

1. Study of pollination mechanisms, pollen morphology and viability in solanaceous vegetable crops.
2. Study of pollination mechanisms, pollen morphology and viability in cucurbits.
3. Study of pollination mechanisms, pollen morphology and viability in crucifers.
4. Assessment of variability for vegetable improvement.
5. Estimation of genetic distance – D² analysis
6. Estimation of heterosis and combining ability
7. Study of diallel and line x tester analysis
8. Study of correlation and path analysis
9. Floral biology and techniques of hybridization in solanaceous vegetables.
10. Floral biology and techniques of hybridization in leguminous vegetables.
11. Floral biology and techniques of hybridization in cucurbitaceous vegetables.
12. Practices in breeding methods of cruciferous vegetable crops.
13. Practices in breeding methods of potato, tapioca and sweet potato.
14. Practices in breeding methods of root vegetables.
15. Practices in breeding methods of onion and garlic.
16. Practices in breeding methods of moringa and amaranthus.
17. Practices in breeding methods of okra.

Reference books

1. Dhillon, B.S., R.K. Tyagi., S. Saxena. & G.J. Randhawa. 2005. Plant Genetic Resources: Horticultural Crops. Narosa Publ. House., New Delhi.
2. Fageria, M.S., P.S. Arya. & A.K. Choudhary. 2000. Vegetable Crops: Breeding and Seed Production. Vol. I. Kalyani Publ.,New Delhi.

3. Gupta, S.K. 2000. Plant Breeding. Theory and Techniques. Vedam Publishers, Solan.
4. Harihar Ram. 2001. Vegetable Breeding. Kalyani Publishers, Ludhiana.
5. Kalloo, G. 1994. Vegetable Breeding – Combined Edition – Panima Book Publishers, New Delhi.
6. Kumar, U. and M.J. Asija. 2004. Biodiversity: Principles and Conservation Agrobios, Jodhpur.
7. Peter, K.V. and T. Pradeepkumar. 2008. Genetics and Breeding of Vegetables. Revised, ICAR, New Delhi.
8. Rai, N. and M. Rai. 2006. Heterosis Breeding in Vegetable Crops. New India Publ. Agency, New Delhi.
9. Rana, M.K. 2011. Breeding and Protection of Vegetables. New India Publishing Agency. New Delhi.
10. Singh, P.K., S.K. Dasgupta. and S.K. Tripathi. 2004. Hybrid Vegetable Development. International Book Distributing Co., New Delhi.

**VSC 612 PRODUCTION TECHNOLOGY OF WARM SEASON
VEGETABLE CROPS (2 + 1)**

Objectives

To impart knowledge on the production technology of warm season vegetables.

Theory

Introduction- commercial varieties / hybrids- climatic and soil requirements- seed rate and seed treatment- nursery management- protray nursery - sowing/planting -cropping systems- nutrient management- fertigation- irrigation management- plant growth regulators- intercultural operations- weed management- mulching- physiological disorders and corrective measures- biotic stresses and their management- organic production technologies- maturity standards- harvesting- seed production techniques- protected cultivation of the following crops:

Unit I Production techniques of solanaceous vegetables

Tomato, brinjal, chilli and sweet pepper

Unit II Bhendi and leguminous vegetables

Okra, dolichos beans, cowpea and cluster bean

Unit III Cucurbitaceous vegetables

Cucurbitaceous vegetables, pumpkin, gourds and melons, perennial cucurbitaceous, vegetables

Unit IV Tuber crops and other minor tubers

Tapioca, sweet potato, elephant foot yam, taro and minor tuber crops

Unit V Green leafy vegetables and under exploited vegetables

Onion, moringa, amaranthus, underexploited and lesser known vegetables

Practical

Description of commercial varieties and hybrids- seed treatment and nursery practices- study of nutritional and physiological disorders- identification of biotic stresses- role of mineral elements- deficiency symptoms- preparation of cropping schemes for commercial farms- experiments to demonstrate the role of mineral elements- application of plant growth regulators in vegetables- seed extraction techniques- identification of important pests and diseases and their control-

economics of warm season vegetable crops- maturity standards and harvesting- seed production techniques- cost economics of the following crops.

Lecture schedule

1. Introduction and classification scope and importance of warm season crops.
2. - 4. Tomato
5. - 7. Brinjal
8. - 10. Chillies
11. 11. Sweet pepper
12. - 13. Okra
14. - 15. Dolichos bean
16. Cowpea
17. Mid-semester examination
18. Cluster bean
19. Ash gourd and pumpkin
20. Bottle gourd and ridge gourd
21. Bitter gourd and snake gourd
22. Watermelon and muskmelon
23. Cucumber, gherkin and coccinea
24. - 26. Tapioca
27. Sweet potato
28. Elephant foot yam and minor tuber crops
29. Bellary onion
30. Aggregatum onion
31. Moringa
32. Amaranthus
33. Underexploited vegetables crops
34. Lesser known vegetables crops

Practical schedule

1. Description of commercial varieties / hybrids in solanaceous vegetables.
2. Description of commercial varieties / hybrids in cucurbits.
3. Description of commercial varieties / hybrids in okra, onion and moringa.
4. Description of commercial varieties / hybrids in tapioca and sweet potato.
5. Seed treatment and nursery practices in summer vegetables.
6. Fertigation practices in vegetables.
7. Assessing the efficiency of plant growth regulators in warm season vegetables.
8. Identification of biotic stresses in warm season vegetables.
9. Assessing the maturity standards and harvest indices in solanaceous vegetables and okra.
10. Assessing the maturity standards and harvest indices in cucurbits, onion and dolichos bean.
11. Seed production techniques in solanaceous vegetables.
12. Seed production techniques in cucurbits.

13. Seed production techniques in okra and onion
14. Preparation of cropping scheme for commercial farms.
15. Visit to vegetable markets.
16. Working out cost economics for commercial cultivation of warm season
17. Vegetables
18. Protected cultivation of tropical vegetables.

Reference books

1. Bose, T.K., J. Kabir, T. K. Maity, V. A. Parthasarathy and M. G. Som 2003. Vegetable Crops. Vol. I-III. Naya Prakash Publications, Kolkatta.
2. Decoteau, D.R. 2000. Vegetable Crops. Prentice Hall India Pvt. Ltd. New York.
3. Fageria, M.S., B. R. Choudhary and R. S. Dhaka. 2000. Vegetable Crops: Production Technology. Vol. II. Kalyani Publishers, Ludhiana.
4. Gopalakrishnan, T.R. 2007. Vegetable Crops. New India Publishing Agency, New Delhi.
5. Hazra, P. and M. G. Som. 1999. Technology for Vegetable Production and Improvement. Naya Prakash Publications, Kolkatta.
6. Pranab Hazra, A. Chattopadhyay, K. Karmakar and S. Dutta. 2011. Modern Technology in Vegetable Production. New India Publishing Agency, New Delhi.
7. Rana, M.K. 2008. Olericulture in India. Kalyani Publishers, Ludhiana.
8. Singh, D.K. 2007. Modern Vegetable Varieties and Production Technology. International Book Distributing Company, New Delhi.
9. Thamburaj, S. and N. Singh. 2004. Vegetables, Tuber Crops and Spices. ICAR., New Delhi.

VSC 613 SYSTEMATICS OF VEGETABLE CROPS (2+1)

Objectives

To teach morphological, cytological and molecular taxonomy of vegetable crops.

Theory

Unit I Classification and international code of vegetable crops

Principles of classification- different methods of classification- salient features of international code of nomenclature of vegetable crops.

Unit II Evolving and botany of tropical vegetables

Origin, history- evolution and distribution of vegetable crops- botanical description of families- genera and species covering various tropical vegetables.

Unit III Evolution and botany of temperate vegetables

Origin, history- evolution and distribution of vegetable crops- botanical description of families- genera and species covering various temperate vegetables.

Unit IV Cytology and descriptions for vegetables

Cytological level of various vegetable crops- descriptive keys for important vegetables.

Unit V Molecular markers in vegetable crops

Importance of molecular markers in evolution of vegetable crops, molecular markers as an aid in characterization and taxonomy of vegetable crops.

Practical

Identification, description- classification and maintenance of vegetable species and varieties- survey- collection of allied species and genera locally available-

preparation of keys for species and varieties- methods of preparation of herbarium and specimens.

Lecture schedule

1. Principles of classification of vegetables.
2. Methods of classification of vegetables.
3. Salient features of international code of nomenclature of vegetable crops.
4. Origin, history, evolution and distribution of vegetable crops.
5. Botanical description of genera and species of solanaceae family – tomato.
6. Botanical description of genera and species of solanaceae family – chilli and sweet pepper.
7. Botanical description of genera and species of solanaceae family – brinjal.
8. Botanical description of genera and species of solanaceae family – potato.
9. Botanical description of genera and species of cucurbitaceae family- pumpkin and ash gourd.
10. Botanical description of genera and species of cucurbitaceae family- ribbed gourd, bottle gourd, bitter gourd and snake gourd.
11. Botanical description of genera and species of cucurbitaceae family- watermelon and muskmelon.
12. Botanical description of genera and species of cucurbitaceae family- cucumber and gherkin.
13. Botanical description of genera and species of cucurbitaceae family- chow chow and coccinia.
14. Botanical description of genera and species of alliaceae family.
15. Botanical description of genera and species of cruciferae family – cabbage, cauliflower.
16. Botanical description of genera and species of cruciferae family – knolkhol, turnip and radish.
17. Mid -semester examination.
18. Botanical description of genera and species of umbelliferae family.
19. Botanical description of genera and species of chenopodiaceae family.
20. Botanical description of genera and species of fabaceae family – peas and cowpea.
21. Botanical description of genera and species of fabaceae family – french beans, dolichos beans and cluster beans.
22. Botanical description of genera and species of moringaceae family.
23. Botanical description of genera and species of amaranthaceae family.
24. Botanical description of genera and species of malvaceae family.
25. Botanical description of genera and species of asteraceae family.
26. Botanical description of genera and species of euphorbiaceae family.
27. Botanical description of genera and species of convolvulaceae family.
28. Botanical description of genera and species of araceae family.
29. Botanical description of genera and species of dioscoreaceae family.
30. Botanical description of genera and species of labiatae family.
31. Cytological level of various vegetable crops.

32. Descriptive keys for important vegetables
33. Importance of molecular markers in evolution of vegetable crops.
34. Molecular markers as an aid in characterization and taxonomy of vegetable crops.

Practical schedule

1. Identification, description, classification and maintenance of vegetable species and varieties of solanaceae family.
2. Identification, description, classification and maintenance of vegetable species and varieties of cucurbitaceae family - gourds.
3. Identification, description, classification and maintenance of vegetable species and varieties of cucurbitaceae family - melons.
4. Identification, description, classification and maintenance of vegetable species and varieties of alliaceae family.
5. Identification, description, classification and maintenance of vegetable species and varieties of cruciferae family.
6. Identification, description, classification and maintenance of vegetable species and varieties of umbelliferae family.
7. Identification, description, classification and maintenance of vegetable species and varieties of chenopodiaceae family.
8. Identification, description, classification and maintenance of vegetable species and varieties of fabaceae family.
9. Identification, description, classification and maintenance of vegetable species and varieties of moringaceae family.
10. Identification, description, classification and maintenance of vegetable species and varieties of amaranthaceae family.
11. Identification, description, classification and maintenance of vegetable species and varieties of malvaceae family.
12. Identification, description, classification and maintenance of vegetable species and varieties of asteraceae family.
13. Identification, description, classification and maintenance of vegetable species and varieties of euphorbiaceae and convolvulaceae families.
14. Identification, description, classification and maintenance of vegetable species and varieties of araceae, dioscoreaceae and labiatae families.
15. Collection of locally available allied species, genera and preparation of keys for the species and varieties.
16. Methods of preparation of herbarium.
17. Methods of preparation of specimens.

Reference books

1. Dutta, A.C. 1986. A Class Book of Botany. Oxford Univ. Press., New Delhi.
2. Pandey, B.P. 1999. Taxonomy of Angiosperms. S. Chand and Company, India.
3. Peter. K.V. & T. Pradeepkumar. 2008. Genetics and Breeding of Vegetables. (Revised), ICAR, New Delhi.

4. Peter, K.V. and T. Pradeepkumar. 2008. Genetics and Breeding of Vegetables. (Revised), ICAR, New Delhi.
5. Pooja, 2004. Angiosperms, Discovery Publishing House, New Delhi.
6. Soule, J. 1985. Glossary for Horticultural Crops. John Wiley and Sons, UK.
7. Srivastava, U., R.K. Mahajan, K.K. Gangopadyay, M. Singh & B.S. Dhillon. 2001. Minimal Descriptors of Agri-Horticultural Crops. Part-II: Vegetable Crops. NBPGR, New Delhi.
8. Srivastava, U., R.K. Mahajan, K.K. Gangopadyay, M. Singh. and B.S. Dhillon. 2001. Minimal Descriptors of Agri-Horticultural Crops. Part-II: Vegetable Crops. NBPGR, New Delhi.
9. Vasistha, 1998. Taxonomy of Angiosperms. Kalyani Publishers, Ludhiana.
10. Vincent, E.R. and M. Yamaguchi. 1997. World Vegetables. 2nd Ed. Chapman Hall, UK.

HOR 621 GROWTH REGULATION AND STRESS MANAGEMENT IN HORTICULTURAL CROPS (2+1)

Objectives

To study the physiology of vegetative and reproductive growth in horticultural crops, to understand the growth regulation concepts in relation to productivity of crops and their environment and to study the physiological stresses in crop production and strategies to overcome them.

Theory

Unit I Concepts of crop growth analysis

Growth and development: definition- parameters of growth and development- growth dynamics- morphogenesis - different stages of growth- growth curves: sigmoid- polynomial and asymptotic - growth analysis in horticultural crops- CGR- RGR- NAR- LAI- LAR- HI in horticultural crops- canopy development- plant density and crop productivity - solar radiation concept and techniques for harvesting solar radiation for crop productivity.

Unit II Plant growth regulators

Plant growth regulators: auxins- gibberellins- cytokinins- ethylene- brassinosteroids- morphactins- inhibitors and retardants- bioassay- biosynthesis- translocation/movement- physiological role in cell level and their basic functions - mechanism of action of pgrs and theories - role of bio stimulants in crop growth and development - seaweed extract- humic acid- fulvic acid- chitosan and growth promoting microorganisms.

Unit III Developmental physiology of horticultural crops

Developmental physiology and biochemistry of seed germination- dormancy- bud break- methods of overcoming dormancy in horticultural crops - juvenility- vegetative to reproductive interphase and flowering - effect of light- photosynthesis- photoperiodism- vernalisation- temperature- heat units and thermoperiodism on developmental physiology - physiology of flowering : factors affecting flowering - floral induction theories/models: abc model- photoperiodism- vernalisation- florigen and anti-florigen concepts - stages of flowering: floral induction- initiation and organ primordial identification.

Unit IV Physiology of growth regulation in horticultural crops

Physiology of source and sink relationship- translocation of assimilates - physiological basis of training and pruning - physiology of fruit & seed development and maturation - physiological basis of unfruitfulness- fruit drop and fruit thinning -physiology of ripening - climacterics in ripening - post harvest physiology of horticultural crops - physiology of tuber and bulb formation – growth regulation for tuber and bulb yield.

Unit V Physiology of senescence and stress management in Horticultural crops

Senescence: Physiology- biochemistry- molecular and genetic approaches in plant senescence - longevity of leaves in perennial and annual crops - stress physiology concepts: stress and strain terminology- eustress- distress- stress tolerance- resistance- avoidance - stress responses of plants: cellular and molecular level- causes- effects and methods of overcoming stress - heat- low temperature- water deficit- flooding and salinity stresses.

Practical

Mechanism of dormancy- stratification -PGR experiments on seeds- tubers and bulbs -visit to arid- subtropical and temperate horticultural zones to identify growth and development patterns- to perform growth analysis and to evaluate photosynthetic efficiency under different environments - experiment on growth regulator functions- hormone assays and ripening phenomenon in horticultural crops - experiment on impact of physical and chemical manipulations on growth and development of horticultural crops - growing of plants in sand culture under salt stress for biochemical and physiological studies - experiment on effect of osmotic and ionic stress on seed germination and seedling growth-measurement of low/high temperature injury under field conditions.

Lecture schedule

1. Growth and development: definitions and parameters of growth and development.
2. Principles of growth dynamics and morphogenesis.
3. Growth curves:stages and different pattern of growth curves of horticultural crops.
4. Growth analysis in horticultural crops (CGR, RGR, NAR, LAI, LAR, HI in horticultural crops).
5. Canopy development and plant density with respect to crop productivity.
6. Solar radiation concept and techniques for harvesting solar radiation for crop productivity.
7. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of auxin.
8. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of gibberellins.
9. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of cytokinins.
10. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of ethylene.

11. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of brassinosteroids and morphactins
12. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of inhibitors and retardants
13. Role of bio stimulants in crop growth and development: seaweed extract, humic acid, fulvic acid, chitosan and growth promoting microorganisms.
14. Physiology and biochemistry of seed germination
15. Physiology and biochemistry of dormancy : seed and bud dormancy
16. Physiology of bud breaking and methods of overcoming dormancy in horticultural crops
17. Mid -semester examination.
18. Effect of light, photosynthesis and photoperiodism on developmental physiology.
19. Effect of vernalisation, temperature, heat units and thermoperiodism on developmental physiology.
20. Physiology of flowering : factors affecting flowering and different stages of flowering
21. Physiology of flowering: floral induction theories/models: ABC model, photoperiodism and vernalisation.
22. Physiology of flowering : florigen and anti-florigen concepts with special reference to horticultural crops.
23. Source and sink relationship and concepts (carbon partitioning, sucrose synthesis, phloem loading and transportation).
24. Physiological and biochemical basis of training and pruning.
25. Physiology of fruit set and development with a special reference to chemical regulation of fruit set.
26. Physiological basis of unfruitfulness, fruit drop and fruit thinning
27. Physiological and biochemical basis of ripening and post harvest physiology of horticultural crops
28. Physiological and biochemical basis of tuber and bulb formation with special reference to growth regulation for tuber and bulb yield.
29. Physiological and biochemical basis of senescence with special reference to molecular and genetic approaches in plant senescence
30. Concepts of stress physiology: stress, eustress, distress, stress tolerance, resistance, avoidance
31. Stress responses of plants at cellular and molecular level.
32. Causes, effects and methods of overcoming heat and low temperature stress.
33. Causes, effects and methods of overcoming water deficit and flooding stress.
34. Causes, effects and methods of overcoming salinity stress.

Practical schedule

1. Estimation of growth parameters for analyzing the growth - estimation of leaf area index.
2. Estimation of growth parameters for analyzing the growth – DMP and growth rates.

3. Evaluation of photosynthetic efficiency of horticultural crops under different environments.
4. Visit to arid, subtropical and temperate horticultural zones to identify growth and development pattern of different horticultural crops.
5. Studies on mechanism breaking of dormancy by stratification in seeds.
6. PGR experiments on seeds, tubers and bulbs breaking of dormancy.
7. Hormone assays (Auxin)
8. Experiments on growth regulator functions - rooting of cuttings and herbicidal effect.
9. Experiments on growth regulator functions - fruit ripening in climacteric and non-climacteric fruits.
10. Experiments on growth regulator functions – senescence.
11. Experiments on growth regulation by pruning, pinching, defoliation and disbudding in horticultural crops .
12. Experiments on growth regulator functions – fruit thinning, overcoming fruit drop and unfruitfulness.
13. Experiments on growth regulator functions – post harvest losses in horticultural crops and post harvest treatments for shelf life.
14. Growing of plants in sand culture to study the effect of drought stress.
15. Growing of plants in artificially salinized soil in pots to study the effect of salt stress.
16. Effect of osmotic and ionic stress on seed germination and seedling growth
17. Estimation of proline content in stress and normal condition in crops.

Reference books

1. Helgi, O., Pik and A. Stephen. Rolfe. 2005. The Physiology of Flowering Plants. Fourth Edition (Arthur J. Willis, Ed.) Cambridge University Press The Edinburgh Building, Cambridge, UK.
2. Leopold, A.C. and P.E. Kriedermann. 1985. Plant Growth and Development. 3rd Ed. Mc Graw-Hill, UK.
3. Peter, K.V. (Ed.). 2008. Basics of Horticulture. New India Publ. Agency, New Delhi.
4. Roberto L. Benech-Arnold and A. Rodolfo. 2014. Handbook of seed physiology: Applications to Agriculture. CRC press, Boca Raton.
5. Roberts, J., S. Downs. and P. Parker. 2002. Plant Growth and Development in Plants. (I. Ridge, Ed.), Oxford University Press.UK.
6. Salisbury, F.B. and C.W. Ross. 1992. Plant Physiology. 4th Ed. Wadsworth Publ. UK.

HOR 622 PROTECTED AND PRECISION HORTICULTURE (2+1)

Objectives

This course aims to impart knowledge on various modes of protected cultivation and their technology components. It highlights various measures to control light- temperature- relative humidity and CO₂ and recent advances in control of substrate factors like pH- EC and soil microbes. It elaborates the production system so as to acquire knowledge on the cost of establishment and

procedures for commencing hi-tech projects on protected and precision cultivation of horticultural crops.

Theory

Unit I Scope, importance and principles of protected cultivation

Profile of crop production systems - protected cultivation systems: overview-importance- scope and constraints under Indian conditions - comparison with conventional crop production system – microclimatological principles of protected cultivation: effect of light- temperature- relative humidity and CO₂ on crop growth and productivity- modes of protected cultivation types of protected structures: greenhouse- polyhouses/ walk in tunnels- plastic tunnels shade houses- cold frames- rain shelters- etc.

Unit II Structure and components of green house

Site selection and planning of green house structure - types/styles of green house- orientation- design- frames- civil work requirement- drainage and gutter - green house components - environment control systems: green house covering materials- ventilation systems- temperature control by cooling/heating system-shade and light systems- photoperiod manipulation - green house growing media - beds- green house benches- grow containers for different systems/crops – components of different growing media – media preparation.

Unit III Irrigation systems for green house

Green house irrigation systems: different types and components- planning- lay out- designing- installation- operation and maintenance – water requirement and irrigation scheduling for different crops – fogging systems- fertilizer sources – fertigation systems- water soluble fertilizers and their compatibility- application methods – fertilizer programmes for important vegetables and flowers.

Unit IV Green house automation (smart green house)

Green house automation – commercial smart green house systems – sensor based signalling and monitoring for environment control- irrigation and fertigation scheduling- automation components for plug production- modular containers-media mixers and fillers- mechanical seeder- seed pelleting- priming- root trainers-insects and disease control system- smoke generator- thermal fogging for insect and disease control - automatic green house logistical system and internet of things – multi-level growing and vertical farming.

Unit V Precision horticulture and hydroponics

Precision horticulture- principles and concepts- enabling technologies of precision farming- GPS- GIS- remote sensing- sensors- variability management in precision farming- mapping- variable rate technology- precision equipments-computers and robotics in precision farming- precision farming displays- software-expert systems and application – hydroponics: principles and system designs-system components – materials- growing media and methods of establishment – management of hydroponic growing systems – aquaponics.

Practical

Green house designing- site analysis and lay out - parts of green house and structural components- glazing/cladding materials - growing media and sterilization - beds- specification for benches- construction and lay out- plant

growing containers - environment control systems: ventilation- cooling- heating- lighting- irrigation and fertigation systems - IPM- special horticultural practices- cost economics of different greenhouse production systems - visit to hi-tech units - GPS- GIS- remote sensing facility- designing of prototype hydroponic system.

Lecture schedule

1. Protected cultivation systems: overview and importance in comparison with conventional crop production system.
2. Current scenario of green house cultivation in India: focus on constraints and scope.
3. Microclimatological principles of protected cultivation: effect of light, temperature and relative humidity on crop growth and productivity.
4. Microclimatological principles of protected cultivation: effect of elevated CO₂ on crop growth and productivity.
5. Modes and types of protected structures: greenhouse, polyhouses/ walk in tunnels and plastic tunnels
6. Modes and types of protected structures: shade houses, cold frames, rain shelters etc.
7. Types/styles of green house structure, site selection and planning
8. Structural designing and specifications of frames, gutter and fittings for different types of green houses.
9. Civil work requirement and specifications for green house erection.
10. Components of green house for environment control : green house covering materials, accessories and ventilation systems
11. Components of green house for environment control : temperature control by cooling/heating system and photoperiod manipulation by shade and light systems,
12. Grow beds, benches and grow containers for different green house systems and crops.
13. Components of different growing media and media preparation for different greenhouse crops.
14. Different types and designing principles of green house irrigation systems.
15. Installation, operation and maintenance of green house irrigation systems.
16. Water requirement and irrigation scheduling for different green house crops.
17. Mid -semester examination.
18. Fogging systems for green house: principles, designing and components.
19. Advantages of fertigation systems in green house and working principles and design of different fertigation systems.
20. Sources of water soluble fertilizers and their compatibility in fertigation systems.
21. Fertilizer programmes for important vegetables and flowers under green house growing.
22. Green house automation : scope and advantages of commercial smart green house systems

23. Sensor based signalling and monitoring for environment control and scheduling of irrigation and fertigation in smart green house.
24. Automation components: plug production, modular containers, media mixers and fillers.
25. Mechanical seeding, seed pelleting, priming and root training practices in green house automation.
26. Automated insects and disease control system: smoke generator, thermal fogging for insect and disease control.
27. Automatic green house logistical systems and internet of things.
28. Vertical farming and multi-level growing: principles, design and practices.
29. Precision horticulture: principles, concepts and role of GPS, GIS, Remote sensing and sensors.
30. Variability management in precision farming, mapping- variable rate technology.
31. Precision equipments, computers and robotics in precision farming.
32. Precision farming displays, software, expert systems and applications
33. Hydroponics: principles, system designs, components and management of hydroponic growing systems.
34. Aquaponics: Integration of hydroponic system with domestic aquaculture.

Practical schedule

1. Study on components of greenhouse, polyhouses/ walk in tunnels and plastic tunnels
2. Study on site analysis and lay out designing for green house.
3. Estimating the cost of low cost green house of IARI model.
4. Designing covering material.
5. Designing of ventilation – passive and active systems.
6. Designing of cooling systems.
7. Designing an irrigation system.
8. Designing of fogging systems
9. Estimation of light requirement for various purposes.
10. Working out the space use efficiency of beds and benches.
11. Study of fertigation methods.
12. Fertilizer calculation.
13. Economics of green house cultivation of cut flowers.
14. Economics of green house cultivation of vegetables.
15. Visit to export oriented floriculture units and precision farming units.
16. Visit to GPS, GIS and remote sensing facility.
17. Designing of prototype hydroponic system.

Reference books

1. Aldrich R.A and J.W. Bartok. 1994. Green House Engineering. NRAES (Natural Resource, Agriculture, and Engineering Service), Ithaca, New York.
2. James, Lr. Boodley. 1981. The Commercial Green House. Ball Publishing, USA.

3. Paul, V. Nelson. 1991. Green House Operation and Management. Ball Publishing, USA.
4. Pranab Hazra, A., Chattopadhyay, K., Karmakar S. Dutta. 2011. Modern Technology in vegetable production. New India publishing agency, New Delhi
5. Prasad, S. and U. Kumar. 2005. Greenhouse Management for Horticultural Crops. 2nd Ed. Agrobios India, Jodhpur.
6. Prasad, S. and V. Kumar. 1999. Green House Management for Horticultural Crops. Agrobios India, Jodhpur.
7. Premjit Sharma, 2007. Precision Farming, Gene-Tech Books, New Delhi.
8. Reddy, S., B. Janakiram., T. Balaji, S. Kulkarni. and R.L .Misra. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.
9. Robert, A., Aldrich. and W. John. Bartok, Jr. 1990. Green House Engineering. Ball publishing, USA.
10. Tiwari, G.N. 2003. Green House Technology for Controlled Environment. Narosa publishing house, New Delhi.

VSC 621 PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS (2 + 1)

Objectives

To impart knowledge on production technology of cool season vegetables.

Theory

Introduction- commercial varieties and hybrids- climatic and soil requirements- seed rate- seed treatment- nursery management- sowing / planting cropping systems- nutrient management fertigation- role of plant growth regulators- irrigation management physiological disorders and corrective measures- major biotic stresses and their management- intercultural operations- mulching- weed management- organic production technologies- maturity standards- harvesting seed- production techniques of the following crops:

Unit I Production technology of cole crops

Cole crops – cabbage, cauliflower, knolkhol, sprouting broccoli and brussel sprouts.

Unit II Production technology of root crops

Root crops - carrot, radish, turnip and beetroot.

Unit III Tuber and bulb crops

Potato and garlic.

Unit IV Leguminous vegetables

Peas, french beans, lima beans and other temperate beans

Unit V Leafy vegetables and perennial temperate vegetables

Leafy vegetables- lettuce, celery, spinach, chinese cabbage. Perennial vegetables- chow chow, asparagus, globe artichoke, rhubarb.

Practical

Description of commercial varieties and hybrids, seed treatment and nursery practices, study of nutritional and physiological disorders- mulching- experiments to demonstrate the role of mineral elements and plant growth regulators- maturity

standards and harvesting- preparation of cropping scheme for commercial farms- seed production techniques.

Lecture schedule

1. Introduction, classification, scope and importance of cool season vegetables.
Commercial varieties / hybrids, climate and soil requirements, seed rate, nursery management sowing / planting , nutrient management, PGR's, irrigation management, physiological disorders and corrective measures, major biotic stresses and their management, intercultural operations, mulching, weed management, maturity standards and seed production techniques of the following crops :
2. - 4. Cabbage
5. - 7. Cauliflower
8. Precision production technology for cabbage and cauliflower.
9. Knol khol
10. Sprouting broccoli
11. Brussel sprouts
12. - 14. Carrot
15. Radish
16. Turnip
17. Mid-semester examination.
18. Beetroot
19. - 21. Potato
22. Garlic
23. - 24. Peas and French beans
25. - 26. lima beans and broad beans
27. Lettuce
28. Celery
29. Spinach
30. Chinese cabbage
31. Chow chow
32. Asparagus
33. Globe artichoke
34. Rhubarb

Practical schedule

1. Description of commercial varieties / hybrids in crucifers.
2. Description of commercial varieties / hybrids in potato.
3. Description of commercial varieties / hybrids in root vegetables.
4. Description of commercial varieties / hybrids in peas and beans.
5. Seed treatment and nursery practices.
6. Fertigation practices in cool season vegetables
7. Study of nutritional and physiological disorders and their remedies.
8. Preparation of growth regulators and their application.

9. Maturity standards and harvest indices of crucifers, peas and beans.
10. Maturity standards and harvest indices of potato and root vegetables.
11. Seed production techniques in crucifers.
12. Seed production techniques in potato and root vegetables.
13. Seed production techniques in peas and beans.
14. Identification of biotic stresses in cool season vegetables.
15. Preparation of cropping scheme for commercial farms.
16. Visit to commercial vegetable production units / markets.
17. Working out cost economics.

Reference books

1. Bose, T.K., J. Kabir, T. K. Maity, V. A. Parthasarathy and M. G. Som 2003. Vegetable Crops. Vol. I-III. Naya Prakash Publications, Kolkatta.
2. Decoteau, D.R. 2000. Vegetable Crops. Prentice Hall India Pvt. Ltd. New Delhi.
3. Fageria, M.S., B. R. Choudhary and R. S. Dhaka. 2000. Vegetable Crops: Production Technology. Vol. II. Kalyani Publishers, Ludhiana.
4. Gopalakrishnan, T.R. 2007. Vegetable Crops. New India Publishing Agency, New Delhi.
5. Hazra, P. and M.G. Som. 1999. Technology for Vegetable Production and Improvement. Naya Prokash Publications, Kolkatta
6. Rana, M.K. 2008. Scientific Cultivation of Vegetables. Kalyani Publishers, Ludhiana.
7. Singh, D.K. 2007. Modern Vegetable Varieties and Production Technology. International Book Distributing Company, New Delhi.
8. Thamburaj, S. and N. Singh. 2004. Vegetables, Tuber Crops and Spices. ICAR, New Delhi.
9. Pranab Hazra, A. Chattopadyay, K. Karmakar and S. Dutta. 2011. Modern Technology in Vegetable Production. New India Publishing agency, New Delhi.

VSC 622 BIOTECHNOLOGY OF VEGETABLE CROPS (1+1)

Objectives

Understanding the principles of biotechnology- learning about the various developments in biotechnology and its potential applications.

Theory

Unit I Importance of biotechnology and factors affecting tissue culture

Bio-technology and its scope in vegetable crops- influence of plant materials- physical- chemical factors and growth regulators on growth and development of plant cell- tissue and organ cultures.

Unit II Techniques in biotechnology- I

Callus culture - types- cell division- differentiation- organogenesis- embryogenesis- organ culture- meristem- embryo- endosperm- anther- ovule culture- embryo rescue- rapid clonal propagation- somaclonal variations.

Unit III Techniques in biotechnology -II

Ex vitro establishment of tissue cultured plants- physiology of hardening - hardening and field transfer- use of bioreactors and *in vitro* methods for production

of secondary metabolites- suspension cultures- regeneration of tissues- *in vitro* pollination and fertilization- *in vitro* mutation.

Unit IV Techniques in biotechnology- III

Protoplast culture and fusion- construction and identification of somatic hybrids and cybrids- wide hybridization- artificial seeds cryopreservation

Unit V Techniques in biotechnology -IV

Genetic engineering in vegetable crops- application of molecular techniques for identification and characterization of different types of vegetables- *in vitro* selection for biotic and abiotic stress- achievements of biotechnology in vegetable crops.

Practical

An exposure to tissue culture laboratories- media preparation- inoculation of explants for clonal propagation- callus induction and culture- regeneration of plantlets from callus- sub-culturing- techniques on anther- ovule- embryo culture- somaclonal variation- *in vitro* mutant selection against abiotic stress- development of protocols for mass multiplication- project development for establishment of commercial tissue culture laboratory.

Lecture schedule

1. Role of biotechnology in vegetable crops.
2. Influence of plant materials physical and chemical physical factors on growth and development of plant cell tissues and organs.
3. Callus cultures, differentiation, organogenesis and somatic embryogenesis.
4. Meristem culture for disease elimination.
5. Production of haploids and dihaploids through anther, pollen and ovule culture.
6. Embryo culture and endosperm culture techniques.
7. Rapid *in vitro* clonal propagation through direct organogenesis.
8. Hardening and establishment of tissue cultured plantlets in the primary, secondary nursery and field.
9. Mid-semester examination.
10. Somaclonal variations and its applications.
11. *In vitro* production of secondary metabolites.
12. Techniques of *in vitro* pollination and fertilization and *in-vitro* mutation.
13. Protoplast culture and regeneration and protoplast fusion.
14. Synthetic seed production techniques.
15. *In vitro* conservation and cryopreservation techniques.
16. Genetic engineering and transgenics.
17. Vectors and methods of transformation.

Practical schedule

1. Components of tissue culture laboratory.
2. Laboratory equipments-uses and methods of operation.
3. Nutrient stock and growth regulator stock preparation.
4. Culture media preparation.
5. Sterilization techniques for glassware and media.
6. Inoculation of explants for direct organogenesis.

7. Inoculation of explants for callus culture.
8. Clonal propagation through meristem culture.
9. Anther, pollen and ovule culture.
10. Sub-culturing techniques for regeneration.
11. Induction of multiple shoots and roots.
12. *In vitro* screening of cell lines for abiotic stress.
13. *In vitro* mutation for abiotic stress.
14. Synthetic seed production.
15. Hardening techniques.
16. Visit to leading commercial tissue culture units.
17. Project preparation for establishment of tissue culture labs.

Reference books

1. Alex Mathew. 2010. Principles of Biotechnology. Adhayan Publ., New Delhi.
2. Balasubramanian, D., C.F.A. Bryce, K. Dharmalingam, J. Green. And K. Jayaraman. 1998. Concepts in Biotechnology. University Press, India.
3. Bhojwani, S.S. and M.K. Razdan. 2006. Plant Tissue Culture Studies – Theory and Practice. Elsevier Publication.
4. Brown, T.A. 2001. Gene Cloning and DNA Analysis- an Introduction. Blackwell Publ., USA.
5. Endress, R. & E. Rudolf. 2004. Plant Cell Biotechnology. Springer – Verlag Publication, London.
6. Keshavachandran, R., P.A. Nazeem, D. Girija, P.S. John. & K.V. Peter. 2007. Recent Trends in Biotechnology of Horticultural Crops. Vols. I, II. New India Publ., New Delhi.
7. Manoj, V. Parakhia .2010. Molecular Biology and Biotechnology ,New India. Publ., New Delhi.
8. Prakash S.Lohar.2012. Text Book of Biotechnology, MJP Publ., New Delhi.
9. Sambrook, J., T. Fritsch. & T. Maniatis 2001. Molecular Cloning – A Laboratory Manual. 2nd Ed. Cold Spring Harbour Laboratory Press, UK.

VSC 623 ORGANIC VEGETABLE PRODUCTION (1+1)

Objectives

To impart knowledge about specific techniques followed in organic vegetables and to educate the students about the principles- concepts and production of organic farming in vegetable crops

Theory

Unit I Importance of organic production of vegetable crops

Scope- importance- principles- perspective- concepts and components of organic production of vegetable crops- global and Indian scenario of organic vegetable production- history and development of organic farming in India and world.

Unit II Soil health in organic horticulture

Soil health – concepts – problem diagnosis – conservation of soil – problem soil reclamation under organic horticulture – soil physical- chemical and biological improvement – organic carbon status and improvement strategies – C:N ratio and its influence on nutrient availability and methodology to improve organic carbon status.

Unit III Bio inputs in organic horticulture

Organic manures -FYM- coirpith- vermicompost- pressmud- oilcake- biofertilizers- biodynamics preparation etc.- indigenous methods of compost preparation- methods for enhancing soil fertility- mulching- raising green manure crops- role of botanicals- panchagavya- humic acid- sea weed extract- manchurian mushroom tea and vermiwash and em technology- ITK's in organic farming- role of bio-control agents -non chemical weed- pest and disease control.

Unit IV Organic production technology of vegetable crops

Organic production of vegetables crops- *viz.*- solanaceous crops- cucurbits- cole crops- root and tuber crops.

Unit V GAP and GMP- Certification of organic products

GAP and GMP- certification of organic products; agencies involved- organic production and export - opportunity and challenges- processing and quality control for organic foods -sustainability indices for evaluating long term and indirect benefits of organic farming- economic evaluation of organic horticultural technologies – net returns and B:C ratio.

Practical

Soil physical parameters with relevance to organic horticulture- method of preparation of compost- vermicomposting- biofertilizers- soil solarization- bio pesticides in horticulture- green manuring- mycorrhizae and organic crop production- waste management- organic soil amendment for root disease- weed management in organic horticulture- visit to organic fields and marketing centres

Lecture Schedule

1. Scope and importance of organic horticulture and its merits and demerits. Global and Indian scenario of organic horticulture.
2. History and development of organic farming in India and World.
3. Soil problems and its reclamation through organic horticulture.
4. Soil physical, chemical and biological properties and conservation of soil resource under organic horticulture.
5. Importance of C:N ratio, its influence on nutrient availability and methodology to improve organic carbon status.
6. Bulky and concentrated organic manures.
7. Green manures, biofertilizers and bio dynamic farming.
8. Role of botanicals, panchagavya, humic acid, sea weed extract, Manchurian mushroom tea and vermiwash and EM technology,
9. Mid- semester examination.
10. Role of ITK's in organic farming
11. Organic cultivation of solanaceous crops
12. Organic production of cucurbits and cole crops
13. Organic production of root and tuber crops
14. Non -chemical weed,pest and disease control
15. GAP and GMP in organic production - Organic certification – standards and agencies – marketing and export avenues for organic produce.
16. Sustainability indices for evaluating indirect benefits of organic farming and Processing and quality control for organic foods
17. Economic evaluation of organic horticultural technologies – net returns and B:C ratio.

Practical schedule

1. Soil physical parameters with relevance to organic horticulture.
2. Estimate on soil chemical parameters (pH, EC and ESP).
3. Estimation of Soil biological parameters.
4. Nursery bed soil solarization for vegetable crops.
5. Agro techniques for composting farm wastes and agro industrial wastes.
6. Recycling of crop wastes through vermiculture.
7. Preparation of panchakavya humic acid and sea weed extract.
8. Preparation of activated EM solution, Manchurian mushroom tea and vermiwash.
9. Organic production of vegetable crops.
10. Application of various mulch materials to horticultural crops.
11. Study of bio agents for crop protection.
12. Preparation of organic formulations for pest control.
13. Preparation of organic formulations for disease control.
14. Organic certification, standards and agencies.
15. Working out indices for organic horticulture.
16. Economic evaluation of organic horticulture system.
17. Visit to farmers field under organic cultivation.

Reference books

1. Allen V. Baker. 2010. Science and Technology of Organic farming. CRC press, Boca Raton.
2. Dahama, A.K. 2005. Organic Farming for Sustainable Agriculture. 2nd Ed Agrobios, Jodhpur
3. Gehlot, G. 2005. Organic Farming; Standards, Accreditation Certification and Inspection. Agrobios, Jodhpur.
4. Lampkin, N. 1990. Organic farming Farming Press, USA.
5. Palaniappan, S.P. and K. Annadorai. 2003. Organic Farming, Theory and Practice. Scientific Publ., New Delhi.
6. Pradeepkumar, T., B. Suma, Jyothibhaskar and K.N. Satheesan. 2008. Management of Horticultural Crops. New India Publ., New Delhi.
7. Sharma and K. Arun. 2002. A Hand Book of Organic Farming. Agrobios (India) Jodhpur.

VSC 624 PRINCIPLES AND PROCESSING OF VEGETABLE CROPS (2+1)**Objectives**

To educate the students principles and practices of processing in vegetable crops.

Theory**Unit I Post harvest technology scenario of vegetable crops**

History of food preservation- present status and future prospects of vegetable preservation industry in India- harvest indices- harvesting methods- harvesting practices for specific market requirements- influence of pre harvest factors on post harvest quality and shelf life of horticultural crops- factors leading to post harvest technology.

Unit II Role of microorganisms in food preservation

Role of microorganisms in food preservation- spoilage of fresh and processed horticultural produce; biochemical changes and enzymes associated with spoilage of horticultural produce; principal spoilage organisms- food poisoning and their control measures.

Unit III Storage methods and processing

Storage methods *viz.*- ventilated- refrigerated- MAS- CAS- physical injuries and disorders during storage- raw materials for processing- primary and minimal processing; processing equipments- nutritionally enriched / fortified products- layout and establishment of processing industry- BIS- AGMARK- Codex Alimentarius – fruit products order (FPO)- FPO licence- importance of hygiene and plant sanitation.

Unit IV Packaging technologies and quality control

Packaging technologies- packaging materials and transport- quality assurance and quality control- TQM- GMP- food standards - FPO- PFA- etc.- food laws and regulation- food safety- hazard analysis and critical control points (HACCP)- role of NHB- APEDA- plant quarantine and other certifying agencies governing internal and foreign trade of harvested produce.

Unit V Value addition and management of wastes from processing industries

Utilization and management of waste and processing industry- labeling and labeling act- nutrition labeling- major value added products from vegetables.utilization of by- products of vegetable processing industry- management of waste from processing factory- investment analysis-principles and methods of sensory evaluation of fresh and processed vegetables.

Practical

Experiments on extension of shelf life- experiments on methods of preservation- changes occurring during preservation- various methods of preservation products- study of machinery and equipments used in processing of horticultural produce- chemical analysis for nutritive value of fresh and processed vegetables- study of different types of spoilages in fresh as well as processed horticultural produce- classification and identification of spoilage organisms- study of biochemical changes and enzymes associated with spoilage- laboratory examination of vegetable products- sensory evaluation of fresh and processed vegetables- study of food standards - national- international- codex alimentarius- visit to processing units to study the layout- equipments- hygiene- sanitation and residual / waste management.

Lecture schedule

1. Post harvest technology scenario in vegetable crops.
2. Harvest indices and harvesting methods.
3. Physical and horticultural maturity.
4. Harvesting practices for specific market requirements.
5. History of food preservation.
6. Influence of pre harvest factors on post harvest quality and shelf life of horticultural crops,
7. Factors leading to post harvest technology.

8. Irradiation technology.
9. Development of new and innovative products in vegetables.
10. Vegetable extracts and powder for global trading.
11. Vegetable flavors, essence aromatics and pigments.
12. Present status and future prospects of vegetable preservation industry in India.
13. Pre-cooling, treatments prior to transport.
14. Role of microorganisms in food preservation- spoilage of fresh and processed horticultural produce.
15. Biochemical changes and enzymes associated with spoilage of horticultural produce- principal spoilage organisms, food poisoning and their control measures.
16. Storage methods *viz.*, ventilated and refrigerated.
17. Mid-semester examination
18. Modified Atmospheric storage (MAS).
19. Controlled atmospheric Storage (CAS).
20. Storage consideration temperature, humidity, atmospheric composition etc.
21. Physical injuries and disorders during storage.
22. Raw materials for processing.
23. Primary and minimal processing of vegetable crops.
24. Processing equipments; nutritionally enriched / fortified products.
25. Layout and establishment of processing industry, FPO licence. Importance of hygiene- plant sanitation.
26. Packaging technologies, packaging materials and transport by products from processing and its management.
27. Quality assurance and quality control, TQM, GMP.
28. BIS, AGMARK, Codex Alimentarius –food standards FPO, PFA, etc.
29. Food laws and regulation- food safety- hazard analysis and critical control points (HACCP).
30. Role of NHB, APEDA- plant quarantine and other certifying agencies governing internal and foreign trade of harvested produce.
31. Labeling and labeling act, nutrition labeling.
32. Major value added products from vegetables.
33. Utilization of byproducts of vegetable processing industry- Management of waste from processing factory- investment analysis.
34. Principles and methods of sensory evaluation of fresh and processed vegetables.

Practical schedule

1. Exercise on harvesting of fruit based on maturity indices.
2. Pre-cooling, grading, washing and waxing treatments.
3. Collection and practicing usage of various packaging materials.
4. Experiments to hasten ripening of fruits.
5. Experiments on extension of self life vegetable crops.
6. Practice in judging the maturity of vegetable crops

7. Experiments on methods of preservation, changes occurring during preservation.
8. Study of machinery and equipments used in processing of horticultural produce.
9. Preparation of sauce and ketchup.
10. Preparation of brine and syrup for preservation.
11. Preparation of pickles.
12. Preparation of value added products from vegetables.
13. Chemical analysis for nutritive value of fresh and processed vegetables.
14. Sensory evaluation of fresh and processed vegetables.
15. Study of food standards. National, international standards.
16. Visit to processing units, to study the layout, equipments, hygiene, sanitation and residual / waste management.
17. Project preparation to establish processing industry.

Reference books

1. Arthey, D. and C. Dennis. 1996. Vegetable Processing. Blackie/Springer Verlag, Germany.
2. Ashwani, K. Goel. 2007. Post Harvest Management and Value Addition. Daya Publishing House, New Delhi.
3. Chadha, D.S. 2006. The Prevention of Food Adulteration Act. Confed. of Indian Industry, India.
4. Frazier, W.C. and D.C. Westhoff. 1995. Food Microbiology. 4th Ed. Tata McGraw Hill., India.
5. Giridharilal, G.S., Siddappa. and G.L. Tandon. 1986. Preservation of Fruits and Vegetables. ICAR, New Delhi.
6. Manorajan Kaila. 2006. Post Harvest Technology of Vegetables. Agrotech Publ.Academy, Udaipur.
7. Pandit P.S. 2014. Post harvest technology and processing of horticulture crops at a glance. New India Publishing Agency, New Delhi.
8. Saraswathy, S.T.L., Preethi, S. Balasubramnyan, S.Suresh, N. Revathy and S. Natarajan. 2008. Post Harvest Management of Vegetable Crops. Agrobios (India) Jodhpur.
9. Sudheer, K.P. and V. Indira. 2007. Post Harvest Technology of Horticultural .Crops, New India Publishing Agency, New Delhi.
10. Verma L.R. and V.K. Joshi 2000. Post Harvest Technology of Fruits and Vegetables (Vol I &Vol II). Indus Publishing Company, New Delhi.

OPC- HOR 711 PROPAGATION AND NURSERY MANAGEMENT OF HORTICULTURAL CROPS (2+1)

Objectives

This course deals with different methods of plant propagation and strategies for nursery management of various fruit crops. Knowledge of tools and implements is essential to carry out all scientific horticultural operations and also nursery management practices. The above themes are discussed elaborately in this course

and the basic knowledge gained will be useful for the career development of students in commercial nursery business.

Theory

Unit I Principles of plant propagation

Sexual and asexual methods of propagation - principles and factors influencing seed germination-dormancy- hormonal regulation of germination and seedling growth- seed quality- packing- storage- certification and testing.

Unit II Anatomical and physiological aspects of plant propagation

Techniques of cottage - layerage- graftage and budding- compatibility-dwarfing rootstocks of important fruit trees.

Unit III Plant growth regulators and plant tissue culture

Role of PGR'S in plant propagation- role of nucellar embryony- apomixes-tissue culture techniques- hardening techniques .

Unit IV Planning of a nursery unit and modern propagation structures

Raising of nursery plants- selection- certification maintenance of mother plants and bud wood and root stock nurseries- use of modern structures- mist chambers- low cost poly houses- tunnel houses.

Unit V Marketing methods of nursery plants and economics

Media/soil mixtures- containers- use of machinaries- lifting- packing-transport- marketing- economics of raising nursery and management in different fruit crops.

Practical

Media/soil mixture- containers and soil sterilisation- use of chemicals for seed treatment and sowing- preparation of nursery beds- polybags- seedpans- thumb rule for raising seedlings- stratification and scarification of seeds and use of tetrazolium salts for germination tests-identification of nucellar seedlings- practice of different asexual methods of propagation- viz.-cuttage- layering- budding-approach- veneer and softwood grafting-use of plant growth regulators in propagation of plants -use of mist chambers- modern propagation structures- low cost polyhouses- low tunnels and bottom heating techniques- selection- lifting-packing- transportation and marketing of nursery plants- economics of raising nurseries- visit to local commercial/private nurseries.

Lecture schedule

1. Scope and importance of plant propagation.
2. Study of sexual and asexual methods of propagation.
3. Advantages and disadvantages of seed and vegetative propagation.
4. Factors influencing seed germination of Horticultural crops.
5. Studies on dormancy, hormonal regulation of germination and seedling growth.
6. Study of seed quality, packing, storage, certification and testing.
7. Study of anatomical and physiological aspects of asexual propagation.
8. Studies on graft compatibility on fruit crops.
9. Dwarfing rootstocks of commercial importance in fruit crops.
10. Role of PGR's in raising seedlings and rooting of cuttings and layers.
11. Role of nucellar embryony and apomixis.

12. Studies on tissue culture techniques.
13. Micro grafting (STG).
14. Techniques of cuttings and layering.
15. Techniques of budding and grafting.
16. Planning of nursery unit.
17. Mid-semester examination
18. Study of raising of nursery plants and their after care- role of protray nursery and their after care.
19. Study of modern propagation structures.
20. Role of mist chambers in plant propagation.
21. Study of bottom heating techniques.
22. Hardening techniques in nursery.
23. Progeny orchard and scion bank.
24. Establishment of bud wood bank.
25. Media -soil mixture preparation for nursery plants.
26. Study of containers used for nursery.
27. Use of machineries in nurseries.
28. Soil sterilization techniques.
29. Irrigation systems in nursery plants.
30. Lifting and packing of nursery plants.
31. Transportation and marketing of nursery plants.
32. Nursery planning and layout .
33. Economics of raising nursery and management of different fruit crops.
34. Nursery acts.

Practical schedule

1. Media/soil mixture, containers and soil sterilization.
2. Use of chemicals for seed treatment and sowing.
3. Preparation of nursery beds, polybags, seedpans, thumbrule for raising seedlings.
4. Stratification and scarification of seeds and use of tetrazolium salts for germination.
5. Identification of nucellar seedlings.
6. Practice of different asexual methods of propagation, viz.,cuttage, layering.
7. Buddingmethods.
8. Grafting- methods.
9. Use of plant growth regulators in propagation.
10. Role of mist chambers in plant propagation.
11. Other protected structures uses for plant propagation.
12. Low cost polyhouses, low tunnels.
13. Bottom heating techniques and soil sterilization.
14. Selection, lifting, packing of nursery plants.
15. Transportation and marketing of nursery plants.
16. Economics of raising nurseries.
17. Visit to local commercial/private nurseries.

Reference books

1. Adams, C.R., K.M. Bandford and M.P. Early. 1996. Principles of Horticulture CBS Publishes and Distributors, New Delhi.
2. Bose, T.K., S.K. Mitra., M.K. Sadhu and B. Mitra. 1991. Propagation of Tropical and subtropical Horticultural Crops, Naya Prokash, Calcutta. India.
3. Edmond, J.B., T.L. Senna., F.S. Andrews and R.R. Halfacre. 1990. Fundamentals of Horticulture. Tata McGraw Hill Publishing Co. Ltd.
4. Hartmann, H.T., D.E. Kester., F.T. Davies. and R.L. Greeneve. 1997. Plant propagation – Principles and Practices, Prentice Hall of India Private Ltd., New Delhi.
5. Prasad, S. and V. Kumar. 1999. Green House Management of Horticultural Crops, AgroBios India, Jodhpur.
6. Reddy, Y.T.N., T. Janakiram. and D. Satyanarayana Reddy. 2001. Scientific Nursery Management, The House of Sarpan (Media), Bangalore

OPC VSC 712 HI - TECH VEGETABLE PRODUCTION (2+1)

Objectives

To impart latest knowledge in growing of vegetable crops under protected environmental conditions.

Theory

Unit I Importance, scope and principles of Hi-tech vegetable production

Importance and scope of protected cultivation of vegetable crops. principles used in protected cultivation- energy management- low cost structure- training methods- engineering aspects.

Unit II Environmental factors and its manipulation for vegetable production

Types of green house- poly house/ net house hot- cold framers- effect of environmental factors viz temp- light - CO₂ and humidity on growth of different vegetables- manipulation of CO₂- and temperature for vegetable production.

Unit III Green house media- containers- heating and cooling systems

Growing media and sterilization- soilless cultivation- hydro-ponics and aero-ponics- types of benches and containers irrigation and fertigation- green house environmental control systems- cooling system- heating system light and photo period manipulation.

Unit IV Techniques of raising vegetables in protected structures

Regulation of flowering and fruiting in vegetable crops. technology for raising tomato- sweet pepper- cucumber and other vegetables in protected structures- training and staking in protected crops- varieties and hybrids for growing vegetables in protected structures.

Unit V Problems and remedies in Hi-tech cultivation

Problem of growing vegetables in protected structures and their remedies- insect and disease management in protected structures- soil-less culture- use of protected structures for seed production.

Practical

Study of different protected structures- cladding materials used- installation and their management study of environment control devices used in protected

structures measurement of temperature- RH- light and CO₂ study of growing media and sterilization- study of irrigation and fertigation systems and their management- soilless cultivation- hydroponics and aeroponics- control of insect pest and disease in green house -working out economics of protected cultivation visit to established green/poly house/net/shade house in the region.

Lecture schedule

1. History of protected cultivation of vegetables and its scope in India.
2. Present status of Hi-tech cultivation and its importance.
3. Principles involved in Hi-tech vegetable cultivation.
4. Modes of protected cultivation.
5. Nursery raising in protected structures.
6. Low – cost protected structures.
7. Site selection, structural designs, styles single span, multi-span.
8. Effect of environmental factors on the growth of vegetables.
9. Manipulation of CO₂, light and temperature for vegetable production
10. Green house roofing materials.
11. Green house media, natural and synthetic and sterilization.
12. Soilless cultivation, Hydroponics and Aeroponics.
13. Green house beds and benches construction and space use efficiency.
14. Green house temperature control, heating, cooling and lighting.
15. Cooling methods, ventilations, evaporative cooling and air conditioning.
16. Types of irrigation in green house, purpose and advantage.
17. Mid-semester examination.
18. Fertigation of vegetable crops under protected cultivation.
19. Pruning of vegetable crops under protected structure.
20. Training, staking and other operations under Hi-tech vegetable production.
21. Regulation of flowering and fruiting of vegetable crops.
22. Hi tech production of tomato.
23. Hi tech production of sweet pepper.
24. HI tech production of cucumber and other vegetables.
25. Hi tech production of exotic vegetables.
26. Suitable varieties and hybrids for growing vegetables in protected structures.
27. Problems in Hi-tech cultivation and remedies.
28. Insect and disease management in protected structures.
29. Use of protected structures for seed production.
30. Precision Horticulture, principles and concepts.
31. GPS, GIS remote sensing sensors.
32. Variability management in precision farming, mapping, variable rate technology.
33. Precision equipments, computers and robotics in precision farming.
34. Cost – economics of Hi-tech vegetable production.

Practical schedule

1. Study of various modes of protected cultivation.
2. Study of environment control devices used in protected structures.

3. Study of growing media and sterilization.
4. Study of irrigation and Fertigation systems.
5. Study of soilless cultivation, Hydroponics and Aeroponics.
6. Estimating the cost of low cost green house of IARI model.
7. Designing of covering materials.
8. Designing of cooling systems.
9. Designing of irrigation system.
10. Control of insect pest and disease in green house.
11. Economics of green house cultivation of tomato.
12. Economics of green house cultivation of sweet pepper.
13. Economics of green house cultivation of cucumber.
14. Visit to established green/poly house/ net/ shade house in the region.
15. Visit to export oriented vegetable units.
16. Visit to precision farming unit.
17. Visit to GPS, GIS and remote sensing facility.

Reference books

1. Aldrich, R.A. and K.W. Bartok. 1994. Green house Engineering, NRAE, Riley, Robb Hall, Cornell University, Ithaca, New York.
2. Paul.V Nelson 1991. Green house operation and Management. Ball Publishing, USA.
3. Pranab Hazya, A., Chattopadyay, K. Karmakar and S. Dutta. 2011. Modern technology in vegetable production. New India Publishing Agency, New Delhi.
4. Prasad, S. and U. Kumar. 2005. Green house management for Horticultural crops. 2nd ed. Agrobios, Jodhpur.
5. Tiwari Gn. 2003. Green house technology for controlled environment. Narosa Publ.House

**M.SC. (HORT.) FLORICULTURE AND LANDSCAPE ARCHITECTURE
COURSE-WISE DISTRIBUTION**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	FLA 611	Breeding of flower crops and ornamental plants	2+1
2.	FLA 612	Production technology of loose flowers	2+1
3.	FLA 613	Production technology of cut flowers	2+1
4.	HOR 621 HOR 622	Growth regulation and stress management in horticultural crops (or) Protected and precision horticulture	2+1
5.	FLA 621	Ornamental and landscape gardening	2+1
6	FLA 622 FLA 623	CAD for outdoor and indoor scaping (or) Value addition in flowers	1+1
7	FLA 624	Turfing and turf management	2+1
			13+7=20
Minor- 9 credits			
1.	OPC- GPB 611	Concepts of crop physiology	2+1
2.	OPC- HOR 711	Propagation and nursery management of horticultural crops	2+1
3.	OPC FLA 712	Ornamental horticulture	2+1
		Total	6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistical Methods and Design of Experiments	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
		Total	3+2=5
Seminar + Research - 21 credits			
1.	FLA -032	Seminar	0+1
2.	FLA -011; 021;031;041	Research 011-0+1; , 021-0+2; , 031- 0+8; , 041- 0+9	0+20
		Grand Total	22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0+1
4	PGS 624	Library and information services	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture	1+0
6	PGS 716 e-course	Disaster management	1+0
			2 + 4=6

**M.SC. (HORT.) FLORICULTURE AND LANDSCAPE ARCHITECTURE
SEMESTER WISE DISTRIBUTION**

S.No.	Course No.	Courses	Credit Hours
FIRST SEMESTER			
1.	FLA 611	Breeding of flower crops and ornamental plants	2+1
2.	FLA 612	Production technology of loose flowers	2+1
3.	FLA 613	Production technology of cut flowers	2+1
4.	STA 611	Statistical Methods and Design of Experiments	2+1
5.	COM 611	Computer Programming and its Applications	1+1
6.	FLA 011	Research	0+1
7.	PGS 611	Agricultural Research Ethics & Methodology (0+1)	-
8.	PGS 612	Technical Writing and Communication Skills (0+1)	-
		Total	9+6=15
SECOND SEMESTER			
1.	HOR 621 HOR 622	Growth regulation and stress management in horticultural crops (or) Protected and precision horticulture	2+1
2.	FLA 621	Ornamental and landscape gardening	2+1
3.	FLA 622 FLA 623	CAD for outdoor and indoor scaping (or) Value addition in flowers	1+1
4.	FLA 624	Turfing and turf management	2+1
4.	OPC GPB 621	Concepts of crop Physiology	2 + 1
5.	FLA 021	Research	0+2
6.	PGS 623	Basic Concepts in Laboratory Techniques (0+1)	-
7.	PGS 624	Library and Information Services (0+1)	-
		Total	9+7=16
THIRD SEMESTER			
1.	OPC XXX 711	Minor Course - Related discipline	2+1
2.	OPC XXX 712	Minor Course - Related discipline	2+1
3.	FLA 031	Research	0+8
4.	FLA 032	Seminar	0+1
5.	PGS 715 e-course	Intellectual property and its management in agriculture (1+0)	-
6.	PGS 716 e-course	Disaster management (1+0)	-
		Total	4+11 =15
FOURTH SEMESTER			
1.	FLA 041	Research	0 + 9
		Total	0 + 9
		Grand Total	22+33 = 55

FLA 611 BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS (2+1)

Objectives

To impart comprehensive knowledge about the principles and practices of breeding of flower crops and ornamental plants.

Theory

Origin- distribution- breeding principles- genetic resources- genetic divergence- genetic inheritance- evolution of varieties- breeding objectives- breeding methods- specific breeding problems and achievements- seed production- patents- plant variety protection act and IPR issues of the following crops:

Unit I Breeding of flower crops -I

Rose, jasmine, chrysanthemum, nerium and crossandra.

Unit II Breeding of flower crops -II

Tuberose, carnation, marigold, gerbera and gladiolus.

Unit III Breeding of flowers crops -III

Orchids, anthurium, dahlia and liliams.

Unit IV Breeding of annuals

Flowering annuals – zinnia, petunia, cosmos, dianthus, snap dragon, pansy, aster and petunia

Unit V Breeding of ornamental plants

Heliconia, bird of paradise, hibiscus, bougainvillea and other foliages- breeding of ornamental plants for waterscaping and xeriscaping.

Practical

Description of botanical features, cataloguing of cultivars, varieties and species in flower crops, floral biology, practices in hybridization, evaluation of hybrid progenies, induction of polyploidy, induction of mutants through physical and chemical mutagens, screening for resistance against biotic and abiotic stress and environmental pollution, *in-vitro* breeding in flower crops and ornamental plants, seed production techniques in flowering annuals, visit to organizations working on breeding of flower crops and ornamental plants.

Lecture schedule

Origin, distribution, breeding principles, genetic resources, genetic divergence, genetic inheritance, evolution of varieties, breeding objectives, breeding methods, specific breeding problems and achievements of the following crops:

1. - 3. Rose
4. - 6. Jasmine.
7. - 9. Chrysanthemum.
10. Crossandra.
11. - 12. Tuberose.
13. Carnation.
14. Marigold.
15. Gerbera
16. Gladiolus
17. Mid- semester examination.
18. Orchids.
19. Anthurium

20. Dahlia
21. Nerium
22. Zinnia
23. Cosmos
24. Dianthus
25. Snapdragon
26. Pansy and petunia
27. Aster
28. Petunia
29. Lilium
30. Heliconia and bird of paradise
31. Hibiscus
32. Bougainvillea and other foliages
33. Patents and Plant Variety Protection Act and IPR issues.
34. Breeding of ornamental plants for waterscaping and xeriscaping.

Practical schedule

1. Cataloguing of cultivars, varieties and species of rose, jasmine and chrysanthemum.
2. Cataloguing of cultivars, varieties and species of marigold, tuberose and crossandra.
3. Cataloguing of cultivars, varieties and species of orchids, anthurium and gerbera.
4. Cataloguing of cultivars, varieties and species of carnation and gladioli.
5. Study of floral biology of flower crops.
6. Study of pollen production and fertility.
7. Practices in hybridization of flower crops.
8. Evaluation of hybrid progenies.
9. Experiments on hybrid seed production in flower crops.
10. Practices in ploidy breeding in flower crops.
11. Practices in induction of mutation in flower crops.
12. Practices in *in vitro* breeding of flower crops and ornamental plants.
13. Seed production techniques in flowering annuals.
14. Screening of plants for resistance against biotic stress.
15. Screening of plants for resistance against abiotic stress.
16. Screening of plants for resistance against environmental pollution.
17. Visit to Research Institutions working on improvement of flower crops, commercial flower breeding / seed production centres.

Reference books

1. Arora, J.S. 2012. Introductory Ornamental Horticulture. Kalyani Publ. New Delhi.
2. Bhattacharjee, S.K. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. New Delhi
3. Choudhary, R.C. 1993. Introduction to Plant Breeding. Oxford & IBH.
4. Bose, T.K. and L.P. Yadav. 1989. Commercial Flowers. NayaProkash. Kolkatta

5. Chadha, K.L. and B. Choudhury. 1992. Ornamental Horticulture in India. ICAR, New Delhi
6. Chadha, K.L. and S.K. Bhattacharjee. 1995. Advances in Horticulture. Vol. XII. Malhotra Publ. House, New Delhi.
7. De.L.C. and S.K. Bhattacharjee. 2011. Ornamental crop Breeding. NayaProkash. Kolkatta.
8. Singh, B.D. 1990. Plant Breeding. Kalyani, New Delhi
9. Singh, A.K. 2015. Breeding of flowers and ornamental plants. Kalyani Publ. New Delhi.

FLA 612 PRODUCTION TECHNOLOGY OF LOOSE FLOWERS (2+1)

Objectives

To impart basic knowledge about the importance and production technology of loose flowers in India.

Theory

Scope and importance of loose flower trade- significance in the domestic /export market- Institutional support- agri export zones- floricultural enterprises- varietal wealth and diversity- Area under loose flowers and production problems in india- soil and climate requirements- special nursery techniques- field preparation- systems of planting- transplanting techniques- water and nutrient management- weed management- training and pruning- special horticultural practices- inter cultural operations- growth regulators - use of growth regulators- chemicals flower forcing and year round flowering- precision farming techniques- production for special occasions through physiological interventions- pest and disease management-physiological disorders and remedies- harvest indices and harvesting techniques of the following crops:

Unit I- Production technology of loose flower crops -I

Jasmine, rose, tuberose and marigold

Unit II Production technology of loose flower crops- II

Chrysanthemum, crossandra, celosia and barleria

Unit III Production technology of loose flower crops -III

Nerium, gomphrena, lotus, champaka, maruvu and marikolundu.

Unit IV- Production technology of loose flower crops -IV

Ixora, nyctanthes, tabernaemontana, tecoma, gaillardia, hibiscus and pandanus.

Unit V Post harvest technology and value addition in loose flower crops

Post-harvest handling- packing and storage- transportation and marketing- prospects of value addition- value addition in loose flowers (garlands- veni- floats- floral decorations- etc.) and extensions of shelf life- dry flowers- techniques in dry flower making- concrete and essential oil extraction methods.

Practical

Description of species and varieties- propagation techniques- training and pruning techniques- practices in manuring- drip and fertigation- foliar nutrition- growth regulator application- pinching- disbudding- staking- harvesting techniques- post-harvest handling- storage and cold chain- project preparation for regionally important commercial loose flowers- visit to fields- essential oil extraction units and markets.

Lecture schedule

1. Scope and importance of loose flowers, scenario of global and national loose flower production
2. Export potential, institutional support
3. Agri Export Zones, floricultural enterprises
4. Production constraints in loose flowers
Varietal wealth, soil and climate requirements, special nursery techniques, field preparation, systems of planting, transplanting techniques, water and nutrient management, weed management, training and pruning, special horticultural practices, pinching, disbudding, use of growth regulators, flower forcing and year round flowering, precision farming techniques, production for special occasions through physiological interventions, chemical regulation, integrated pest management and integrated disease management, physiological disorders and remedies, harvest indices and harvesting techniques of the following crops:
5. - 6. Jasmine
7. - 9. Rose
10. Tuberose
11. Marigold
12. - 13. chrysanthemum
14. Crossandra
15. Celosia
16. Barleria
17. Mid semester examination
18. Nerium
19. Gomphrena
20. Lotus
21. Champaka
22. Maruvu and Marikolundu
23. Ixora
24. Nyctanthes
25. Tabernae montana and tecoma
26. Gaillardia
27. Hibiscus and pandanus.
29. Post-harvest handling of loose flowers
30. Packaging and storage techniques in loose flowers
31. Prospects of value addition in loose flowers
32. - 33. Dry flowers
34. 34. Concrete and essential oil extraction methods.

Practical schedule

1. Description of varieties of jasmine, rose, chrysanthemum.
2. Description of varieties of marigold, tuberose, crossandra.
3. Propagation techniques of jasmine, scented rose, chrysanthemum.
4. Propagation techniques of marigold, tuberose, crossandra.

5. Practices in pro-tray nursery and shade nets.
6. Training and pruning techniques in jasmine and rose.
7. Training and pruning techniques in other loose flowers.
8. Practices in layout of drip and fertigation systems.
9. Practices in manuring and fertilizer scheduling in loose flowers.
10. Practices in foliar nutrition and growth regulator application in loose flowers.
11. Practices in special horticultural practices in loose flowers.
12. Diagnosis of physiological and nutritional disorders and remedial measures in loose flowers.
13. Maturity and harvesting standards and packaging techniques in loose flowers.
14. Experiments on dry flower making and essential oil extraction.
15. Visit to dry flower units.
16. Visit to concrete and essential oil extraction units.
17. Project preparation on commercial loose flower production with cost-benefit analysis.

Reference books

1. Bhattacharjee, S.K. 2006. Advances in Ornamental Horticulture. Vols. 1- VI. Pointer Publ., Jaipur.
2. Bose, T.K., L.P. Yadav, P. Pal, P. Das. and V.A. Parthasarathy. (Eds.) 2002 and 2003. Commercial Flowers, Vol. I and II. Second Revised Edition. NayaUdyog, Kolkata.
3. Bose, T.K., R.G. Maiti, R.S. Dhua. and P. Das. 1999. Floriculture and Landscaping. NayaProkash, Kolkata
4. Chadha, K.L. 1986. Ornamental Horticulture in India ICAR, KrishiBhavan, New Delhi.
5. Chadha, K.L. and B. Chaudhury. 1992. Ornamental Horticulture in India ICAR KrishiBhavan, New Delhi.
6. Chadha, K.L. and S.K. Bhattacharjee. 1995. Advances in Horticulture Vol.12. Ornamental Plants (eds.). Malhotra Publishing House, New Delhi, India.
7. Larsen, R.A. 1981. Introduction to Floriculture. Academic Press, New York.
8. Lauria, A. and V.H. Ries. 2001. Floriculture – Fundamentals and Practices, Agrobios, Jodhpur.
9. Prasad, S. and U.Kumar. 2003. Commercial Floriculture. Agrobios, Jodhpur.
10. Reddy, S., B. Janakiram, T. Balaji, S. Kulkani and R.I. Misra. 2007. High tech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.
11. Sheela, V.L. 2007. Flowers in Trade, New India Publ. Agency, New Delhi.

FLA 613 PRODUCTION TECHNOLOGY OF CUT FLOWERS (2+1)

Objectives

To impart basic knowledge about the importance and production technology of cut flowers in India.

Theory

Scope of cut flowers in global trade- global and national scenario of cut flower production- area under cut flowers and production problems in india- export potential- Institutional support- agri export zones- varietal wealth and diversity-

nursery management- open cultivation- protected cultivation- influence of environmental parameters- light- temperature- moisture- humidity and CO₂ on growth and flowering- growing media- soil decontamination techniques- planting methods- water and nutrient management- fertigation- weed management- training and pruning- special horticultural practices growth regulation- use of growth regulators-flower forcing- year round flowering through physiological interventions- chemical regulation- environmental manipulation- physiological disorders and remedies- production for exhibition purposes- harvest indices and harvesting techniques, standards and grades- post-harvest handling methods of the following crops:

Unit I Production technology of cut flowers- I

Rose, chrysanthemum and Orchids

Unit II Production technology of cut flowers- II

Carnation, gerbera, and anthurium

Unit III Production technology of cut flowers- III

Lilium gladiolus, alstroemeria dahlia, bird of paradise, heliconia,

Unit IV Production technology of cut flowers - IV

China aster, gypsophilla, golden rod and lisianthus.

Unit V Production technology of cut flowers - V

Limonium, statice and stock ornamental ginger, bromeliads, alpinia and cut foliages.

Practical

Description of varieties- propagation techniques- layout of drip and fertigation system- training and pruning techniques- practices in manuring- fertilizer scheduling- foliar nutrition- growth regulator application- special horticultural practices- diagnosis of physiological and nutritional disorders and control measures- maturity and harvesting standards- practices in post harvest handling- project preparation on commercial cut flower production with cost-benefit analysis.

Lecture schedule

1. Scope and importance of cut flowers, scenario of global and national cut flower production.
2. Export potential and production problems in India, Institutional support, Agri Export Zones.

Varietal wealth and diversity, nursery management, open cultivation, protected cultivation, influence of environmental parameters, light, temperature, moisture, humidity and CO₂ on growth and flowering, growing media, soil decontamination techniques, planting methods, water and nutrient management, fertigation, weed management, training and pruning, special horticultural practices, use of growth regulators, flower forcing, year round flowering through physiological interventions, chemical regulation, environmental manipulation, physiological disorders and remedies, production for exhibition purposes, harvest indices and harvesting techniques of the following crops:

3. - 4. Rose.
5. - 6. Chrysanthemum

7. Tuberose
8. Bird of Paradise
9. - 10. Carnation
11. Gerbera
12. - 13. Anthurium
14. - 15. Liliium
16. Statice
17. Mid- semester examination
18. - 19. Orchids
20. Gladiolus
21. Dahlia
22. Heliconia
23. Gypsophila
24. Stock
25. China aster
26. Alstroemeria
27. Golden rod
28. Lisianthus and alpinia
29. Limonium
30. Ornamental ginger and bromeliads
31. Cut foliages
32. Cut flower standards and grades
33. Post-harvest handling, methods of delaying flower opening, pre-cooling, pulsing.
34. Value addition in cut flowers.

Practical schedule

1. Study of varieties of rose, chrysanthemum, carnation and gerbera.
2. Study of varieties of gladiolus, anthurium and orchids.
3. Propagation techniques of rose, chrysanthemum, carnation and gerbera.
4. Propagation techniques of gladiolus, anthurium and orchids.
5. Propagation techniques of open field cut flowers.
6. Practices in fumigation techniques, field and bed preparation in the green house.
7. Practices in layout of drip and fertigation systems.
8. Practices in manuring and fertilizer scheduling in cut flowers.
9. Practices in foliar nutrition and growth regulator application in cut flowers.
10. Practices in special horticultural techniques in rose, chrysanthemum, carnation and gerbera.
11. Practices in special horticultural techniques in gladiolus, anthurium and orchids.
12. Practices in special horticultural techniques in open field cut flowers.
13. Diagnosis of physiological and nutritional disorders and remedial measures in cut flowers.

14. Maturity and harvesting standards and packaging techniques in cut flowers.
15. Project preparation on commercial cut flower production with cost-benefit analysis.
16. Studies on post harvest handling of cut flowers.
17. Visit to hi-tech flower production units.

Reference books

1. Bose, T.K. and L.P. Yadav. 1989. Commercial Flowers. Naya Prokash, Kolkatta
2. Bose, T.K., R.G. Maiti, R.S. Dhua and P. Das. 1999. Floriculture and Landscaping. Naya Prokash, Kolkatta
3. Chadha, K.L., and B. Chaudhury. 1992. Ornamental Horticulture in India. ICAR, New Delhi.
4. Chadha, K.L. and S.K. Bhattacharjee. 1995. Advances in Horticulture Vol.12- Ornamental plants (eds.). Malhotra Publishing House, New Delhi.
5. Larsen, R.A. 1981. Introduction to Floriculture. Academic Press, New York.
6. Lauria, A. and V.H. Ries. 2001. Floriculture-Fundamentals and Practices, Agrobios Jodhpur.
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8. Reddy, S., B. Janakiram, T. Balaji, S. Kulkani and R.I. Misra. 2007. High tech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.
9. Sheela, V.L. 2007. Flowers in Trade, New India Publ. Agency, New Delhi.

HOR 621 GROWTH REGULATION AND STRESS MANAGEMENT IN HORTICULTURAL CROPS (2+1)

Objectives

To study the physiology of vegetative and reproductive growth in horticultural crops, to understand the growth regulation concepts in relation to productivity of crops and their environment and to study the physiological stresses in crop production and strategies to overcome them.

Theory

Unit I Concepts of crop growth analysis

Growth and development: definition- parameters of growth and development- growth dynamics- morphogenesis - different stages of growth- growth curves: sigmoid- polynomial and asymptotic - growth analysis in horticultural crops- CGR- RGR- NAR- LAI- LAR- HI in horticultural crops- canopy development- plant density and crop productivity - solar radiation concept and techniques for harvesting solar radiation for crop productivity.

Unit II Plant growth regulators

Plant growth regulators: auxins- gibberellins- cytokinins- ethylene- brassinosteroids- morphactins- inhibitors and retardants- bioassay- biosynthesis- translocation/movement- physiological role in cell level and their basic functions –

mechanism of action of pgrs and theories - role of bio stimulants in crop growth and development - seaweed extract- humic acid- fulvic acid- chitosan and growth promoting microorganisms.

Unit III Developmental physiology of horticultural crops

Developmental physiology and biochemistry of seed germination- dormancy- bud break- methods of overcoming dormancy in horticultural crops - juvenility- vegetative to reproductive interphase and flowering - effect of light- photosynthesis- photoperiodism- vernalisation- temperature- heat units and thermoperiodism on developmental physiology - physiology of flowering : factors affecting flowering – floral induction theories/models: abc model- photoperiodism- vernalisation- florigen and anti-florigen concepts – stages of flowering: floral induction- initiation and organ primordial identification.

Unit IV Physiology of growth regulation in horticultural crops

Physiology of source and sink relationship- translocation of assimilates - physiological basis of training and pruning - physiology of fruit & seed development and maturation - physiological basis of unfruitfulness- fruit drop and fruit thinning -physiology of ripening - climacterics in ripening - post harvest physiology of horticultural crops - physiology of tuber and bulb formation – growth regulation for tuber and bulb yield.

Unit V Physiology of senescence and stress management in Horticultural crops

Senescence: Physiology- biochemistry- molecular and genetic approaches in plant senescence - longevity of leaves in perennial and annual crops - stress physiology concepts: stress and strain terminology- eustress- distress- stress tolerance- resistance- avoidance - stress responses of plants: cellular and molecular level- causes- effects and methods of overcoming stress - heat- low temperature- water deficit- flooding and salinity stresses.

Practical

Mechanism of dormancy- stratification -PGR experiments on seeds- tubers and bulbs -visit to arid- subtropical and temperate horticultural zones to identify growth, development patterns and growth analysis and to evaluate photosynthetic efficiency under different environments - experiment on growth regulator functions- hormone assays and ripening phenomenon in horticultural crops - experiment on impact of physical and chemical manipulations on growth and development of horticultural crops - growing of plants in sand culture under salt stress for biochemical and physiological studies - experiment on effect of osmotic and ionic stress on seed germination and seedling growth-measurement of low/high temperature injury under field conditions.

Lecture schedule

1. Growth and development: definitions and parameters of growth and development.
2. Principles of growth dynamics and morphogenesis.
3. Growth curves:stages and different pattern of growth curves of horticultural crops.
4. Growth analysis in horticultural crops (CGR, RGR, NAR, LAI, LAR, HI in horticultural crops).

5. Canopy development and plant density with respect to crop productivity.
6. Solar radiation concept and techniques for harvesting solar radiation for crop productivity.
7. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of auxin.
8. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of gibberellins.
9. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of cytokinins.
10. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of ethylene.
11. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of brassinosteroids and morphactins
12. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of inhibitors and retardants
13. Role of bio stimulants in crop growth and development: seaweed extract, humic acid, fulvic acid, chitosan and growth promoting microorganisms.
14. Physiology and biochemistry of seed germination
15. Physiology and biochemistry of dormancy : seed and bud dormancy
16. Physiology of bud breaking and methods of overcoming dormancy in horticultural crops
17. Mid -semester examination.
18. Effect of light, photosynthesis and photoperiodism on developmental physiology.
19. Effect of vernalisation, temperature, heat units and thermoperiodism on developmental physiology.
20. Physiology of flowering : factors affecting flowering and different stages of flowering
21. Physiology of flowering: floral induction theories/models: ABC model, photoperiodism and vernalisation.
22. Physiology of flowering : florigen and anti-florigen concepts with special reference to horticultural crops.
23. Source and sink relationship and concepts (carbon partitioning, sucrose synthesis, phloem loading and transportation).
24. Physiological and biochemical basis of training and pruning.
25. Physiology of fruit set and development with a special reference to chemical regulation of fruit set.
26. Physiological basis of unfruitfulness, fruit drop and fruit thinning
27. Physiological and biochemical basis of ripening and post harvest physiology of horticultural crops
28. Physiological and biochemical basis of tuber and bulb formation with special reference to growth regulation for tuber and bulb yield.

29. Physiological and biochemical basis of senescence with special reference to molecular and genetic approaches in plant senescence
30. Concepts of stress physiology: stress, eustress, distress, stress tolerance, resistance, avoidance
31. Stress responses of plants at cellular and molecular level.
32. Causes, effects and methods of overcoming heat and low temperature stress.
33. Causes, effects and methods of overcoming water deficit and flooding stress.
34. Causes, effects and methods of overcoming salinity stress.

Practical schedule

1. Estimation of growth parameters for analyzing the growth - estimation of leaf area index.
2. Estimation of growth parameters for analyzing the growth – DMP and growth rates.
3. Evaluation of photosynthetic efficiency of horticultural crops under different environments.
4. Visit to Arid, Subtropical and Temperate horticultural zones to identify growth and development pattern of different horticultural crops.
5. Studies on mechanism breaking of dormancy by stratification in seeds.
6. PGR experiments on seeds, tubers and bulbs breaking of dormancy.
7. Hormone assays (Auxin)
8. Experiments on growth regulator functions - rooting of cuttings and herbicidal effect.
9. Experiments on growth regulator functions - fruit ripening in climacteric and non-climacteric fruits.
10. Experiments on growth regulator functions – senescence.
11. Experiments on growth regulation by pruning, pinching, defoliation and disbudding in horticultural crops .
12. Experiments on growth regulator functions – fruit thinning, overcoming fruit drop and unfruitfulness.
13. Experiments on growth regulator functions – post harvest losses in horticultural crops and post harvest treatments for shelf life.
14. Growing of plants in sand culture to study the effect of drought stress.
15. Growing of plants in artificially salinized soil in pots to study the effect of salt stress.
16. Effect of osmotic and ionic stress on seed germination and seedling growth
17. Estimation of proline content in stress and normal condition in crops.

Reference books

1. Helgi, O. Pik and A. Stephen. Rolfe, 2005, The Physiology of Flowering Plants Fourth Edition (Arthur J. Willis, Ed.) Cambridge University Press, UK.
2. Leopold, A.C. and P.E. Kriedermann. 1985. Plant Growth and Development. 3rd Ed. Mc Graw-Hill, New York

3. Peter, K.V. (Ed.).2008. Basics of Horticulture. New India Publ.,New Delhi.
4. Roberto L. Benech-Arnold, A. Rodolfo. 2014. Handbook of seed physiology : Applications to Agriculture, CRC press, Boca Raton
5. Roberts, J., S. Downs. and P. Parker. 2002. Plant Growth and Development in Plants. (I. Ridge, Ed.), Oxford University Press.UK
6. Salisbury, F.B. and C.W. Ross. 1992. Plant Physiology. 4th Ed. Wadsworth Publ., California

HOR 622 PROTECTED AND PRECISION HORTICULTURE (2+1)

Objectives

This course aims to impart knowledge on various modes of protected cultivation and their technology components. It highlights various measures to control light- temperature- relative humidity and CO₂ and recent advances in control of substrate factors like pH- EC and soil microbes. It elaborates the production system so as to acquire knowledge on the cost of establishment and procedures for commencing hi-tech projects on protected and precision cultivation of horticultural crops.

Theory

Unit I Scope, importance and principles of protected cultivation

Profile of crop production systems - protected cultivation systems: overview-importance- scope and constraints under Indian conditions - comparison with conventional crop production system – microclimatological principles of protected cultivation: effect of light- temperature- relative humidity and CO₂ on crop growth and productivity- modes of protected cultivation types of protected structures: greenhouse- polyhouses/ walk in tunnels- plastic tunnels shade houses- cold frames- rain shelters- etc.

Unit II Structure and components of green house

Site selection and planning of green house structure - types/styles of green house- orientation- design- frames- civil work requirement- drainage and gutter - green house components - environment control systems: green house covering materials- ventilation systems- temperature control by cooling/heating system-shade and light systems- photoperiod manipulation - green house growing media - beds- green house benches- grow containers for different systems/crops – components of different growing media – media preparation.

Unit III Irrigation systems for green house

Green house irrigation systems: different types and components- planning- lay out- designing- installation- operation and maintenance – water requirement and irrigation scheduling for different crops – fogging systems- fertilizer sources – fertigation systems- water soluble fertilizers and their compatibility- application methods – fertilizer programmes for important vegetables and flowers.

Unit.IV Green house automation (smart green house)

Green house automation – commercial smart green house systems – sensor based signalling and monitoring for environment control- irrigation and fertigation scheduling- automation components for plug production- modular containers-media mixers and fillers- mechanical seeder- seed pelleting- priming- root trainers-insects and disease control system- smoke generator- thermal fogging for insect

and disease control - automatic green house logistical system and internet of things – multi-level growing and vertical farming.

Unit V Precision horticulture and hydroponics

Precision horticulture- principles and concepts- enabling technologies of precision farming- GPS- GIS- remote sensing- sensors- variability management in precision farming- mapping- variable rate technology- precision equipments- computers and robotics in precision farming- precision farming displays- software- expert systems and application – hydroponics: principles and system designs- system components – materials- growing media and methods of establishment – management of hydroponic growing systems – aquaponics.

Practical

Green house designing- site analysis and lay out - parts of green house and structural components- glazing/cladding materials - growing media and sterilization - beds- specification for benches- construction and lay out- plant growing containers - environment control systems: ventilation- cooling- heating- lighting- irrigation and fertigation systems - IPM- special horticultural practices- cost economics of different greenhouse production systems - visit to hi-tech units - GPS- GIS- remote sensing facility- designing of prototype hydroponic system.

Lecture schedule

1. Protected cultivation systems: overview and importance in comparison with conventional crop production system.
2. Current scenario of green house cultivation in India: focus on constraints and scope.
3. Microclimatological principles of protected cultivation: effect of light, temperature and relative humidity on crop growth and productivity.
4. Microclimatological principles of protected cultivation: effect of elevated CO₂ on crop growth and productivity.
5. Modes and types of protected structures: greenhouse, polyhouses/ walk in tunnels and plastic tunnels
6. Modes and types of protected structures: shade houses, cold frames, rain shelters etc.
7. Types/styles of green house structure, site selection and planning
8. Structural designing and specifications of frames, gutter and fittings for different types of green houses.
9. Civil work requirement and specifications for green house erection.
10. Components of green house for environment control : green house covering materials, accessories and ventilation systems
11. Components of green house for environment control : temperature control by cooling/heating system and photoperiod manipulation by shade and light systems,
12. Grow beds, benches and grow containers for different green house systems and crops.
13. Components of different growing media and media preparation for different greenhouse crops.

14. Different types and designing principles of green house irrigation systems.
15. Installation, operation and maintenance of green house irrigation systems.
16. Water requirement and irrigation scheduling for different green house crops.
17. Mid -semester examination.
18. Fogging systems for green house: principles, designing and components.
19. Advantages of fertigation systems in green house and working principles and design of different fertigation systems.
20. Sources of water soluble fertilizers and their compatibility in fertigation systems.
21. Fertilizer programmes for important vegetables and flowers under green house growing.
22. Green house automation : scope and advantages of commercial smart green house systems
23. Sensor based signalling and monitoring for environment control and scheduling of irrigation and fertigation in smart green house.
24. Automation components: plug production, modular containers, media mixers and fillers.
25. Mechanical seeding, seed pelleting, priming and root training practices in green house automation.
26. Automated insects and disease control system: smoke generator, thermal fogging for insect and disease control.
27. Automatic green house logistical systems and internet of things.
28. Vertical farming and multi-level growing: principles, design and practices.
29. Precision horticulture: principles, concepts and role of GPS, GIS, Remote sensing and sensors.
30. Variability management in precision farming, mapping- variable rate technology.
31. Precision equipments, computers and robotics in precision farming.
32. Precision farming displays, software, expert systems and applications
33. Hydroponics: principles, system designs, components and management of hydroponic growing systems.
34. Aquaponics: Integration of hydroponic system with domestic aquaculture.

Practical schedule

1. Study on components of greenhouse, polyhouses/ walk in tunnels and plastic tunnels
2. Study on site analysis and lay out designing for green house.
3. Estimating the cost of low cost green house of IARI model.
4. Designing covering material.
5. Designing of ventilation – passive and active systems.
6. Designing of cooling systems.
7. Designing an irrigation system.
8. Designing of fogging systems
9. Estimation of light requirement for various purposes.

10. Working out the space use efficiency of beds and benches.
11. Study of fertigation methods.
12. Fertilizer calculation.
13. Economics of green house cultivation of cut flowers.
14. Economics of green house cultivation of vegetables.
15. Visit to export oriented floriculture units and precision farming units.
16. Visit to GPS, GIS and remote sensing facility.
17. Designing of prototype hydroponic system.

Reference books

1. Aldrich, R.A. and J.W. Bartok. 1994. Green House Engineering. NRAES, Riley, Robb Hall, Cornell University, Ithaca, New York.
2. James, Lr. Boodley. 1981. The Commercial Green House. Ball Publishing, USA.
3. Paul, V. Nelson. 1991. Green House Operation and Management. Ball Publishing, USA.
4. Pranab Hazra, A. Chattopadyay, K.Karmakar and S.Dutta. 2011. Modern Technology in vegetable production. New India publishing agency.
5. Prasad, S. and U. Kumar. 2005. Greenhouse Management for Horticultural Crops. 2nd Ed. Agrobios India, Jodhpur.
6. Prasad, S. and V. Kumar. 1999. Green House Management for Horticultural Crops. Agrobios India, Jodhpur.
7. Reddy, S., B. Janakiram, T. Balaji, S. Kulkarni. and R.L. Misra. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.
8. Robert, A., Aldrich and W. John. Bartok, Jr. 1990. Green House Engineering. Ball publishing, USA.
9. Premjit Sharma, 2007. Precision Farming, Gene-Tech Books, New Delhi.
10. Tiwari, G.N. 2003. Green House Technology for Controlled Environment. Narosa Publishing house, New Delhi.

FLA 621 ORNAMENTAL AND LANDSCAPE GARDENING (2+1)

Objectives

To make on-site analysis, designing with garden elements and principles manually and using softwares.

Theory

Unit I Ornamental gardening -history and principles

Ornamental and landscape horticulture- definitions- scope and oppurtunities in landscape industry- history of landscape gardening- types of garden - bio-aesthetic planning- horticultural therapy- psychological and social aspects of ornamental plants- basic principles of gardening- beauty components- colour concept- grouping concepts.

Unit II Softscape elements in the garden

Softscape elements (living components)- basic function and utility- their culture- training and pruning- special techniques in softscaping- transplanting of

container grown plants- burlapping- tree transplanting- living components for different situation- house plants- interior scaping - concepts and components.

Unit III Turf establishment and management

Turfing- turf grasses- types- species- varieties and hybrids- selection of grasses for different locations- advances in turf establishment- turf management- irrigation- nutrition- special practices- turf mowing- aerating- rolling- top dressing- use of turf growth regulators (TGRS) and micro nutrients- establishment and maintenance of turfs for playgrounds- *viz.*- golf- football- hockey- cricket and tennis.

Unit IV Hardscape elements in the garden

Hardscape elements (non-living components)- construction and maintenance- basic function and utility- establishment and maintenance of special types of garden- water garden- floating plants- oxygenating plants- rock garden- bog garden- vertical garden- roof garden- xeriscaping- bonsai- plants for bonsai- methods of bonsai culture- terrarium- flower arrangement and other horticultural crafts.

Unit V Designing landscape gardens

Site analysis- client preference- home- institute- industrial garden- public parks- amusements and theme parks- landscape drawing- fundamentals of manual drawing- scale- symbols- layout- plan view- elevation and perspective diagrams- computer software- manual and computer aided designing- applications of CAD in landscape garden designing- creating legends for plant and non plant components- basics of photoshop software in garden designing.

Practical

Identification of ornamental plants and garden components- study of form- size- shape- texture- flowering season and description of trees- shrubs- flower bed- foliage bed- climbers and creeper- hedges- edges cacti- succulents- ferns and palms- evaluation of different styles of garden- turf- study of types of turf grasses- establishment- care and maintenance of turf- art of topiary- practices in planning and planting of special types of gardens- identification- planning and designing of non-living components- principles and concepts in garden designing techniques in transplanting of container grow plants- burlapping- tree transplanting- preparation of landscape plan layout- application of cad in landscape garden designing- 2D drawing by autocad- 3D drawing by 3D max software- basics of photoshop software in garden designing- project preparation on landscape execution for home- institute- industrial- public parks and theme parks- study on horticultural crafts- bonsai- terrarium and flower arrangement- visit to parks and botanical garden.

Lecture schedule

1. Ornamental and landscape horticulture, definitions, prospects of landscape industry.
2. History of landscape gardening.
3. Types of gardens.
4. Bio-aesthetic planning, Horticultural therapy.
5. Psychological and social aspects of ornamental plants.
6. Basic principles of gardening.
7. Beauty components, colour concept, grouping concepts.

8. - 10. Softscape elements (living components), basic function and utility, their culture, raining and pruning.
11. - 12. Special techniques in softscaping, transplanting of container grown plants, burlapping, tree transplanting.
13. 13. Living components for different situations.
14. - 15. House plants, interior scaping, concepts and components.
16. Turfing, turf grasses, types, species, varieties and hybrids, selection of grasses for different locations.
17. Mid -semester examination.
18. Advances in turf establishment.
19. - 20. Turf management, irrigation, nutrition, special practices, turf mowing, aerating, rolling, top dressing, use of turf growth regulators (TGRs) and micro nutrients
21. - 22. Establishment and maintenance of turfs for playgrounds, *viz.*, golf, football, hockey, cricket and tennis.
23. - 25. Hardscape elements (non-living components), construction and maintenance, basic function and utility.
26. - 27. Establishment and maintenance of special types of garden, water garden floating plants oxy generating plants, rock garden, bog garden vertical garden, roof garden, xeriscaping.
28. - 29. Bonsai, plants for bonsai, methods of bonsai culture, terrarium, flower arrangement and other horticultural crafts.
30. - 31. Site analysis, cliental preference, home, institute, industrial garden, public parks, amusements and theme parks.
32. Landscape drawing, fundamentals of manual drawing, scale symbols, layout ,plan view, elevation and perspective diagrams.
33. Computer software, manual and computer aided designing, applications of CAD in landscape garden designing.
34. Applications of CAD in landscape garden designing.

Practical schedule

1. Identification of ornamental plants and garden components.
2. – 3. Study of form, size, shape, texture, flowering season and description of trees, shrubs, flower bed, foliage bed, climbers and creeper, hedges, edges cacti, succulents, ferns and palms.
4. Evaluation of different styles of garden.
5. Turf - study of types of turf grasses - establishment, care and maintenance of turf.
6. Art of topiary – practices in planning and planting of special types of gardens.
7. – 8. Identification, planning and designing of non-living components.
9. Techniques in transplanting of container grown plants, burlapping, tree transplanting.
10. Principles and concepts in garden designing.

11. Manual preparation of landscape plan layout.
12. Application of CAD in landscape garden designing.
13. Creating legends for plant and non plant components using photoshop.
14. 2D drawing by AUTOCAD and 3D drawing by 3D MAX software.
15. Project preparation on landscape execution for home, institute, industrial, public parks and theme parks.
16. Study on horticultural crafts, bonsai, terrarium and flower arrangement.
17. Visit to parks and botanical garden.

Reference books

1. Beard, J.B. 1973. Turfgrass: Science and Culture. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA.
2. Bose, T.K. and D. Mukherjee. 1977. Gardening in India. Oxford and IBH Publication Co., Kolkata.
3. Brain Closton. 1990. Landscape design with plants. CRC press, Boca Raton
4. Chadha, K.L. 1986. Ornamental Horticulture in India. ICAR. KrishiBhavan, New Delhi.
5. Gopalasamy Iyyankar. 1970. Complete Gardening In India. Kalyan Printers, Bangalore.
6. Hari Krishna Pahiwal. 2009. Ornamental gardening. National Book Trust, New Delhi.
7. Karuppaiah, P. and K. Manivannan. 2017. Ornamental Horticulture. Agrobios, Jodhpur.
8. Lancaster, P. 1991. Gardening in India, Oxford and IBH Publishing Co. (P) Ltd. Kolkatta.
9. Nambisan, K.M. P. 1992. Design Elements of Landscape Gardening, Oxford and IBH Publishing Co. (P) Ltd. Kolkatta.
10. Randhawa, G.S. 1973. Ornamental Horticulture in India. Today and Tomorrows Printers and publishers, New Delhi.

FLA 622 CAD FOR OUTDOOR AND INDOORSCAPING (1+1)

Objectives

To impart basic knowledge about the operation of Computer Aided Designing (CAD) in landscape garden designing.

Theory

Unit I Exposure to CAD (Computer Aided Designing)

Applications of CAD in landscape garden designing- 2D drawing by AUTOCAD- 3D drawing by ARCHICAD- 3D drawing by 3D MAX software- creating legends for plant and non-plant components- basics of photoshop software in garden designing.

Unit II Basics of AUTOCAD

2D drawing methods- AUTOCAD basics- coordinate systems in AUTOCAD LT 2007- point picking methods- toolbars and icons- file handling functions- modifying tools- modifying comments- Isometric drawings- drafting objects.

Unit III AUTOCAD drawing- 2 D drawing methods

Using patterns in AUTOCAD drawing- dimension concepts- hyperlinking- script making- using productivity tools- e-transmit file- making sample drawing for

outdoor and indoor garden by AUTOCAD 2D drawing techniques- drawing web format design- making layout.

Unit IV 3 D drawing methods and basics of ARCHICAD

3D drawing methods- ARCHICAD file system- tools and infobox- modification tools- structural elements- GDL objects (Grid dimensional Linking)- creation of garden components through ARCHICAD.

Unit V ARCHICAD drawing and Plan preparation

ARCHICAD organization tools- dimensioning and detailing of designs- attribute settings of components- visualization tools for landscape preview- data management- plotting and accessories for designing- inserting picture using photoshop- making sample drawing for outdoor and indoor gardens.

Practical

Practices in point picking methods- using tool bars and icons- using modifying tools and modifying comments- isometric drawings- using productivity tools- drawing designs by autocad for home garden- institutional garden and special types of garden- using tools and info-box for 3D drawing- creation of garden components with archicad- organization- dimensioning- detailing and visualization tools with archicad- using photoshop package for 3D picture insertion- drawing designs with ARCHICAD for home garden- interior garden designing- it parks- corporates- theme parks and ecotourism spots-making sample drawing for indoor gardens.

Lecture schedule

1. Exposure to CAD (Computer Aided Designing).
2. Applications of CAD in landscape garden designing: 2D drawing by AUTOCAD and 3D drawing by ARCHICAD and MAX software.
3. Creating legends for plant and non-plant components and basics of photoshop software in garden designing.
4. 2D drawing methods: AUTOCAD basics, coordinate systems in AUTOCAD LT 2007,
5. 2D drawing methods: point picking methods, toolbars and icons and file handling functions,
6. 2D drawing methods: modifying tools, modifying comments, isometric drawings and drafting objects,
7. 2D drawing methods: using patterns, dimension concepts, hyperlinking and script making .
8. 2D drawing methods: using productivity tools, e-transmit file and making sample drawing for outdoor and indoor garden by AUTOCAD.
9. Mid -semester Examination.
10. 2D drawing methods: drawing web format design, making layout.
11. 3D drawing methods in ARCHICAD: file system, tools, infobox, and modification tools.
12. 3D drawing methods in ARCHICAD: structural elements and GDL objects (grid dimensional linking).
13. 3D drawing methods in ARCHICAD: creation of garden components through ARCHICAD.

14. 3D drawing methods in ARCHICAD: ARCHICAD organization tools, and dimensioning.
15. 3D drawing methods in ARCHICAD: detailing of designs and attribute settings of components.
16. Visualization tools for landscape preview, data management, plotting, accessories for designing and inserting picture using photoshop.
17. Making sample drawing for outdoor and indoor gardens in ARCHICAD.

Practical schedule

1. Practices in point picking methods.
2. Using tool bars and icons.
3. Using modifying tools and modifying comments.
4. Isometric drawings and using productivity tools.
5. Drawing designs by AUTOCAD for home garden and institutional garden.
6. Drawing designs by AUTOCAD for special types of garden.
7. Using tools and info-box for 3D drawing.
8. Creation of garden components with ARCHICAD.
9. Organization, dimensioning, detailing and visualization tools with ARCHICAD.
10. Using photoshop package for 3D picture insertion.
11. Using photoshop package for 3D picture insertion.
12. Drawing designs with ARCHICAD for home garden.
13. Drawing designs with ARCHICAD for interior garden designing.
14. Drawing designs with ARCHICAD for IT parks.
15. Drawing designs with ARCHICAD for corporates.
16. Drawing designs with ARCHICAD for theme parks.
17. Drawing designs with ARCHICAD for ecotourism spots.

Reference books

1. Christine Wein-Ping Yu, 1987. Computer-aided Design: Application to Conceptual Thinking in Landscape Architecture. Agrobios Publishing company, Jodhpur.
2. David Byrnes. 2010. Auto CAD 2010 for DUMMIES. Wiley Publishing Inc., UK.
3. Donnie Gladfelter. 2016. Auto CAD 2016 and Auto CAD LT .2016. Autodesk Official Press, Wiley India.
4. Farin Gerald, E., Josef Hoschek. and Myung-Soo Kim. 2002. Handbook of computer aided geometric design. Elsevier, Amsterdam.

FLA 623 VALUE ADDITION IN FLOWERS (1+1)

Objectives

To develop understanding of the scope and ways of value addition in flowers.

Theory

Unit I Prospects of value addition

National and global scenario- production and exports- women empowerment through value added products making- supply chain management.

Unit II Types of value added products

Value addition in loose flowers- garlands- veni- floats- floral decorations- value addition in cut flowers- flower arrangement- styles- Ikebana- morebana- free style-

bouquets- button-holes- flower baskets- corsages- floral wreaths- garlands- etc- selection of containers and accessories for floral products and decorations.

Unit III Dry flowers

Identification and selection of flowers and plant parts; raw material procurement- preservation and storage- techniques in dry flower making – drying- bleaching- dyeing- embedding- pressing- accessories- designing and arrangement – dry flower baskets- bouquets- pot-pourri- wall hangings- button holes- greeting cards- wreaths- packing and storage.

Unit IV Concrete and essential oils

Selection of species and varieties (including non-conventional species)- extraction methods- packing and storage-extraction methods- applications.

Unit V Pigments

Selection of species and varieties- types of pigments- carotenoids- anthocyanin- chlorophyll- betalains- significance of natural pigments- extraction methods- applications.

Practical

Techniques in loose flower decoration- practices in garlands- veni and floats making with with fresh flowers -techniques and styles in cut flower arrangements- practices in preparation of bouquets in different styles- practices in preparation of button-holes and flower baskets- practices in preparation of corsages and floral wreaths- identification of plants for dry flower making- practices in dry flower making- practices preparation of dry flower baskets- practices in preparation of bouquets- pot-pourri and button holes- practices in preparation of wall hangings- wreaths-etc- practices in preparation of greeting cards- etc- skeletanizing- leaf cup making and leaf painting- packaging and storage of fresh and dry flower products- visit to dry flower units- extraction methods of concrete and essential oil- extraction methods of pigments- visit to concrete- essential oil and pigment extraction unit.

Lecture schedule

1. National and global scenario, production and export of value addition in flowers.
2. Women empowerment through value added flower products making and supply chain management.
3. Value addition in loose flowers- garlands, veni and floats making
4. Value addition in loose flowers- other floral decorations through loose flowers. Value addition in cut flowers: flower arrangements.
5. Eastern styles of flower arrangements like Japanese art of flower arrangements like Ikebana, morebana. etc.
6. Western styles of flower arrangements and bouquets, button-holes and flower baskets, corsages, floral wreaths, garlands, etc.
7. Selection of containers and accessories for floral products and decorations.
8. Identification, selection of flowers and plant parts, raw material procurement, preservation and storage for dry flower making.
9. Mid -semester examination

10. Raw material procurement, preservation and storage for dry flower making and Accessories for dry flower making.
11. Techniques in dry flower making – drying, bleaching, dyeing and embedding, designing and arrangement
12. Dry flower baskets, bouquets and pot-pourri making, wall hangings, button holes, wreaths and other designs making.
13. Skeletanising, leaf painting, leaf cup making, pressed flower arrangements like greeting cards, Packing and storage of dry flowers.
14. Selection of species and varieties of flowers for concrete and essential oils and their significance.
15. Non-conventional species for concrete and essential oil, extraction methods and their applications.
16. Packing, storage, types of pigments-carotenoids, anthocyanin, chlorophyll and betalains.
17. Significance of natural pigments, selection of species and varieties for pigment extraction and extraction methods and applications.

Practical schedule

1. Techniques in loose flower decoration.
2. Practices in garlands, veni and floats making with with fresh flowers.
3. Techniques and styles in cut flower arrangements.
4. Practices in preparation of bouquets in different styles.
5. Practices in preparation of button-holes and flower baskets.
6. Practices in preparation of corsages and floral wreaths.
7. Identification of plants for dry flower making.
8. Practices in dry flower making.
9. Practices preparation of dry flower baskets.
10. Practices in preparation of bouquets, pot-pourri and button holes.
11. Practices in preparation of wall hangings, wreaths, etc.
12. Practices in preparation of greeting cards, etc.
13. Skeletanizing, leaf cup making and leaf painting.
14. Packaging and storage of fresh and dry flower products.
15. Visit to dry flower units.
16. Extraction methods of concrete, essential oil and pigments.
17. Visit to concrete, essential oil and pigment extraction units.

Reference books

1. Bhattacharjee, S.K. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. Jaipur.
2. Bhattacharjee, S.K. and L.C. De. 2005. Post-harvest technology of Flowers and Ornamental Plants . Pointer Publ., Jaipur.
3. Bose, T.K. and P. Yadav. (Eds.). 1989. Commercial flowers. Naya Prokash Publishers, Calcutta.
4. Chadha, K.L.1995. Advances in Horticulture. Vol.XII. Malhotra Publ. House, New Delhi

5. Karuppaiah, P. and K.Manivannan. 2017. Ornamental Horticulture.Agrobios, Jodhpur.
6. Lauria, A. and H.R. Victor. 2001. Floriculture – Fundamentals and Practices Agrobios, Jodhpur.
7. Prasad, S. and U. Kumar. 2003. Commercial Floriculture.Agrobios, Jodhpur.
8. Reddy, S., B. Janakiram, T. Balaji, S. Kulkarni. and R.L. Misra. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.
9. Salunkhe, D.K., Bhatt. and B.B. Desai. 1990. Post-harvest Bio technology of Flowers and Ornamental plants. Springer-Verlag, US.

FLA 624 TURFING AND TURF MANAGEMENT (2+1)

Objectives

To develop understanding of the principles and management of turfing.

Theory

Unit I Importance of turf grass in industry

History of landscape gardening pertaining to turfing- importance and scope of turf industry in india- site selection- basic requirements- site evaluation- concepts of physical- chemical and biological properties of soil pertaining to turf grass establishment.

Unit II Turf grasses

Turf grass- types- species- varieties- hybrids-propagation of turf grass- selection of grasses for different locations- grouping according to climatic requirement and adaptation.

Unit III Preparatory operations

Growing media used for turf grasses - turf establishment methods- seeding- sprigging/dibbling- plugging- sodding/turfing- turf plastering- hydro-seeding- astro - turfing.

Unit IV Turf management

Irrigation- drainage- nutrition- special practices- aerating- rolling- soil top dressing- use of turf growth regulators (tgrs) and micronutrients- turf mowing – mowing equipments- techniques to minimize wear and compaction- weed control- biotic and abiotic stress management in turfs.

UnitV Turf establishment, Care and maintenance

Establishment and maintenance of turfs for playgrounds- viz. golf- football- hockey- cricket- tennis- rugby- etc- turfing for roof gardens- turfing for special purposes- repair and rejuvenation of old turf- equipments for turfing.

Practical

Identification of turf grasses- propagation of turf grasses- preparatory operations in turf making- practices in turf establishment- layout of macro and micro irrigation systems- water and nutrient management; drainage practices- special practices – mowing- raking- rolling- soil top dressing- use of turf growth regulators- weed management; biotic and abiotic stress management; project preparation for turf establishment- visit to it parks- model cricket and golf grounds- airports- corporates- govt. organizations; renovation of lawns; turf economics.

Lecture Schedule-

1. History of landscape gardening pertaining to turfing.
2. Importance and scope of turf industry in India.
3. Site selection and site evaluation.
4. Basic requirements for turfing.
5. Concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment.
6. Turf grass- Types, species.
7. Turf grass- varieties, hybrids.
8. Propagation of turf grass.
9. Selection of grasses for different locations.
10. Grouping of turf grasses according to climatic requirement and adaptation.
11. Growing media used for turf grasses.
12. Turf establishment methods- seeding, sprigging/dibbling and plugging.
13. Turf establishment methods-sodding/turfing, turf plastering and hydro-seeding.
14. Irrigation methods for different turfs.
15. Automized irrigation methods
16. Drainage methods for different turfs.
17. Mid semester examination.
18. Soil top dressing and micronutrients
19. Special practices- aerating and rolling.
20. Use of turf growth regulators (TGR's).
21. Turf mowing – mowing equipments,
22. Turf grass-Patterning
23. Techniques to minimize wear and compaction of turf.
24. Weed control in turfs.
25. Biotic stress management in turfs
26. Abiotic stress management in turfs.
27. Establishment and maintenance of turfs for golf ground.
28. Establishment and maintenance of turfs for football and hockey grounds.
29. Establishment and maintenance of turfs for cricket ground.
30. Establishment and maintenance of turfs for tennis, rugby grounds, etc.
31. Turfing for roof gardens.
32. Turfing for special purposes.
33. Repair and rejuvenation of old turf.
34. Equipments for turfing.

Practical Schedule

1. Identification of turf grasses.
2. Propagation of turf grasses.
3. Preparatory operations in turf making.
4. Practices in turf establishment.
5. Layout of macro and micro irrigation systems.
6. Layout of drainage systems.
7. Water management practices.

8. Nutrient management practices.
9. Special practices – mowing, raking and rolling.
10. Soil top dressing and use of plant growth regulators.
11. Weed management practices.
12. Pest,diseases and nematode management practices.
13. Abiotic stress management practices.
14. Astrourfing practices.
15. Project preparation for turf establishment in cricket or football or hockey or golf ground.
16. Renovation of lawns.
17. Turf economics.
18. Visit to IT parks, model cricket and golf grounds, airports, corporates, Govt. organizations.

Reference Books

1. Beard, J.B. 1973. Turf grass: science and culture.Pearson Publishers, New Delhi.
2. Chadha, K.L. 1986. Ornamental Horticulture in India.ICAR, KrishiBhavan, New Delhi.
3. Karuppaiah, P. and K.Manivannan.2017. Ornamental Horticulture. Agrobios, Jodhpur.
4. Nick, E., Christians, J. Aaron, Patton, Quincy D. Law. 2016. Fundamentals of Turfgrass Management, 5th Edition. Wiley Publishers, US
5. Carrow, R.N., Waddington, D.V and Rieke, P.E.2002.Turf Grass –soil fertility and chemical problems: Assessment and Management.Wiley Publ., US.
6. Mahammed,P.2007. Handbook of Turf grass Management and Physiology, CRC press, Boca Raton.
7. Robert Emmons, 2016.Turf grass science and management, Cengage, New Delhi.

OPC- HOR 711 PROPAGATION AND NURSERY MANAGEMENT OF HORTICULTURAL CROPS (2+1)

Objectives

This course deals with different methods of plant propagation and strategies for nursery management of various fruit crops. Knowledge of tools and implements is essential to carry out all scientific horticultural operations and also nursery management practices. The above themes are discussed elaborately in this course and the basic knowledge gained will be useful for the career development of students in commercial nursery business.

Theory

Unit I Principles of plant propagation

Sexual and asexual methods of propagation - principles and factors influencing seed germination-dormancy- hormonal regulation of germination and seedling growth- seed quality- packing- storage- certification and testing.

Unit II Anatomical and physiological aspects of plant propagation

Techniques of cottage - layerage- graftage and budding- compatibility-dwarfing rootstocks of important fruit trees.

Unit III Plant growth regulators and plant tissue culture

Role of PGR'S in plant propagation- role of nucellar embryony- apomixes- tissue culture techniques- hardening techniques .

Unit IV Planning of a nursery unit and modern propagation structures

Raising of nursery plants- selection- certification maintenance of mother plants and bud wood and root stock nurseries- use of modern structures- mist chambers- low cost poly houses- tunnel houses.

Unit V Marketing methods of nursery plants and economics

Media/soil mixtures- containers- use of machinaries- lifting- packing- transport- marketing- economics of raising nursery and management in different fruit crops.

Practical

Media/soil mixture- containers and soil sterilisation- use of chemicals for seed treatment and sowing- preparation of nursery beds- polybags- seedpans- thumb rule for raising seedlings- stratification and scarification of seeds and use of tetrazolium salts for germination tests-identification of nucellar seedlings- practice of different asexual methods of propagation- viz.-cuttage- layering- budding- approach- veneer and softwood grafting-use of plant growth regulators in propagation of plants -use of mist chambers- modern propagation structures- low cost polyhouses- low tunnels and bottom heating techniques- selection- lifting- packing- transportation and marketing of nursery plants- economics of raising nurseries- visit to local commercial/private nurseries.

Lecture schedule

1. Scope and importance of plant propagation.
2. Study of sexual and asexual methods of propagation.
3. Advantages and disadvantages of seed and vegetative propagation.
4. Factors influencing seed germination of Horticultural crops.
5. Studies on dormancy, hormonal regulation of germination and seedling growth.
6. Study of seed quality, packing, storage, certification and testing.
7. Study of anatomical and physiological aspects of asexual propagation.
8. Studies on graft compatibility on fruit crops.
9. Dwarfing rootstocks of commercial importance in fruit crops.
10. Role of PGR's in raising seedlings and rooting of cuttings and layers.
11. Role of nucellar embryony and apomixis.
12. Studies on tissue culture techniques.
13. Micro grafting (STG).
14. Techniques of cuttings and layering.
15. Techniques of budding and grafting.
16. Planning of nursery unit.
17. Mid-semester examination
18. Study of raising of nursery plants and their after care- role of protrait nursery and their after care.
19. Study of modern propagation structures.
20. Role of mist chambers in plant propagation.

21. Study of bottom heating techniques.
22. Hardening techniques in nursery.
23. Progeny orchard and scion bank.
24. Establishment of bud wood bank.
25. Media -soil mixture preparation for nursery plants.
26. Study of containers used for nursery.
27. Use of machineries in nurseries.
28. Soil sterilization techniques.
29. Irrigation systems in nursery plants.
30. Lifting and packing of nursery plants.
31. Transportation and marketing of nursery plants.
32. Nursery planning and layout .
33. Economics of raising nursery and management of different fruit crops.
34. Nursery acts.

Practical schedule

1. Media/soil mixture, containers and soil sterilization.
2. Use of chemicals for seed treatment and sowing.
3. Preparation of nursery beds, polybags, seedpans, thumbrule for raising seedlings.
4. Stratification and scarification of seeds and use of tetrazolium salts for germination.
5. Identification of nucellar seedlings.
6. Practice of different asexual methods of propagation, viz.,cuttage, layering.
7. Buddingmethods.
8. Grafting- methods.
9. Use of plant growth regulators in propagation.
10. Role of mist chambers in plant propagation.
11. Other protected structures uses for plant propagation.
12. Low cost polyhouses, low tunnels.
13. Bottom heating techniques and soil sterilization.
14. Selection, lifting, packing of nursery plants.
15. Transportation and marketing of nursery plants.
16. Economics of raising nurseries.
17. Visit to local commercial/private nurseries.

Reference books

1. Adams, C.R., K.M. Bandford and M.P. Early. 1996. Principles of Horticulture CBS Publishes and Distributors, New Delhi.
2. Bose, T.K., S.K. Mitra., M.K. Sadhu and B. Mitra. 1991. Propagation of Tropical and subtropical Horticultural Crops, Naya Prokash, Calcutta. India.
3. Edmond, J.B., T.L. Senna., F.S. Andrews and R.R. Halfacre. 1990. Fundamentals of Horticulture. Tata McGraw Hill Publishing Co. Ltd.
4. Hartmann, H.T., D.E. Kester., F.T. Davies. and R.L. Greneve. 1997. Plant propagation – Principles and Practices, Prentice Hall of India Private Ltd., New Delhi.

5. Prasad, S. and V. Kumar. 1999. Green House Management of Horticultural Crops, AgroBios India, Jodhpur.
6. Reddy, Y.T.N., T. Janakiram. and D. Satyanarayana Reddy. 2001. Scientific Nursery Management, The House of Sarpan (Media), Bangalore

OPC-FLA 712 ORNAMENTAL HORTICULTURE (2+1)

Objectives

Familiarization with principles and practices of landscaping and ornamental gardening.

Theory

Unit I Ornamental horticulture- History and principles

Ornamental horticulture-definition- scope and importance- history of ornamental horticulture. types of gardens. styles of garden- formal- informal and free style gardens. beauty components- basic principles of gardening.

Unit II Softscape and Hardscape elements

Garden plant components-basic function and utility- arboretum- shrubbery- fernery- palmatum- edges and hedges -topiary and trophy- climbers and creepers- cacti and succulents- herbs- annuals- flower borders and beds- ground covers- carpet beds- bamboo groves; lawns- establishment and maintenance- production technology for selected ornamental plants .non-plant components.

Unit III Special types of gardens and horticultural crafts

Special types of gardens- vertical garden- roof garden- bog garden- sunken garden- rock garden- clock garden- temple garden and sacred groves. Study on horticultural crafts- bonsai- terrarium and flower arrangement-

Unit IV Landscape drawing

Site analysis- client preference- home- institute- industrial garden- public parks- amusements and theme parks- landscape drawing- fundamentals of manual drawing- scale- symbols- layout- plan view- elevation and perspective diagrams- computer software- manual and computer aided deigning- applications of CAD in landscape garden designing.

Unit V Landscaping for specific situations

Urban landscaping- landscaping for specific situations- hospitals- roadsides- traffic islands- damsites- it parks- corporates. bio-aesthetic planning- eco-tourism- indoor gardening- therapeutic gardening- water scaping and xeriscaping.

Practical

Identification of ornamental plants and garden components- study of form-size- shape- texture- flowering season and description of trees- shrubs- flower bed- foliage bed- climbers and creeper- hedges- edges cacti- succulents- ferns and palms- evaluation of different styles of garden- turf- study of types of turf grasses- establishment- care and maintenance of turf- art of topiary- practices in planning and planting of special types of gardens- identification- planning and designing of non-living components- principles and concepts in garden designing- techniques in transplanting of container grow plants- burlapping- tree transplanting- preparation of landscape plan layout- application of cad in landscape garden designing- project preparation on landscape execution for home- institute- industrial- public parks

and theme parks. study on horticultural crafts- bonsai- terrarium and flower arrangement- visit to parks and botanical garden.

Lecture Schedule

1. Ornamental horticulture-Definition, scope and importance.
2. History of ornamental horticulture,
3. Types of gardens.
4. Styles of garden, formal, informal and free style gardens
5. Beauty components
6. Basic principles of gardening.
7. Garden plant components, arboretum,
8. Shrubbery, fernery, palmatum, edges and hedges,
9. Climbers and creepers, cacti and succulents and herbs,
10. Annuals, flower borders and beds,
11. Ground covers, carpet beds and bamboo groves,
12. Lawns, Establishment and maintenance,
13. Production technology for selected ornamental plants.
14. Non-plant components-basic function and utility.
15. Special types of gardens, vertical garden and roof garden,
16. Bog garden, sunken garden and rock garden,
17. Mid semester examination.
18. Clock garden, temple garden, sacred groves.
19. Study on horticultural crafts, bonsai and terrarium.
20. Flower arrangement,
21. Site analysis, cliental preference,
22. Home, institute and industrial garden,
23. Public parks, amusements and theme parks,
24. Landscape drawing, fundamentals of manual drawing, scale, symbols and layout,
25. Plan view, elevation and perspective diagrams,
26. Computer software,manual and computer aided designing, applications of CAD in landscape garden designing.
27. Urban landscaping,
28. Landscaping for specific situations,residents, hospitals, roadsides and traffic islands,
29. Damsites, IT parks and corporates.
30. Bio-aesthetic planning,
31. Eco-tourism and theme parks
32. Indoor gardening,
33. Therapeutic gardening,
34. Water scaping and xeriscaping.

Practical schedule

1. Identification of ornamental plants and garden components.

2. - 5. Study of form, size, shape, texture, flowering season and description of trees, shrubs, flower bed, foliage bed, climbers and creeper, hedges, edges cacti, succulents, ferns and palms.
6. Evaluation of different styles of garden.
7. Turf - study of types of turf grasses - establishment, care and maintenance of turf.
8. Art of topiary –
9. Practices in planning and planting of special types of gardens.
10. - 11. Identification, planning and designing of non-living components.
12. Techniques in transplanting of container grown plants, burlapping, tree transplanting.
13. Principles and concepts in garden designing.
14. Manual preparation of landscape plan layout.
15. Application of CAD in landscape garden designing.
16. Project preparation on landscape execution for home, institute, industrial, public parks and theme parks.
17. Study on horticultural crafts, bonsai, terrarium and flower arrangement.
Visit to parks and botanical garden

Reference Books

1. Beard, J.B. 1973. Turfgrass: Science and Culture. Agro Botanica. Jodhpur.
2. Bose, T.K., R.G. Maiti, R.S. Dhua. and P. Das. 1999. Floriculture and Landscaping. NayaProkash, Kolkatta.
3. Brain Closton.1984. Landscape design with plants. Van Nostrad Reinhold company NewYork.
4. Gopalasamy Iyyankar.1970.Complete Gardening In India. Kalyan Printers, Bangalore.
5. Hari Krishna Pahiwal. 2009. Ornamental gardening. National Book Trust, New Delh.
6. Karuppaiah, P. and K. Manivannan. 2017. Ornamental Horticulture.Agrobios,Jodhpur.
7. Lancaster, P. 1991.Gardening in India, Oxford and IBH Publishing Co. (P) Ltd. Kolkatta.
8. Nambisan, K.M.P. 1992.Design Elements of Landscape Gardening, Oxford and IBH Publishing Co. (P) Ltd. Kolkatta.
9. Sabina, G.T. and K.V. Peter. 2008. Ornamental Plants for Gardens. New India Publ., New Delhi.
10. Valsalakumari, P.K.,P.K.Rajeevan, P.K.Sudhadevi and C.K.Geetha. 2008. Flowering Trees. New India Publ., New Delhi.

**M.SC. (HORT.) PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS
COURSE-WISE DISTRIBUTION**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	PSM 611	Breeding of plantation and spice crops	2+1
2.	PSM 612	Breeding of medicinal and aromatic crops	2+1
3.	PSM 613	Production technology of plantation crops	2+1
4.	HOR 621 PSM 621	Growth regulation and stress management in horticultural crops (or) Production technology of medicinal and aromatic crops	2+1
5.	PSM 622	Production technology of spice crops	2+1
6	PSM 623 PSM 624	Organic Cultivation of spices and plantation crops (or) Underexploited medicinal and aromatic plants	1+1
7	PSM 625	Processing of plantation, spice, medicinal and aromatic crops	2+1
			13+7=20
Minor- 9 credits			
1.	OPC- GPB 611	Concepts of crop physiology	2+1
2.	OPC- HOR 711	Propagation and nursery management of horticultural crops	2+1
3.	OPC PSM 712	Genetic resources and conservation of medicinal and aromatic crops	2+1
		Total	6+3=9
Supporting courses- 5 credits			
1.	STA-611	Statistical Methods and Design of Experiments	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
		Total	3+2=5
Seminar + Research - 21 credits			
1.	PSM -032	Seminar	0+1
2.	PSM - 011;021;031;041	Research 011-0+1; , 021-0+2; , 031- 0+8; , 041- 0+9	0+20
		Grand Total	22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Agricultural research ethics and methodology	0 + 1
2	PGS 612	Technical writing and communication skills	0 + 1
3	PGS 623	Basic concepts in laboratory techniques	0+1
4	PGS 624	Library and information services	0+1
5	PGS 715 e-course	Intellectual property and its management in agriculture	1+0
6	PGS 716 e-course	Disaster management	1+0
			2 + 4=6

**M.SC. (HORT.) PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS
SEMESTER WISE DISTRIBUTION OF COURSES**

S.No.	Course No.	Courses	Credit Hours
FIRST SEMESTER			
1.	PSM 611	Breeding of plantation and spice crops	2+1
2.	PSM 612	Breeding of medicinal and aromatic crops	2+1
3.	PSM 613	Production technology of plantation crops	2+1
4.	STA 611	Statistical Methods and Design of Experiments	2+1
5.	COM 611	Computer Programming and its Applications	1+1
6.	PSM 011	Research	0+1
7.	PGS 611	Agricultural Research Ethics & Methodology (0+1)	-
8.	PGS 612	Technical Writing and Communication Skills (0+1)	-
		Total	9+6=15
SECOND SEMESTER			
1.	HOR 621 PSM 621	Growth regulation and stress management in horticultural crops (or) Production technology of medicinal and aromatic crops	2+1
2.	PSM 622	Production technology of spice crops	2+1
3.	PSM 623 PSM 624	Organic Cultivation of spices and plantation crops production (or) Underexploited medicinal and aromatic plants	1+1
4.	PSM 625	Processing of plantation, spice, medicinal and aromatic crops	2+1
4.	OPC GPB 621	Concepts of crop Physiology	2 + 1
5.	PSM 021	Research	0+2
6.	PGS 623	Basic Concepts in Laboratory Techniques (0+1)	-
7.	PGS 624	Library and Information Services (0+1)	-
		Total	9+7=16
THIRD SEMESTER			
1.	OPC XXX 711	Minor course- Related discipline	2+1
2.	OPC XXX 712	Minor course- Related discipline	2+1
3.	PSM 031	Research	0+8
4.	PSM 032	Seminar	0+1
5.	PGS 715 e-course	Intellectual property and its management in agriculture (1+0)	-
6.	PGS 716 e-course	Disaster management (1+0)	-
		Total	4+11 =15
FOURTH SEMESTER			
1.	PSM 041	Research	0 + 9
		Total	0 + 9
		Grand Total	22+33 = 55

PSM 611 BREEDING OF PLANTATION AND SPICE CROPS (2+1)

Objectives

To impart comprehensive knowledge about the principles and practices of breeding of plantation crops and spices.

Theory

Species and cultivars- cytogenetics- survey- collection- conservation and evaluation- blossom biology- breeding objectives- approaches for crop improvement- introduction- selection- hybridization- mutation breeding- polyploid breeding- improvement of quality traits- resistance breeding for biotic and abiotic stresses- molecular aided breeding and biotechnological approaches- marker-assisted selection- bioinformatics- IPR issues- achievements and future thrusts.

Unit I Breeding of plantation crops –I

Coffee, cashew, cocoa & rubber

Unit II Breeding of plantation crops –II

Palmyrah, oil palm, coconut & arecanut

Unit III Breeding of spice crops - I

Black pepper, cardamom, ginger

Unit IV Breeding of spice crops- II

Fenugreek, coriander, fennel

Unit V Breeding of spice crops - III

Nutmeg, cinnamon, clove, allspice

Practical

Characterization and evaluation of germplasm accessions- blossom biology- studies on pollen behaviour- practices in hybridization- ploidy breeding- mutation breeding- evaluation of biometrical traits and quality traits- screening for biotic and abiotic stresses- haploid culture- protoplast culture and fusion- induction of somaclonal variation and screening the variants. Identification and familiarization of spices; floral biology; anthesis; fruit set; selfing and crossing techniques; description of varieties. Salient features of improved varieties and cultivars from public and private sector- bioinformatics- visit to radiotracer laboratory- national institutes for plantation crops and plant genetic resource centers- genetic transformation in plantation crops for resistance to biotic stress/quality improvement.

Lecturer schedule

1. Approaches for crop improvement.
2. Methods of breeding in perennial spices
3. Methods of breeding in seed spices
4. Methods of breeding in plantation crops
5. Biotechnological approaches in breeding of spice crops
6. IPR issues, protection of plant varieties and farmers rights act.
7. Breeding methods in Tea
8. Coffee
9. Cashew
10. Cocoa
11. Coconut

12. Rubber
13. Arecanut
14. Palmyrah
15. Betelvine
16. Oil palm
17. Mid- semester examination
18. Black pepper
19. Cardamom
20. Ginger
21. Turmeric
22. Fenugreek
23. Coriander
24. Fennel
25. Cumin
26. Cinnamon
27. Clove
28. All spice
29. Ajowan
30. Dill, Celery
31. Tamarind,
32. Garcinia
33. Saffron,
34. Vanilla

Practical schedule

1. Scoring techniques for genomic status in coffee and tea.
2. Study of blossom biology in Coffee and tea.
3. Study of blossom biology in Cashew and Cocoa
4. Study of blossom biology in Coconut and arecanut
5. Study of blossom biology in Rubber, palmyrah and Oil palm.
6. Study of floral biology, anthesis in Black pepper, cardamom, ginger and turmeric.
7. Study of floral biology, anthesis in fenugreek, coriander, fennel and nutmeg.
8. Study of floral biology, anthesis in cinnamon, clove and celery.
9. Practices in in-vitro approaches in improvement of plantation crops.
10. Practices in in-vitro approaches in improvement of spice crops.
11. Estimation of pollen output, viability and germinability in plantation crops.
12. Estimation of pollen output, viability and germinability in spice crops
13. Practices in hybridization of fenugreek, coriander.
14. Screening techniques for resistance against abiotic stress -salt and drought tolerance in possible plantation crops.
15. Screening techniques for resistance against abiotic stress -salt and drought tolerance in possible spice crops.

16. Visit to research institutes working on important plantation crops and studying breeding programmes.
17. Visit to research institutes working on important spice crops and studying breeding programmes.

Reference books

1. Arya, P.S. 2003. Spice crops of India. Kalyani Publishers, New Delhi.
2. Chadha, K.L., P.N. Ravindran. and L. Sahijram. 2000. Biotechnology in Horticulture and Plantation Crops. Malhotra Publ., India.
3. Nybe, E.V., N. Miniraj. and K.V. Peter. 2007. Spices New India. Publishers Agency, New Delhi.
4. Peter, K.V. 2001. Hand book of herbs and spices Vol I-II Wood Head Publishers Co, USA
5. Peter, K.V. and Z. Abraham (Eds). 2007. Biodiversity in horticultural crops. Vol.1 Daya publishers, New Delhi.
6. Peter, K.V. (Ed). 2010. Biodiversity in Horticultural crops . Vol.3 Daya publishers, New Delhi.
7. Ramawat, K.G. and J.M. Merillon. 2003. Biotechnology secondary metabolites. Oxford and IBH., new Delhi.
8. Shanmugavelu, K.G., N. Kumar. and K.V. Peter. 2002. Production technology of spices and plantation crops. Agrobios, Jodhpur

PSM 612 BREEDING OF MEDICINAL AND AROMATIC CROPS (2+1)

Objectives

To impart comprehensive knowledge about the principles and practices of breeding of plantation crops and spices.

Theory

Unit I Scope and importance

Plant bio-diversity- conservation of germplasm- IPR issues- major objectives of breeding of medicinal and aromatic crops- scope for introduction- cytogenetic background of important medicinal and aromatic crops- scope for improvement of medicinal and aromatic crops -through selection- intra and interspecific hybridization- induced autotetraploidy- mutation breeding and biotechnological approaches.

Unit II Breeding techniques

Breeding for yield and quality improvement in medicinal plants- breeding for high herbage yield- essential oil and quality components- secondary metabolites in medicinal and aromatic crops; genetics of active principles and assay techniques useful in evaluation of breeder's material. breeding problems in seed and vegetatively propagated medicinal and aromatic crops.

Unit III Achievements and prospects in breeding of medicinal crops

Achievements and prospects in breeding of medicinal crops- viz. senna madagascar- periwinkle- glory lily- coleus forskohlii- stevia- ashwagandha- poppy- isabgol- dioscorea.

Unit IV Breeding of medicinal crops

Prospects in breeding of medicinal crops- viz. chlorophytum sp- rauwolfia serpentina- aloe vera- ocimum sp- phyllanthus amarus- solanum sp.

Unit V Breeding of aromatic crops

Prospects in breeding of aromatic crops viz.- geranium- vetiver- lemon grass- palmarosa- citronella- rosemary- patchouli- eucalyptus- artemisia and mint.

Practical

Characterization and evaluation of germplasm accession- blossom biology- studies on pollen behaviour- practices in hybridization- ploidy breeding- mutation breeding- evaluation of biometrical traits and quality traits- screening for biotic and abiotic stresses of medicinal and aromatic crops- identification and familiarization of spices; selfing and crossing techniques and description of varieties- high alkaloid- and high essential oil mutants- evolution of mutants through physical and chemical mutagens in medicinal and aromatic crops.

Lecture schedule

1. Methods of breeding for medicinal plants
2. Methods of breeding for aromatic plants
3. Biotechnological approaches in breeding of medicinal plants and aromatic plants
4. Biodiversity and germplasm conservation
5. IPR issues and PPVFR
6. Ashwagandha
7. Aloe vera
8. Senna
9. Sarpagandha
10. Glory lily
11. Coleus
12. Dioscorea
13. Ocimum
14. Periwinkle
15. Solanum
16. Gymnema
17. Mid-semester examination
18. Geranium
19. Medicinal yam
20. Poppy
21. Stevia
22. Kalmegh
23. Isabgol
24. Phyllanthus, safed musli
25. Palmarosa
26. Lemongrass
27. Citronella
28. Mentha
29. Ocimum
30. Rosemary
31. Thyme
32. Patchouli, Eucalyptus
33. Lavender, Marjoram
34. Oreganum, Artemisia.

Practical schedule

1. Study of floral biology, anthesis and pollination mechanisms in medicinal crops.
2. Study of floral biology, anthesis and pollination mechanisms in aromatic crops.
3. Characterization, evaluation and screening of germplasm accessions in medicinal crops.
4. Characterization, evaluation and screening of germplasm accessions in aromatic crops.
5. Hybridization techniques in medicinal crops.
6. Hybridization techniques in aromatic crops.
7. Mutation breeding in medicinal crops.
8. Mutation breeding in aromatic crops.
9. Polyploidy breeding in medicinal crops.
10. polyploidy breeding in aromatic crops.
11. Practices in in-vitro approaches in improvement of medicinal crops.
12. Practices in in-vitro approaches in improvement of aromatic crops.
13. Identification and description of high alkaloid and essential oils.
14. Visit to radiation laboratory.
15. - 16. Visit to commercial oil extraction units.
17. Visit to National institutes.

Reference books

1. Farooqi, A.A., M.M. Khan and M. Vasundhara. 2001 Production technology of medicinal and aromatic crops. Natural remedies Pvt.ltd
2. Jain, S.K. 2000. Medicinal plants. National Book Trust, India.
3. Prajapati, N.D., S.S. Pacro Hit, A.K. Sharma, T. Kumar. 2006. A Hand book of medicinal plants Agrobios (India)
4. Farooqi, A.A. and B.S. Sriramu. 2000. Cultivation practices for medicinal and aromatic crops, University Press, Hyderabad.
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PSM 613 PRODUCTION TECHNOLOGY OF PLANTATION CROPS (2+1)**Objectives**

To impart basic knowledge about the importance and production technology of plantation crops grown in India.

Theory

Role of plantation crops in national economy- export potential- IPR issues- classification and varietal wealth- plant multiplication including *in vitro* multiplication- systems of cultivation- multitier cropping- photosynthetic

efficiencies of crops at different tiers- rainfall- humidity- temperature- light and soil PH on crop growth and productivity- high density planting- nutritional requirements- physiological disorders- role of growth regulators - macro and micro nutrients- water requirement- fertigation- moisture conservation- shade regulation- weed management- training and pruning- crop regulation - maturity indices- harvesting- post harvest practices- cost benefit analysis- management of drought- precision farming of the following crops.

Unit I Production technology of plantation crops -I

Tea and coffee

Unit II Production technology of plantation crops –II

Rubber and cashew

Unit III Production technology of plantation crops- III

Coconut and arecanut

Unit IV Production technology of plantation crops- IV

Palmyrah- oil palm and cocoa

Unit V Production technology of plantation crops -V

Wattle and betel vine

Practical

Description of botanical and varietal features of plantation crops- selection of mother palms and seedlings in coconut and arecanut- processing and value addition of plantation crops- visit to plantation industries and commodity boards.

Lecture schedule

1. Role of plantation crops in national economy, export potential and imports, area and production.
2. IPR issues in plantation crops.
Varietal status, eco physiological requirements, recent trends in plant multiplication, planting and high density planting, cropping systems, irrigation and fertigation, role of major and minor nutrients, nutrient management, growth regulators and shade regulation, training and pruning, weed management, soil and moisture conservation, major biotic stresses and their management, harvesting, curing, processing, grading, packing, storage and value addition of the following crops:
3. - 6. Tea
:
7. - 10. Coffee
:
11. - 13. Rubber
:
14. - 16. Cashew
:
17. Mid semester examination
18. - 21. Coconut
:
21. - 24. Arecanut
:
25. - 26. Palmyrah
:
27. - 28. Oil palm
:
29. - 30. Cocoa
:
31. Wattle
32. Betel vine
33. Role of commodity boards and developmental institutions in plantation crops.

Practical schedule

1. Description of botanical and varietal features of tea.
2. Description of botanical and varietal features of coffee.
3. Processing of tea and coffee.
4. Description of botanical and varietal features of rubber.
5. Description of botanical and varietal features of cashew.
6. Processing of rubber and cashew.
7. Description of botanical and varietal features of coconut.
8. Selection of mother palms and seed nuts, quality nursery production in coconut.
9. Description of botanical and varietal features of arecanut.
10. Processing of arecanut.
11. Description of botanical and varietal features of palmyrah.
12. Description of botanical and varietal features of cocoa.
13. Processing of cocoa.
14. Description of botanical and varietal features of betel vine.
15. Description of botanical and varietal features of oil palm and wattle.
16. - 17. Visit to Commodity Boards and plantation industries.

Reference books

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2. Chopra, V.L. and K.V. Peter. 2005. Handbook of Industrial Crops. Haworth Food Products Press, New York.
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**HOR 621 GROWTH REGULATION AND STRESS MANAGEMENT IN
HORTICULTURAL CROPS (2+1)**

Objectives

To study the physiology of vegetative and reproductive growth in horticultural crops, to understand the growth regulation concepts in relation to productivity of crops and their environment and to study the physiological stresses in crop production and strategies to overcome them.

Theory**Unit I Concepts of crop growth analysis**

Growth and development: definition- parameters of growth and development- growth dynamics- morphogenesis - different stages of growth- growth curves:

sigmoid- polynomial and asymptotic - growth analysis in horticultural crops- CGR- RGR- NAR- LAI- LAR- HI in horticultural crops- canopy development- plant density and crop productivity - solar radiation concept and techniques for harvesting solar radiation for crop productivity.

Unit II Plant growth regulators

Plant growth regulators: auxins- gibberellins- cytokinins- ethylene- brassinosteroids- morphactins- inhibitors and retardants- bioassay- biosynthesis- translocation/movement- physiological role in cell level and their basic functions – mechanism of action of pgrs and theories - role of bio stimulants in crop growth and development - seaweed extract- humic acid- fulvic acid- chitosan and growth promoting microorganisms.

Unit III Developmental physiology of horticultural crops

Developmental physiology and biochemistry of seed germination- dormancy- bud break- methods of overcoming dormancy in horticultural crops - juvenility- vegetative to reproductive interphase and flowering - effect of light- photosynthesis- photoperiodism- vernalisation- temperature- heat units and thermoperiodism on developmental physiology - physiology of flowering : factors affecting flowering – floral induction theories/models: abc model- photoperiodism- vernalisation- florigen and anti-florigen concepts – stages of flowering: floral induction- initiation and organ primordial identification.

Unit IV Physiology of growth regulation in horticultural crops

Physiology of source and sink relationship- translocation of assimilates - physiological basis of training and pruning - physiology of fruit & seed development and maturation - physiological basis of unfruitfulness- fruit drop and fruit thinning - physiology of ripening - climacterics in ripening - post harvest physiology of horticultural crops - physiology of tuber and bulb formation – growth regulation for tuber and bulb yield.

Unit V Physiology of senescence and stress management in Horticultural crops

Senescence: Physiology- biochemistry- molecular and genetic approaches in plant senescence - longevity of leaves in perennial and annual crops - stress physiology concepts: stress and strain terminology- eustress- distress- stress tolerance- resistance- avoidance - stress responses of plants: cellular and molecular level- causes- effects and methods of overcoming stress - heat- low temperature- water deficit- flooding and salinity stresses.

Practical

Mechanism of dormancy- stratification -PGR experiments on seeds- tubers and bulbs -visit to arid- subtropical and temperate horticultural zones to identify growth, development patterns and growth analysis and to evaluate photosynthetic efficiency under different environments - experiment on growth regulator functions- hormone assays and ripening phenomenon in horticultural crops - experiment on impact of physical and chemical manipulations on growth and development of horticultural crops - growing of plants in sand culture under salt stress for biochemical and physiological studies - experiment on effect of osmotic and ionic stress on seed germination and seedling growth-measurement of low/high temperature injury under field conditions.

Lecture schedule

1. Growth and development: definitions and parameters of growth and development.
2. Principles of growth dynamics and morphogenesis.
3. Growth curves:stages and different pattern of growth curves of horticultural crops.
4. Growth analysis in horticultural crops (CGR, RGR, NAR, LAI, LAR, HI in horticultural crops).
5. Canopy development and plant density with respect to crop productivity.
6. Solar radiation concept and techniques for harvesting solar radiation for crop productivity.
7. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of auxin.
8. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of gibberellins.
9. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of cytokinins.
10. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of ethylene.
11. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of brassinosteroids and morphactins
12. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of inhibitors and retardants
13. Role of bio stimulants in crop growth and development: seaweed extract, humic acid, fulvic acid, chitosan and growth promoting microorganisms.
14. Physiology and biochemistry of seed germination
15. Physiology and biochemistry of dormancy : seed and bud dormancy
16. Physiology of bud breaking and methods of overcoming dormancy in horticultural crops
17. Mid -semester examination.
18. Effect of light, photosynthesis and photoperiodism on developmental physiology.
19. Effect of vernalisation, temperature, heat units and thermoperiodism on developmental physiology.
20. Physiology of flowering : factors affecting flowering and different stages of flowering
21. Physiology of flowering: floral induction theories/models: ABC model, photoperiodism and vernalisation.
22. Physiology of flowering : florigen and anti-florigen concepts with special reference to horticultural crops.
23. Source and sink relationship and concepts (carbon partitioning, sucrose synthesis, phloem loading and transportation).
24. Physiological and biochemical basis of training and pruning.

25. Physiology of fruit set and development with a special reference to chemical regulation of fruit set.
26. Physiological basis of unfruitfulness, fruit drop and fruit thinning
27. Physiological and biochemical basis of ripening and post harvest physiology of horticultural crops
28. Physiological and biochemical basis of tuber and bulb formation with special reference to growth regulation for tuber and bulb yield.
29. Physiological and biochemical basis of senescence with special reference to molecular and genetic approaches in plant senescence
30. Concepts of stress physiology: stress, eustress, distress, stress tolerance, resistance, avoidance
31. Stress responses of plants at cellular and molecular level.
32. Causes, effects and methods of overcoming heat and low temperature stress.
33. Causes, effects and methods of overcoming water deficit and flooding stress.
34. Causes, effects and methods of overcoming salinity stress.

Practical schedule

1. Estimation of growth parameters for analyzing the growth - estimation of leaf area index.
2. Estimation of growth parameters for analyzing the growth – DMP and growth rates.
3. Evaluation of photosynthetic efficiency of horticultural crops under different environments.
4. Visit to Arid, Subtropical and Temperate horticultural zones to identify growth and development pattern of different horticultural crops.
5. Studies on mechanism breaking of dormancy by stratification in seeds.
6. PGR experiments on seeds, tubers and bulbs breaking of dormancy.
7. Hormone assays (Auxin)
8. Experiments on growth regulator functions - rooting of cuttings and herbicidal effect.
9. Experiments on growth regulator functions - fruit ripening in climacteric and non-climacteric fruits.
10. Experiments on growth regulator functions – senescence.
11. Experiments on growth regulation by pruning, pinching, defoliation and disbudding in horticultural crops .
12. Experiments on growth regulator functions – fruit thinning, overcoming fruit drop and unfruitfulness.
13. Experiments on growth regulator functions – post harvest losses in horticultural crops and post harvest treatments for shelf life.
14. Growing of plants in sand culture to study the effect of drought stress.
15. Growing of plants in artificially salinized soil in pots to study the effect of salt stress.
16. Effect of osmotic and ionic stress on seed germination and seedling growth
17. Estimation of proline content in stress and normal condition in crops.

Reference books

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2. Leopold, A.C. and P.E. Kriedermann. 1985. Plant Growth and Development. 3rd Ed. Mc Graw-Hill, New York
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4. Roberto L. Benech-Arnold, A. Rodolfo. 2014. Handbook of seed physiology : Applications to Agriculture, CRC press, Boca Raton
5. Roberts, J., S. Downs. and P. Parker. 2002. Plant Growth and Development in Plants. (I. Ridge, Ed.), Oxford University Press.UK
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PSM 621 PRODUCTION TECHNOLOGY OF MEDICINAL AND AROMATIC CROPS (2+1)

Objectives

To impart comprehensive knowledge about the production technology of medicinal and aromatic crops.

Theory

Herbal industry- WTO scenario- export and import status- Indian systems of Medicine- indigenous traditional knowledge- IPR issues- classification of medicinal crops- systems of cultivation- role of institutions and NGO's in production- gap in medicinal crop production- production technology- organic practices- post harvest handling- drying- processing- grading- packing and storage- processing and value addition quality standards in herbal products- phytochemical extraction techniques- aromatic industry- WTO scenario- export and import status- indian perfumery industry- production technology- post-harvest handling- distillation methods- advanced methods- solvent extraction process- quality analysis- value addition- institutional support and international promotion of essential oil and perfumery products.

Unit I Production technology of medicinal plants -I

Senna- coleus- ashwagandha- glory lily- sarpagandha

Unit II Production technology of medicinal plants -II

Dioscorea sp. *Aloe vera*- Phyllanthus- kalmegh- medicinal solanum- gymnema

Unit III Production technology of aromatic crops- I

Isabgol- ipecac- periwinkle- poppy- safed musli- stevia

Unit IV Production technology of aromatic crops -II

Palmarosa- lemon grass- citronella- vetiver- geranium- mentha- artemisia

Unit V Production technology of aromatic crops -III

Ocimum- eucalyptus- rosemary- thyme- patchouli- lavender- marjoram- origanum.

Practical

Botanical description- propagation techniques- maturity standards- extraction of secondary metabolites- project preparation for commercially important medicinal crops- visit to medicinal crop fields- visit to herbal extraction units- extraction of essential oils- project preparation for commercially important aromatic crops- visit to distillation and value addition units.

Lecture schedule

1. Herbal industry, WTO scenario, export and import status.
2. Indian system of medicine, indigenous traditional knowledge of medicinal plants.
3. Classification of medicinal plants and systems of cultivation.
4. Climate and soil requirements, varieties-site selection, season and method of propagation, pre sowing treatment, irrigation and nutrient management, intercultural operations, plant protection measures, maturity indices-harvesting and post harvest management of the following crops:
5. Senna
6. Coleus
7. Ashwagandha
8. Glory lily
9. Sarpagandha
10. Dioscorea and Aloe vera
11. Phyllanthus and kalmegh
12. Gymnema
13. Medicinal solanum and ipecac
14. Isabgol and safedmusli
15. Poppy
16. Periwinkle and stevia
17. Phytochemical extraction techniques
18. Mid -semester examination
19. Aromatic industry-WTO scenario- export and import status
20. Indian perfumery industry- history-advancements in perfume industry
21. Palmarosa and lemongrass
22. Citronella and vetiver
23. Geranium and artemisia
24. Mint
25. Ocimum
26. Patchouli
27. Rosemary and thyme
28. Origanum and marjoram
29. Lavender and eucalyptus
30. Organic production of medicinal and aromatic crops
31. IPR issues for medicinal and aromatic crops
32. Role of institutions and NGO's in production and regulation for herbal raw materials
33. Distillation methods, advanced methods-solvent extraction process
34. Perfumes from non-traditional plants.
35. Quality analysis, value addition, aroma chemicals, quality standards and regulation.

Practical schedule

Botanical description of species - improved cultivars - propagation techniques
 - maturity standards - harvest and post harvest handling of the following crops:

1. Senna and coleus
2. Aloe vera and ashwagandha

3. Gymnema, sarpagandha and poppy
4. Phyllanthus, kalmegh and ipecac
5. Medicinal solanum, safedmusli and dioscorea
6. Periwinkle, isabgol and stevia
7. Aromatic grasses
8. Geranium and mint
9. Ocimum and patchouli
10. Vettiver and eucalyptus
11. Rosemary, thyme, oreganum and marjoram
12. Extraction of secondary metabolites in medicinal crops
13. Extraction of essential oils from aromatic crops
14. Project preparation for commercially important medicinal and aromatic crops
15. Field visit to commercial medicinal plantations
16. Field visit to commercial aromatic plantations
17. Visit to herbal extraction units, distillation and value addition units

Reference books

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2. Farooqi, A. A. and B.S.Sriramu. 2001. Cultivation Practices for Medicinal and Aromatic Crops. University Press, Hyderabad.
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PSM 622 PRODUCTION TECHNOLOGY OF SPICE CROPS (2+1)

Objectives

To impart basic knowledge about the importance, their export, employment potential and production technology of spices grown in India. the various aspects *viz.*, diversification of spices- value addition and constraints in this industry in India are also covered.

Theory

Introduction- importance of spice crops-historical accent- present status - national and international- future prospects- botany and taxonomy- climatic and

soil requirements- commercial varieties/hybrids- site selection- layout- sowing/planting time and methods- seed rate and seed treatment- nutritional and irrigation requirements- intercropping- mixed cropping- intercultural operations- weed control- mulching- physiological disorders- harvesting- post harvest management- plant protection measures and seed planting material and micro-propagation- precision farming- organic resource management- organic certification- quality control- pharmaceutical significance and protected cultivation of:

Unit I Production technology of major spices- I

Black pepper, cardamom

Unit II Production technology of major spices -II

Turmeric, ginger and garlic

Unit III Production technology of tree spices

Clove, cinnamon, nutmeg and allspice

Unit IV Production technology of seed spices

Coriander, fenugreek, cumin, fennel, ajowain, dill and celery

Unit V Production technology of minor spice crops

Tamarind, garcinia, vanilla and herbal spices

Practical

Identification of seeds and plants- botanical description of plants preparation of herbarium- propagation- nursery raising- field layout and method of planting- cultural practices- harvesting- drying- storage- packaging and processing- value addition; short term experiments on spice crops.

Lecture schedule

1. History and classification of spices
2. Scope and importance, area, production, productivity, export potential of spices. Crop improvement, varieties, propagation and production technology of the following crops:
3. Black Pepper
4. Cardamom
5. Turmeric
6. Ginger
7. Garlic
8. Clove
9. Cinnamon
10. Nutmeg
11. All spice
12. Coriander
13. Fenugreek
14. Cumin
15. - 16. Fennel
17. Mid Semester Examination
18. Ajowain
19. Dill
20. - 22. Celery

23. - 25. Tamarind
26. Garcinia
27. Vanilla
28. Herbal spices
29. Organic spice production
30. - 31. Precision farming practices in spice.
32. - 33. Role of commodity boards in spice development.
34. Good Agricultural Practices for spice production

Practical schedule

1. Description of related species and varieties of black pepper and cardamom
2. Propagation and rapid multiplication in pepper and cardamom
3. Processing of pepper and cardamom
4. Description of related species and varieties of turmeric and ginger
5. Processing of turmeric and ginger
6. Description of related species and varieties of garlic
7. Description of related species and varieties of tree spices
8. Nursery techniques in tree spices
9. Description of related species and varieties of seed spices
10. Nursery techniques in seed spices
11. Description of related species and varieties of tamarind, garcinia and vanilla
12. Description of related species and varieties of herbal spices
13. Protected cultivation of spices
14. Value addition in spices
15. Project preparation
16. Visit to spice gardens
17. Visit to commodity boards

Reference books

1. Agarwal, S., E.V.D. Sastry. and R.K. Sharma. 2001. Seed Spices: Production, Quality, Export. Pointer Publ, Jaipur
2. Arya, P. S. 2000. Spice Crops of India. Kalyani Publishers, New Delhi.
3. Chadha, K. L. and P. Rethinam (Eds.). 1993. Advances in Horticulture. Vols. IX-X. Plantation Crops and Spices. Malhotra Publ. House, New Delhi
4. Gupta, S. (Ed.). Hand Book of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.
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9. Shanmugavelu, K.G., N. Kumar. and K. Peter. 2002. Production Technology of Spices and Plantation Crops. Agrobios, Jodhpur.
10. Tiwari, R.S. and A. Agarwal. 2004. Production Technology of Spices. International Book Distr. Co, New Delhi.

PSM 623 ORGANIC CULTIVATION OF SPICES AND PLANTATION CROPS (1+1)

Objectives

To educate principles, concepts and production of organic farming in spice and plantation crops.

Theory

Unit I Concepts in organic cultivation

Importance- principles- perspective- concept and components of organic production of spice and plantation crops.

Unit II Organic production of spice and plantation

Organic production of spice crops and plantation crops- viz. pepper-cardamom- turmeric- ginger- cumin- vanilla- coconut- coffee- cocoa- tea- arecanut.

Unit III Management strategies of organic fields -I

Managing soil fertility status - pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.

Unit IV Management strategies of organic fields -II

Methods for enhancing soil fertility- mulching- raising green manure crops. Indigenous methods of compost panchakavya- biodynamics- pest and disease management in organic farming. Role of botanicals and bio-control agents.

Unit V Handling of organic products

GAP and GMP- Certification of organic products; organic production and export - opportunity and challenges.

Lecture schedule

Principles

1. Organic farming principles
2. Managing of soil fertility
3. Concepts of organic farming
4. Pepper, Cardamom
5. Turmeric, Ginger
6. Cumin, Vanilla
7. Coconut, Coffee
8. Cocoa, Tea
9. Arecanut
10. Mid-semester examination
11. Processing and quality control for organic foods.
12. Methods of enhancing soil fertility
13. Different mulching techniques and raising green manure crops
14. Panchagavya, Bio-dynamic preparations.
15. Pest and disease management in organic farming
16. Role of botanical and bio –control agent
17. GAP and GMP certification of organic products
18. Production and export details in organic products.

Practical

Method of preparation of compost, vermicomposting, biofertilizers, soil solarization, bio pesticides in horticulture, green manuring, mycorrhizae and organic crop production, waste management, organic soil amendment for root disease, weed management in organic horticulture- visit to organic fields and marketing centers.

Practical Schedule

1. Soil physical parameters with relevance to organic horticulture.
2. Estimates on soil chemical parameters (pH, EC and ESP).
3. Nursery bed solarization for spices and plantation crops.
4. Agro techniques for composting farm wastes and agro industrial wastes.
5. Recycling of crop wastes through vermiculture.
6. Preparation of panchakavya, humic acid and sea weed extract.
7. Preparation of activated EM solution, Munchurian mushroom tea and vermiwash .
8. Application of various mulch materials to horticultural crops.
9. Study of bio agents for crop protection.
10. Preparation of organic formulations for pest control.
11. Preparation of organic formulations for disease control.
12. Organic certification, standards and agencies
13. Working out indices for organic horticulture.
14. Economic evaluation of organic horticulture system.
15. Visit to farmers field under organic cultivation.

Reference books

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2. Gehlot, G. 2005. Organic Farming: Standards, Accreditation, Certification and Inspection. Agrobios.
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PSM 624 UNDER EXPLOITED MEDICINAL AND AROMATIC CROPS (1+1)**Objectives**

To facilitate understanding on the importance- conservation and cultivation of medicinal and aromatic crops.

Theory**Unit I Introduction and importance of less known medicinal and aromatic crops**

Introduction- importance- present status and future prospects- origin-distribution- species- varieties- economic parts and their uses in different diseases- biodiversity and conservation- RET (Rare- Endangered and Threatened) and MPCAs (Medicinal Plants Conservation Areas).

Unit II Utility status of less known medicinal and aromatic crops

Underutilized species – importance- traditional usage- ISM- TCM- Functional foods.

Unit III Production technology of underutilized aromatic crops

Production technology of underutilized medicinal crops– noni sappamgu- kallimudayan- terminalia chebula- bilawal poison nut- thoodhuvalai- physalis- bael- thai galangal- cadamba- costus.

Unit IV Processing and value addition

Production technology of underutilized aromatic crops Curcuma aromatica- Coleus aromaticus- Ocimum - Kilimandscharicum- Bursera.

Unit V National and international conservation network

IPR issues- Promotion of under utilized species- Processing and value addition- marketing.

Lecture schedule

1. Types and methods of biodiversity and conservation of medicinal plants.
2. RET (Rare, Endangered and Threatened) and MPCAS (Medicinal plants conservation areas).
3. Under utilized species – importance, traditional usage, ISM, TCM, functional foods.
4. - 8. Production technology of medicinal crops
9. Mid semester examination
10. *Morinda citrifolia*, *Caesal pinia sappan* and *Terminalia chebula*
11. *Strychnos nuxvomica*, *Solanum trilobatum*, *Physalis*, *Aegle marmelos* and *Alpinia* sp.,
12. *Anthocephalus* Cadamba, *Costus*.
13. Production technology of aromatic crops-*Curcuma aromatic* and *C. caesia*, *Coleus aromaticus*, *Ocimum Kilimandscharicum*,
14. *Bursera*
15. National and International conservation network
16. Intellectual property rights issues
17. Processing and value addition, marketing in spices crops.

Practical

Collection of endangered plant species - establishment of endangered plant species - alkaloid estimation - essential oil extraction methods - visit to related industries - value added spice product- harvesting and packaging techniques for minimal loss in medicinal crops - harvesting and packaging techniques for minimal loss in aromatic crops - harvesting and packaging techniques for minimal loss in spices crops.

Practical schedule

1. Collection of endangered plant species
2. Establishment of endangered plant species
3. - 7. Alkaloid estimation
8. Essential oil extraction methods
9. - 11. Visit to related industries

12. - 14. Harvesting and packaging techniques for minimal loss in medicinal crops.
15. - 17. Harvesting and packaging techniques for minimal loss in aromatic crops.

Reference books

1. Atal, C.K and B.M. Kapur, 1982. Cultivation and Utilization of Medicinal Plants. RRL, CSIR, Jammu.
2. Chadha, K.L. and R. Gupta. 1995. Advance in Horticulture. Vol. XI. Medicinal & Aromatic Plants. Malhotra Publ. House, India.
3. Farooqui, A. A., M.M. Khan. and B.S. Sreeramu. 1997. Cultivation of Medicinal and Aromatic Crops in India. NayaProkash.
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PSM 625 PROCESSING OF PLANTATION, SPICE, MEDICINAL AND AROMATIC CROPS (2+1)

Objectives

To facilitate deeper understanding on principles and practices of post harvest technology of plantation crops- spices- medicinal and aromatic crops.

Theory

Unit I Commercial uses of spices and plantation crops

Commercial uses of spices and plantation crops. processing of major spices - cardamom- black pepper- ginger- turmeric- chilli and paprika- vanilla- cinnamon- clove- nutmeg- allspice- coriander- fenugreek- curry leaf. extraction of oleoresin and essential oils.

Unit II Processing of plantation crops

Processing of produce from plantation crops- viz. coconut- arecanut- cashewnut- oil palm- palmyrah- date palm- cocoa- tea- coffee- rubber .

Unit III Processing of medicinal plants

Processing of medicinal plants- dioscorea- gloriosa- stevia- coleus - ashwagandha- tulsi- isabgol- safed musli- senna- aloe- catharanthus. different methods of drying and storage. microbial contamination of stored product. influence of temperature and time combination on active principles.

Unit IV Extraction and analysis of active principles

Extraction and analysis of active principles using TLC / HPCL / GC. distillation- solvent extraction from aromatic plants- davana- mint- rosemary- rose- citronella- lavender- jasmine.

Unit V Processing technology II

Study of aroma compounds and value addition. Nano-processing technology in medicinal and aromatic plants.

Lecture schedule

Commercial uses of spices and plantation crops – extraction of oleoresin and essential oils – different methods of drying and storage – microbial contamination of stored product – extraction and analysis of active principles using TLC / HPLC/ extraction /GC – Distillation- solvent from spice crops.

1. Processing of produce from spice crops
2. Processing of produce from plantation crops
3. Processing of produce from medicinal crops
4. Cardamom
5. Black pepper
6. Ginger
7. Turmeric, Chilli and Paprika
8. Vanilla, Cinnamon, Clove, Nutmeg and Allspice
9. Coriander, Fenugreek and Curry leaf
10. Coconut
11. Arecanut
12. Cashewnut
13. Oil palm, Palmyrah
14. Date palm, cocoa, Tea, Coffee and Rubber
15. Dioscorea
16. Gloriosa
17. Mid semester examination
18. Stevia
19. Coleus, Ashwagandha
20. Tulsi, Isabgol
21. Safed musli Senna
22. Aloe, Catharanthus
23. Distillation and solvent extraction from aromatic plants
24. Davana
25. Mint
26. Rosemary
27. Rose
28. Citronella
29. Lavender
30. Jasmine
31. - 32. Study of aroma compounds and value addition
33. - 34. Nano – processing technology in medicinal and aromatic plants.

Practical

Study of processing of different spices and plantation crops. study of processing of medicinal plants- their drying and storage. extraction of active ingredients from different spices and herbs using tlc- hplc- gc/cg-ms technology. distillation- solvent extraction from aromatic plants – davana- mint- rosemary- citronella- lavender- jasmine- etc. identification of different odoriferous

factors in essential oil with glc/gcms. physico-chemical and sensory evaluation of oils and oleoresin. value added products from spices and plantation crops.

Practical schedule

1. Harvesting procedure and stages of harvesting spice crops.
2. Different processing technology in spice crops.
3. Preparation of value added products from spice crops.
4. Harvesting procedure and stages of harvesting plantation crops.
5. Different processing technology in plantation crops.
6. Preparation of value added products from plantation crops.
7. Harvesting procedure and stages of harvesting medicinal crops.
8. Different processing technology in medicinal crops.
9. Harvesting procedure and stages of harvesting aromatic crops.
10. Distillation and solvent extraction of essential oils from aromatic plants.
11. Identification of different odoriferous factors in essential oils.
12. Extraction of alkaloids from medicinal crops.
13. Sensory evaluation of oils and oleo oleoresins.
14. Study of food standards. National and International standards.
15. Visit to processing units to study the layout, equipments, hygiene, sanitation and residual / waste management.
16. - 17. Project preparation to establish processing industry.

Reference books

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OPC- HOR 711 PROPAGATION AND NURSERY MANAGEMENT OF HORTICULTURAL CROPS (2+1)

Objectives

This course deals with different methods of plant propagation and strategies for nursery management of various fruit crops. Knowledge of tools and implements is essential to carry out all scientific horticultural operations and also nursery management practices. The above themes are discussed elaborately in this course and the basic knowledge gained will be useful for the career development of students in commercial nursery business.

Theory

Unit I Principles of plant propagation

Sexual and asexual methods of propagation - principles and factors influencing seed germination-dormancy- hormonal regulation of germination and seedling growth- seed quality- packing- storage- certification and testing.

Unit II Anatomical and physiological aspects of plant propagation

Techniques of cottage - layerage- graftage and budding- compatibility-dwarfing rootstocks of important fruit trees.

Unit III Plant growth regulators and plant tissue culture

Role of PGR'S in plant propagation- role of nucellar embryony- apomixes-tissue culture techniques- hardening techniques .

Unit IV Planning of a nursery unit and modern propagation structures

Raising of nursery plants- selection- certification maintenance of mother plants and bud wood and root stock nurseries- use of modern structures- mist chambers- low cost poly houses- tunnel houses.

Unit V Marketing methods of nursery plants and economics

Media/soil mixtures- containers- use of machinaries- lifting- packing-transport- marketing- economics of raising nursery and management in different fruit crops.

Practical

Media/soil mixture- containers and soil sterilisation- use of chemicals for seed treatment and sowing- preparation of nursery beds- polybags- seedpans- thumb rule for raising seedlings- stratification and scarification of seeds and use of tetrazolium salts for germination tests-identification of nucellar seedlings- practice of different asexual methods of propagation- viz.-cottage- layering- budding-approach- veneer and softwood grafting-use of plant growth regulators in propagation of plants -use of mist chambers- modern propagation structures- low cost polyhouses- low tunnels and bottom heating techniques- selection- lifting-packing- transportation and marketing of nursery plants- economics of raising nurseries- visit to local commercial/private nurseries.

Lecture schedule

1. Scope and importance of plant propagation.
2. Study of sexual and asexual methods of propagation.
3. Advantages and disadvantages of seed and vegetative propagation.
4. Factors influencing seed germination of Horticultural crops.

5. Studies on dormancy, hormonal regulation of germination and seedling growth.
6. Study of seed quality, packing, storage, certification and testing.
7. Study of anatomical and physiological aspects of asexual propagation.
8. Studies on graft compatibility on fruit crops.
9. Dwarfing rootstocks of commercial importance in fruit crops.
10. Role of PGR's in raising seedlings and rooting of cuttings and layers.
11. Role of nucellar embryony and apomixis.
12. Studies on tissue culture techniques.
13. Micro grafting (STG).
14. Techniques of cuttings and layering.
15. Techniques of budding and grafting.
16. Planning of nursery unit.
17. Mid-semester examination
18. Study of raising of nursery plants and their after care- role of protray nursery and their after care.
19. Study of modern propagation structures.
20. Role of mist chambers in plant propagation.
21. Study of bottom heating techniques.
22. Hardening techniques in nursery.
23. Progeny orchard and scion bank.
24. Establishment of bud wood bank.
25. Media -soil mixture preparation for nursery plants.
26. Study of containers used for nursery.
27. Use of machineries in nurseries.
28. Soil sterilization techniques.
29. Irrigation systems in nursery plants.
30. Lifting and packing of nursery plants.
31. Transportation and marketing of nursery plants.
32. Nursery planning and layout .
33. Economics of raising nursery and management of different fruit crops.
34. Nursery acts.

Practical schedule

1. Media/soil mixture, containers and soil sterilization.
2. Use of chemicals for seed treatment and sowing.
3. Preparation of nursery beds, polybags, seedpans, thumbrule for raising seedlings.
4. Stratification and scarification of seeds and use of tetrazolium salts for germination.
5. Identification of nucellar seedlings.
6. Practice of different asexual methods of propagation, viz.,cuttage, layering.
7. Buddingmethods.
8. Grafting- methods.
9. Use of plant growth regulators in propagation.

10. Role of mist chambers in plant propagation.
11. Other protected structures uses for plant propagation.
12. Low cost polyhouses, low tunnels.
13. Bottom heating techniques and soil sterilization.
14. Selection, lifting, packing of nursery plants.
15. Transportation and marketing of nursery plants.
16. Economics of raising nurseries.
17. Visit to local commercial/private nurseries.

Reference books

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5. Prasad, S. and V. Kumar. 1999. Green House Management of Horticultural Crops, AgroBios India, Jodhpur.
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OPC-PSM 712 GENETIC RESOURCES AND CONSERVATION OF MEDICINAL AND AROMATIC PLANTS (2+1)

Objectives

Understanding the principles of biodiversity- strategies in conservation and utilization of medicinal and aromatic plants- Biodiversity and learning about under exploited medicinal and aromatic plants in India.

Theory

Unit I Importance of biodiversity and methods of conservation

Biodiversity & conservation- issues and goals- centres of origin of cultivated medicinal and aromatic plants- primary and secondary centres of genetic diversity- present status of gene centers- exploration and collection of germplasm- conservation of genetic resources *in-situ* & *ex-situ* germplasm conservation problem of recalcitrant seeds cold storage of scions- tissue culture cryopreservation- pollen and seed storage inventory of germplasm.

Unit II Role of National institutes in conservation of plant quarantine

Introduction of germplasm- plant quarantine- role of knowledge, role of national institutes is conservation- TBGRI- NBPGR. intellectual property rights- regulatory horticulture- plant variety protection authority- maintenance of core group using rational knowledge for plant conservation.

Unit III Bio diversity of medicinal plants -I

Senna- coleus- ashwagandha- glory lily- sarpagandha- dioscorea sp. aloevera- phyllanthus

Unit IV Bio diversity of medicinal plants –II

Kalmegh- medicinal solanum- gymnema- isabgol- ipecac- periwinkle- poppy- safed musli- stevia

Unit V Aromatic plants

Palmarosa- lemongrass- citronella- vetiver- geranium- mentha- artemisia- ocimum- eucalyptus- rosemary- thyme- patchouli- lavender- marjoram- oreganum.

Practical

Documentation of germplasm maintenance of passport data and other records of accessions; field exploration trips- exercise on *ex situ* conservation; cold storage-pollen/seed storage- cryopreservation- visit to National Gene Bank and other centers of PGR activities.

Lecture schedule

1. Bio diversity – introduction- principles, goals and issues in conservation
2. Genetic diversity- occurrence and distribution
3. Exploration, collection, characterization, documentation and cataloging of germplasm
4. Present status of national and international gene banks
5. Role of national institutes in conservation-TBGRI, NBPGR.
6. Germplasm exchange, Material Transfer Agreement and current quarantine protocols
7. Methods for *ex situ* conservation of germplasm and *in situ* conservation of germplasm
8. Use of GIS and documentation of local biodiversity
9. Horticultural cropping system and implication on biodiversity
10. Impact of climate change on biodiversity
11. Advances and issues in conservation of biodiversity through recalcitrant and orthodox seeds
12. Advances and issues in conservation of biodiversity through vegetative propagation
13. Intellectual Property Rights, Plant Variety Protection Authority
14. Status of biodiversity of coffee
15. Status of biodiversity of tea, cashew
16. Status of biodiversity of cocoa, rubber, palmyrah, oil palm, coconut and arecanut.
17. Mid-semester examination
18. Status of biodiversity of black pepper and cardamom
19. Status of biodiversity of ginger and turmeric
20. Status of biodiversity of coriander and fennel
21. Status of biodiversity of nutmeg and cinnamom
22. Status of biodiversity of Clove
23. Status of biodiversity of Aloe vera
24. Status of biodiversity of *Coleus forskohlii* and *Dioscorea sp.*
25. Status of biodiversity of *Ocimum* and *Phyllanthus amarus*
26. Status of biodiversity of Geranium and Vetiver

27. Status of biodiversity of Lemon grass
28. Status of biodiversity of Palmrosa and Citronella
29. Status of biodiversity of Eucalyptus, Artemisia and Mint.
30. Under exploited minor fruit crops - present status and scope
31. - 34. Minor spices and Plantation crop - origin, distribution - biodiversity, propagation, conservation and utilization.

Practical schedule

1. Field exploration trips- exercise in collection and characterization
2. Visit to field germplasm unit and documentation of germplasm
3. Practices in maintenance of passport data
4. Practical study of *ex situ* conservation methods
5. Practical study of *in situ* conservation methods
6. Methods of seed storage for short and long term conservation
7. Methods of conservation using vegetative propagules
8. *In vitro* conservation protocols
9. Study of species diversity in horticultural cropping system
10. Visit to regional conservation centres
11. Visit to subtropical and temperate zone medicinal & aromatic crop fields
12. Characterization of coffee germplasm
13. Characterization of cardamom germplasm
14. Characterization of Ocimum. germplasm
15. Identification of minor plantation and spices crops and their description.
16. Use of molecular tools for characterizing species diversity
17. Estimating extent of diversity through collection and analysis of data

Reference books

1. Frankel, O.H. and J.G. Hawkes. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.UK.
2. Peter, K.V. and Z .Abraham (Eds) .2007. Biodiversity in Horticultural Crops.Vol.1 Daya Publishers, New Delhi.
3. Peter, K.V. (Ed).2008. Biodiversity in Horticultural Crops.Vol.2 Daya Publishers, New Delhi.
4. Peter, K.V. (Ed).2010. Biodiversity in Horticultural Crops.Vol.3 Daya Publishers, New Delhi.

**M.SC (AG.) AGRICULTURAL EXTENSION
DISTRIBUION OF COURSES**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	AEX 611	Advances in Communication and Extension Management	2+1
2.	AEX 612	Programme Planning, Diffusion and Adoption of Innovations	2+1
3.	AEX 613	Cyber Extension for Farm Technologies	2+1
4.	AEX 621	Methods and Designs in Behavioural Science Research	2+1
5.	AEX 622	Perspectives of Human Resource Management	2+1
6.	AEX 623	Entrepreneurship Development and Management	2+1
7.	AEX 624	Gender Sensitization and empowerment	2+0
TOTAL			14+6=20
Minor- 9 credits			
1.	OPC-AEC 621	Natural Resource and Environmental Economics	2+1
2.	OPC- AEX 711	Farm journalism	2+1
3.	OPC- AEX 712	Introduction to Visual Communication and Advertising Technologies	2+1
Total			6+3=9
Supporting courses- 5 credits			
1.	STA-612	Statistics for Social Sciences	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
Total			3+2=5
Seminar + Research - 21 credits			
1.	AEX -032	Seminar	0+1
2.	AEX -011; 021; 031;041	Research 011- 0+1 ; , 021- 0+2 ; , 031- 0+8 ; , 041- 0+9	0+20
Grand Total			22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Research Ethics	0 + 1
2	PGS 612	Technical writing and communication skills (English)	0 + 1
3	PGS 623	Laboratory Techniques for Audio and Video Production	0+1
4	PGS 624	Library and information services (Library Science)	0+1
5	PGS 715* e-course	Intellectual property and its management in Agriculture (Agrl.Economics)	1+0
6	PGS 716* e-course	Disaster management (Agronomy)	1+0
2 + 4=6			

**M.SC (AG.) AGRICULTURAL EXTENSION
SEMESTER WISE DISTRIBUTION**

S.No.	Course No.	Courses	Credit Hours
FIRST SEMESTER			
1.	AEX 611	Advances in Communication and Extension Management	2+1
2.	AEX 612	Programme Planning, Diffusion and Adoption of Innovations	2+1
3.	AEX 613	Cyber Extension for Farm Technologies	2+1
4.	STA 611	Statistics for Social Sciences	2+1
5.	COM 611	Computer Applications for Agrl. Research	1+1
6.	AEX 011	Research	0+1
7.	PGS 611	Research Ethics (0+1)	-
8.	PGS 612	Technical Writing and Communication Skills (0+1)	-
		Total	9+6=15
SECOND SEMESTER			
1.	AEX 621	Methods and Designs in Behavioural Science Research	2+1
2.	AEX 622	Perspectives of Human Resource Management	2+1
3.	AEX 623	Entrepreneurship Development and Management	2+1
4.	AEX 624	Gender Sensitization and empowerment	2+0
4.	OPC-AEC 621	Natural Resource and Environmental Economics	2 +1
5.	AEX -021	Research	0+2
6.	PGS 623	Laboratory Techniques for Audio and Video Production(0+1)	-
7.	PGS 624	Library and Information Services (0+1)	-
		Total	10+6=16
THIRD SEMESTER			
1.	OPC XXX 711	Minor Course - Related discipline	2+1
2.	OPC XXX 712	Minor Course - Related discipline	2+1
3.	AEX-031	Research	0+8
4.	AEX-032	Seminar	0+1
5.	PGS 715 e-course	Intellectual property and its management in agriculture (1+0)	-
6.	PGS 716 e-course	Disaster management (1+0)	-
		Total	4+11 =15
FOURTH SEMESTER			
1.	AEX 041	Research	0 + 9
		Total	0 + 9
		Grand Total	23+32 = 55

AEX 611 - ADVANCES IN COMMUNICATION AND EXTENSION MANAGEMENT (2 +1)**Objectives**

- To understand various advances in agricultural communication
- To analyze the different extension communication methods
- To develop skills for using ICT tools in extension communication
- To understand various management techniques in extension organization

Theory**Unit I – COMMUNICATION**

Communication – meaning - concept and definitions – characteristics, functions – types – elements – models and barriers in communication – credibility, fidelity, empathy and feedback in communication, agricultural communication – TOT, REC linkage, components, organizational communication - meaning and definition, characteristics, elements, models, need and importance– types of communication in organization –principles of communication - barriers to organizational communication.

Unit II - EXTENSION COMMUNICATION METHODS AND AUDIO VISUALS AIDS

Extension communication methods – meaning, types and classification. traditional media for communication in development programmes Radio, T.V and print media in communication. Audio visual aids – meaning and classification, selection, use and production, advances in audio – visual aids – LCD projector, interactive white board, multi-media projectors, digital photography and smart T.V.

Unit III – ICT IN EXTENSION

IT and ICT – concept, definition – unique features and need of ICT in agriculture Role and Scope of ICT in agricultural extension - Types of ICT tools – ICT for agriculture extension initiatives in India – National Policy on ICT in agricultural extension – success stories of ICT use in Rural India - barriers for agricultural extension initiatives – Technology Parks - Extension next – social media in agricultural extension.

Unit IV – MANAGEMENT IN EXTENSION ORGANIZATION

Concept and principles of administration and management, schools of management thought – interpersonal and interpersonal communication skills, virtual organization, - personnel management - national institute of agricultural extension and management (MANAGE), NIRD & PR, EEI and NAARM. corporate management in agriculture sector – POSDCORB functions of management – planning, organizing, staffing, directing and leading, controlling, coordinating, reporting and budgeting. case studies and success stories in agricultural extension management.

Unit V – EXTENSION MANAGEMENT PRACTICES AND TECHNIQUES

Management by objectives (MBO) – Total Quality Management (TQM), Project evaluation and review technique (PERT) – Critical Path Method (CPM) – Logical Frame working Analysis (LFA) – Project Management Techniques – Monitoring, evaluation and impact analysis of extension programmes - critical analysis of organizational set up of extension administration at various levels – Information Technology Parks – Management Information System – Management of Agricultural Knowledge Systems (MAKS).

Practical

Communication networks and communication methods followed in extension organization - communication pattern - business letters in corporate

communication - advances in photography - e-resources – power point presentation - video conferencing - research project in agribusiness management - time management - organizational climate - corporate management practices.

Lecture Schedule

1. Communication – meaning, concept, definitions, credibility, fidelity, empathy and feedback in communication, characteristics
2. Different types communication, elements
3. Models in communication and barriers in Communication
4. Agricultural communication – TOT, REC linkage, components
5. Organizational communication - meaning and definition, characteristics, elements
6. Need and importance, Types of communication in organization
7. Principles and barriers in organizational communication
8. Extension communication methods – meaning, types and classification
9. Traditional media, Radio, Television and Print media use in communication
10. Audio visual aids – meaning and classification, selection, use and production
11. Advances in audio visual aids – LCD projector, interactive white board
12. Multi-media projector, digital photography and smart TV
13. IT and ICT – concept, definition – unique features and need of ICT in agriculture
14. Role and Scope of ICT in agricultural extension - Types of ICT tools
15. ICT for agricultural extension initiatives in India – National Policy on ICT in agricultural extension
16. Success stories of ICT use in Rural India
17. Mid Semester Examination
18. Impact of ICT for agricultural extension initiatives
19. Barriers for agricultural extension initiatives
20. Technology Parks - Extension next – social media in agricultural extension.
21. Concept and principles of administration and management
22. Schools of management thought, virtual organization.
23. Personnel management - Interpersonal and Interpersonal communication skills.
24. National Institute of Agricultural Extension and Management (MANAGE), NIRD & PR, EEI and NAARM.
25. Corporate management in agriculture sector
26. POSDCORB functions of management: planning, organizing, staffing, directing and leading
27. POSDCORB functions of management: controlling, coordinating, reporting and budgeting
28. Case studies and success stories in agricultural extension management
29. Management by objectives (MBO) and Total Quality Management(TQM)
30. Project evaluation and review technique (PERT) Critical Path Method (CPM) and Logical Frame Working (LFW)

31. Project Management Techniques – Monitoring, evaluation and impact analysis of extension programmes
32. Critical analysis of organizational set up of extension administration at various levels
33. Information Technology Parks
34. Management Information System (MIS) and Management of Agricultural Knowledge Systems (MAKS).

Practical Schedule

1. Construction of questionnaire to study the communication networks and communication methods followed in extension organization
2. Studying about the communication pattern followed among the farm scientists of the KVK
3. Practicing skill to write business letters in corporate communication
4. Role playing to understand superior – subordinate relationship
5. Studying about the advances in photography at a digital studio
6. Studying about the Central Library to know about the e-resources
7. Preparation of power point slides
8. Practicing power point presentation
9. Participation and interaction through video conferencing
10. Studying about an E-Extension centre.
11. Studying about the Doordharsan Kendra, Puducherry.
12. Studying about the organizational climate at JDA office.
13. Studying about organizational climate at ADA office.
14. Stress management of agriculture extension personnel.
15. Conducting case studies on management information system of an NGO.
16. Practicing training game on time management to understand skills of productivity efficacy.
17. Studying about an agricultural corporate industry and its management practices.

References

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2. Ray, G.L. 2014. Extension Communication and Management. Kalyani Publ.
3. Shashi K. Gupta and Rosy Joshi. 2014. “Organizational Behaviour”. Kalyani Publishers.
4. Narayana Reddy, G.V. *et al.* 2013. Communication of Agricultural Innovations, Published by National Institute of Agricultural Extension Management, Rajendranagar, Hyderabad.
5. Saravanan, R. C.Karthikeyan and T. Indra Devi. 2011. Information and Communication technology for Agriculture and Rural Development, New India Publishing Agency, New Delhi.
6. www.agriinfo.in
7. <http://mhrd.gov.in/ict>
8. www.agritech.tnau.in
9. www.manage.gov.in
10. <http://www.kopykitab.com>

AEX612 PROGRAMME PLANNING, DIFFUSION AND ADOPTION OF INNOVATIONS (2+1)

Objectives

- To learn about the principles and steps in programme planning and about development programmes for women and youth
- To learn about the various concepts related to diffusion and adoption of innovations.
- To understand the adoption process, stages of adoption and innovation decision process, adopter categories, opinion leaders, attributes of innovations and factors influencing adoption.

Theory

Unit I –PROGRAMME PLANNING AND DEVELOPMENT PROGRAMMES

Programme planning – Concept, meaning, definition, principles and theories of programme planning, Theoretical models of programme planning. Steps in programme planning. Monitoring and evaluation –concept, significance, types, methods and tools. Analysis of ATMA, MGNREGA, Magalir Thittam and ARYA programmes.

Unit II - DIFFUSION AND ADOPTION OF INNOVATIONS

Diffusion – concept and meaning, elements, Innovation-development process, adoption for social change. The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages. The innovation-decision process – Types of innovation - decisions – Optional, collective and authoritative and contingent innovation decisions; A critical appraisal of the new formulation. Models of diffusion and adoption.

Unit III - ADOPTER CATEGORIES AND RATE OF ADOPTION

Adopter categories – Innovativeness and adopter categories, adopter categories as ideal types, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption- barriers in adoption process.

Unit IV - OPINION LEADERSHIP

Diffusion effect and concept of over adoption, opinion leadership-measurement and characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi-step flow of innovation, concepts of homophily and heterophily and their influence on flow of innovations.

Unit V - CONSEQUENCES OF INNOVATIONS AND DECISION MAKING

Consequences of Innovation-Decisions – Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making – meaning, nature, theories, process, steps, factors influencing decision – making.

Practical

Visit to study about the ongoing development programmes viz., ATMA, Magalir Thittam and ARYA programmes. Case studies of individual adoption process, Identification of adopter categories on a selected technology, study of attributes of current farm technologies, Identification of opinion leaders, Sources of information utilized at different stages of adoption on a selected technology, study of factors increasing or retarding the rate of adoption, presentation of reports on adoption and diffusion of innovations.

Lecture Schedule

1. Programme planning – Concept, meaning, definition, principles of programme planning and Steps in programme planning
2. Theories of programme planning, Theoretical models of programme planning .
3. Monitoring and evaluation –Concept, significance, types, methods and tools
4. Analysis of ATMA, MGNREGA, Magalir Thittam and ARYA programmes.
5. Diffusion – Concept and meaning and elements of diffusion process
6. Innovation Development process and adoption for social change
7. Adoption meaning, definition and adoption process
8. & 9. Different stages of adoption: dynamic nature of stages, covert and overt processes
10. Innovation decision process
11. & 12 Types of innovation decisions-Optional, collective, authoritative and contingent innovation decisions
13. Critical appraisal of the new formulations and models of diffusion and adoption
14. & 15. Adopter categories: innovativeness and adopter categories, adopter categories as ideal type
16. Characteristics of adopter categories
17. Mid- Semester Examination
18. Attributes of innovation
19. Rate of adoption of innovation and barriers in adoption process
20. Factors influencing rate of adoption
21. Diffusion effect and concept of over adoption
22. Opinion leadership- Measurement and characteristics of opinion leaders
23. Monomorphic and polymorphic opinion leadership
24. Multi step flow of innovation
25. Concept of homophily and heterophily and their influence on flow of innovation
26. & 27. Consequences of innovation decisions-Desirable or undesirable, direct or indirect, anticipated or unanticipated consequences
28. & 29. Decision making-Meaning, definition and nature of decision making
30. Theories of decision making
31. & 32. Process and steps in decision making
33. & 34. Factors influencing decision making

Practical Schedule

1. Studying ongoing development programmes in a village.
2. Construction of an interview schedule to study about the different stages of diffusion of selected agricultural innovations and the information sources.
3. Visit to a village to collect data on different stages of diffusion of selected agricultural innovations and the information sources.
4. Tabulation of collected data.

5. Analysis and Interpretation
6. Presentation of report.
7. Construction of an interview schedule to study about the extent of adoption of selected agricultural innovations and the reasons of non adoption.
8. Visit to a village to collect data on extent of adoption of selected agricultural innovations and the reasons of non adoption.
9. Tabulation of collected data.
10. Analysis and Interpretation.
11. Presentation of report.
12. Construction of an interview schedule to study about the different adopter categories.
13. Visit to a village to collect data on the different adopter categories.
14. Data analysis, interpretation and presentation.
15. Construction of an interview schedule to identify the opinion leaders.
16. Visit to a village for data collection to identify the opinion leaders.
17. Case studies of individual adoption process.

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AEX 613 – CYBER EXTENSION FOR FARM TECHNOLOGIES (2+1)

Objectives

- To acquaint the students with overall understanding of extent of utility and relevance of ICT in agriculture and allied sectors.
- To gain knowledge and skills in understanding the concepts of Information and communication technologies.
- To know how ICT tools can be used for various fields of extension education.
- To be familiar with various ICT projects which are successful in delivering the services to the agro-based clientele.

Theory

Unit - I CONCEPT OF ICTs

ICTs - Concept, definition and role of ICT in agriculture and rural development. – Reorganizing the extension efforts using ICTs – advantages, limitations and opportunities – Networking system of information and challenges in the use of ICT.

Unit - II ICT TOOLS

ICT tools – print and electronic media – e-mail – Internet – use of mobile phony – web, tele and video conferencing – computer assisted instructions – touch screens – micro-computers – web technologies and information kiosks – e – learning – information resources, sharing and networking – Types of network – PAN, LAN, WAN, Internet, AGRINET, AKIS – Indian National Agricultural Research database.

Unit - III DIFFERENT APPROACHES AND METHODS OF ICTs

ICTs projects – case studies in India and world – Different approaches (models) to ICTs – Use of ICT in the field of extension – Expert systems on selected crops and enterprises – Self learning CDs on package of practices, diseases and pest management – Agricultural web sites and portals related to crop production and marketing etc., Crop doctor – Cloud based extension approaches – Blog extension practices –voice enabled extension services.

Unit - IV ICT IN AGRICULTURAL EXTENSION

Community Radio – Knowledge management – Multimedia and its uses – Online, Offline Extension – Knowledge centres – ICT Extension approaches – pre – requisites, information and science needs of farming community – Need integration – Human resource information Intermediaries – Basic e-extension training issues – ICT enabled extension pluralism – Emerging issues in ICT.

Unit - V ICT PROGRAMMES IN AGRICULTURAL EXTENSION

ICT programmes in agriculture, livestock and fisheries development – Problems and prospects of ICTs in agriculture, livestock and fisheries development – Digitisation – Simulation models – Utilization of Internet for promoting advanced agriculture, livestock and fisheries practices – Communication with rural, semi-urban and urban farmers and livestock owners.

Practical

Visit to various centers like Internet Centre, Innovation Centre, Department of Computer Engineering, Information Service centre, National Informatics Centre (NIC), Collectorate, KVK, Community Radio station, Village Knowledge Centre, Directorate of Agriculture, Veterinary institution, FM Radio, Kisan Call Centre, Publications, All India Radio, Doordarshan kendra, Computer hardware/software industry.

Lecture Schedule

1. ICTs - Concept, definition and role of ICT in agriculture and rural development
2. Reorganizing the extension efforts using ICTs
3. Advantages, limitations and opportunities of ICTs
4. Networking system of information and challenges in the use of ICT
5. ICT tools- print and electronic media, e-mail, Internet
6. Use of mobile phony, web, tele and video conferencing

7. Computer-assisted instructions - touch screens, micro-computers, web technologies
8. Information kiosks and e-learning
9. Information resources, sharing and networking.
10. Types of network – PAN, LAN, WAN, Internet, AGRINET, AKIS, Indian National Agricultural Research database
11. ICTs projects, case studies in India
12. ICTs projects, case studies of the world.
13. Different approaches (models) to ICTs.
14. Use of ICT in the field of extension
15. Expert systems on selected crops and enterprises
16. Self-learning CDs on package of practices, diseases and pest management
17. Mid Semester Examination
18. Agricultural web sites and portals related to crop production and marketing, Crop doctor
19. Cloud based extension approaches
20. Blog extension practices and voice enabled extension services
21. Community Radio –operational guidelines and functions
22. Knowledge management through ICTs
23. Multimedia – Concept, content and creation, use of multimedia
24. Online (technology delivery) and Offline (technology dissemination) Extension
25. Knowledge centres
26. ICT Extension approaches-pre-requisites, information and science needs of farmers and livestock owners
27. Need integration
28. Human resource information intermediaries and basic e-extension training issues.
29. ICT enabled extension pluralism
30. Emerging issues in ICT
31. ICT programmes in agriculture, livestock and fisheries development.
32. Problems and prospects of ICTs in agriculture, livestock and fisheries development
33. Digitisation and simulation models.
34. Utilization of Internet for promoting advanced agriculture, livestock and fisheries practices; communication with rural, semi-urban and urban farmers and livestock owners.

Practical Schedule

1. Studying the Internet Centre - Central Library of the Annamalai University to study about different academic portals and websites
2. Studying the Internet Centre - Central Library of the Annamalai University to study about different agricultural portals and websites
3. Studying the Innovation Centre of the Annamalai University to study about data base management

4. Studying the Department of Computer Engineering of the Annamalai University to study about the networking
5. Studying an Information Service centre for farmers
6. Studying the National Informatics Centre (NIC), at the Collectorate.
7. Studying the KVK to study about the mobile advisory services to farmers
8. Studying a Community Radio station
9. Studying a Village Knowledge Centre
10. Studying the Directorate of Agriculture to study about AGRISNET
11. Studying a veterinary institution to study about the use of ICT tools in livestock sector.
12. Studying FM Radio
13. Studying Kisan Call Centre,
14. Visit to a Publications, to study about the ICT tools used in print media
15. Visit to All India Radio, to study about the ICT tools used in electronic media
16. Visit to Doordarshan to study about the ICT tools used in electronic media
17. Visit to computer hardware/software industry.

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AEX 621 METHODS AND DESIGNS IN BEHAVIOURAL SCIENCE RESEARCH (2+1)

Objectives

- To gain knowledge and skills in methods of behavioural sciences research
- To help the students to learn the Statistical Package for Social Sciences (SPSS)
- To enable the students to choose appropriate statistics tools for data analysis.

Theory

Unit I – CONCEPT OF RESEARCH

Research – meaning, importance, characteristics. behavioural sciences research –meaning, concept, principles, approach and problems in behavioural sciences research. types and methods of research – fundamental, applied and

action research, exploratory, descriptive, diagnostic, evaluation, experimental, analytical, historical, survey and case study. Review of literature – need, search procedure, sources of literature, planning the review work. Research problem – selection and identification of research problem, factors and criteria in selection of research problem, statement of research problem and development of theoretical orientation of the research problem.

Unit II – HYPOTHESIS, RELIABILITY AND VALIDITY

Objectives – meaning, types and criteria for judging the objectives. concept and construct – meaning, role of concepts in research. Variable – meaning, types and their role in research. hypothesis – meaning, importance, testing of hypothesis, types of hypothesis, Measurement – meaning, postulates and levels of measurement, use of appropriate statistics at different levels of measurement. Importance of measurement in research. Validity – meaning and methods of testing. Reliability – meaning and methods of testing.

Unit III – SAMPLING AND RESEARCH DESIGNS

Sampling – universe, sample and sampling- meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors – methods of elimination and minimizing, MAX-MINCON principle, sampling – methods of sampling and sampling procedures. research designs – meaning, purpose and criteria for research design, concept, types, field studies, survey methods, advantages and limitations of each design. Experimental design, ex-post facto design – advantages and limitations.

Unit IV - DATA COLLECTION

Data collection methods - interview – meaning, purpose, types, techniques of interviewing and advantages and limitations. questionnaires – meaning, difference between schedule and questionnaire, types of questions to be used, rating scales – meaning, types, advantages and limitations in its use. ranking scales – meaning, objectives, advantages and limitations. Observation – Meaning, types, advantages and limitations. Case studies – Meaning, types, advantages and limitations. Scalogram analysis, Q sort techniques.

Unit V - DATA PROCESSING AND REPORT WRITING

Data processing –meaning, coding, preparation of master code sheet, statistical package for social sciences (SPSS) statistical tests, normal distribution, tests of significance, ANOVA, correlation, regression. Choosing appropriate statistics for data analysis based on the level of measurement of variables. Interpretation, report writing – meaning, guidelines to be followed in scientific report writing, references in reporting. participatory approaches, PRA, RRA, PEM, PLAM and PTD.

Practical

Selection and formulation of research problem - formulation of objectives and hypothesis-selection of variables based on objectives-developing the conceptual framework of research. operationally defining the selected variables-development of data collection devices.-testing the validity and reliability of the data collection instruments.- pre-testing of the data collection instrument-techniques of interviewing and collection of data using the data collection instruments-data

processing, hands on experiences on SPSS, coding, tabulation and analysis. Formulation of secondary tables based on objectives of research. writing report, writing of thesis and research articles-presentation of reports.

Lecture schedule

1. Research – Meaning, importance, characteristics. Behavioural sciences research –Meaning, concept
2. Principles and approach in behavioural science research and problems in behavioural science research.
3. Types and methods of Research – Fundamental, Applied and Action research
4. Exploratory, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case Study.
5. Review of literature – Need, Search Procedure, Sources of Literature, planning the review work.
6. Research problem – Guiding and principles in the choice of research problem, Factors and criteria in selection of research problem.
7. Statement of research problem and development of theoretical orientation of the research problem.
8. Objectives – Meaning, types and criteria for judging the objectives.
9. Concept and Construct – Meaning, role of concepts in research.
10. Variable – Meaning, types and their role in research. Definition – Meaning, characteristics of workable definitions, types and their role in research.
11. Hypothesis – Meaning, importance.
12. Types of hypothesis.
13. Measurement – Meaning, postulates and levels of measurement
14. Use of appropriate statistics at different levels of measurement, criteria for judging the measuring instrument and importance of measurement in research.
15. Validity – Meaning and methods of testing.
16. Reliability – Meaning and methods of testing.
17. Mid Semester Examination
18. Sampling – Universe, Sample and Sampling, Methods of sampling and sampling procedure
19. Meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors.
20. Research Designs – Meaning, purpose and criteria for research design, Types, advantages and limitations of each design. Experimental design – Advantages and limitations.
21. Data Collection methods - Interview – Meaning, purpose, types, techniques of interviewing - advantages and limitations.
22. Enquiry forms and Schedules – Meaning, types of questions used, steps in construction - advantages and limitations in its use.
23. Questionnaires – Meaning, difference between schedule and questionnaire, types of questions to be used.
24. Rating scales – Meaning, types, advantages and limitations in its use.
25. Ranking Scales – Meaning, objectives, advantages and limitations.

26. Observation – Meaning, types, advantages and limitations. Case studies – Meaning, types, advantages and limitations.
27. Scalogram analysis, Q sort techniques.
28. Data processing – Meaning, coding, preparation of master code sheet.
29. Statistical tests, normal distribution, tests of significance.
30. ANOVA, correlation, regression.
31. Statistical Package for Social Sciences (SPSS) choosing appropriate statistics for data analysis based on the level of measurement of variables.
32. Report writing – Meaning, guidelines to be followed in scientific report writing.
33. References in reporting.
34. Participatory approaches – PRA,RRA,PEM,PLAM and PTD.

Practical schedule

1. Selection and formulation of research problem.
2. Formulation of objectives and hypothesis.
3. Selection of variables based on objectives.
4. Developing the conceptual framework of research.
5. Defining the selected variables.
6. Development of data collection instruments.
7. Testing the validity and reliability of the data collection instruments.
8. Pre-testing of the data collection instrument.
9. Techniques of interviewing.
10. Data collection.
11. Coding, tabulation, preparation of master code sheet.
12. Formulation of secondary tables based on objectives of research.
13. Data processing, hands on experiences on SPSS.
14. Writing report.
15. Writing of thesis and research articles.
16. Presentation of reports.
17. Presentation of reports.

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AEX 622 - PERSPECTIVES OF HUMAN RESOURCE MANAGEMENT (2+1)

Objectives

- To orient the students about key concepts and growth & development of human resource development.
- To understand the subsystems of human resource development for extension organization and process of HRD.

Theory

Unit I – INTRODUCTION TO HRM

Human resources, concept, importance of human resources in agriculture development–human resource management, concept, meaning, importance scope, objectives, functions.

Unit II – RECRUITMENT AND SELECTION

Recruitment, concept, importance, factors influencing recruitment, recruitment process, sources of recruitment, methods, selection, definition, meaning, steps in selection process, selection methods, factors affecting selection, induction, concept, content, advantages.

Unit III - TRAINING

Training, meaning, concepts, types – importance, training models, phases of training, training needs, concept, meaning, identifying training needs, training requirements, developing training modules. designing training programmes. – factors influencing the selection of training methods, training evaluation – concept, meaning, types, levels, principles, techniques, impact assessment. capacity building in relation to agriculture and allied industries.

Unit IV - ORGANIZATIONAL BEHAVIOUR

Organizational behavior, organizational behaviour as facilitators of HRD, stress, meaning, causes, stress management, concept, causes, consequences, stress management techniques, importance. job description, job analysis, job evaluation, motivation, concept, importance, techniques of motivation.

Unit V - ORGANIZATIONAL DEVELOPMENT

Organizational effectiveness, organizational climate, organizational development, job satisfaction, problem solving techniques, Time management. performance appraisal, meaning, concept, methods, organizational climate, team building, process and strategies at organizational and village levels, mobilization, concept, skills and strategies.

Practical

Preparation of an interview schedule to study the training needs of farmers, visit to a village to study the training needs of farmers, visit to an organization to study their recruitment and selection patterns and organizational structure. practicing lecture, demonstration, case method, group brain storming, syndicate, business games, simulation exercise, in-basket exercise, programmed instruction, sensitivity training, T group, fish bowl exercise. Visit to KVK to analyze the training methods followed for training the farmers. Visit to JDA/ADA office to study the training methods followed for training the farmers.

Lecture Schedule

1. Human resources, concept, meaning, importance in agriculture development.
2. Human resource management, concept, meaning, objectives, importance scope functions.

3. Recruitment, concept, meaning, importance.
4. Factors influencing recruitment, recruitment process, sources of recruitment.
5. Selection, definition, meaning, steps in selection process.
6. Selection methods, factors affecting selection.
7. Introduction, concept, content, advantages.
8. Training, meaning, concept, importance, types of training.
9. Training models.
10. Phase of training, pre-training, training, post-training.
11. Training needs, meaning, concept, identifying training needs, training requirements.
12. Setting training objectives.
13. Developing training modules.
14. Planning training sessions.
15. Training methods, factors influencing the selection of training methods.
16. Training evaluation, meaning, concept, types, levels.
17. Mid Semester Examination
18. Training evaluation, principles, techniques.
19. Impact assessment.
20. Capacity building in relation to agriculture and allied industries.
21. Organizational behaviour
22. Organizational behaviour as facilitators of HRD.
23. Stress, meaning, causes, stress management, importance, techniques.
24. Job description, job analysis, job evaluation.
25. Motivation, concept, theories, importance, techniques of motivation.
26. Organizational effectiveness.
27. Organizational climate.
28. Organizational development.
29. Job satisfaction.
30. Problem solving techniques.
31. Time management.
32. Performance appraisal, concept, meaning, methods.
33. Team building, process and strategies at organizational and village levels.
34. Mobilization skills, concept, strategies.

Practical Schedule

1. Preparation of an interview schedule to study the training needs of farmers.
2. Visit to a village to study the training needs of farmers.
3. Visit to an organization to study their recruitment and selection patterns and organizational structure.
4. Practicing lecture
5. Practicing demonstration.
6. Practicing case method.
7. Practicing group brain storming.
8. Practicing syndicate.

9. Practicing simulation exercise.
10. Practicing in-basket exercise.
11. Practicing programmed instruction.
12. Practicing sensitivity training.
13. Practicing T group
14. Practicing fish bowl exercise.
15. Visit to KVK to analyze the training methods followed for training the farmers.
16. Visit to JDA/ADA office to study the training methods followed for training the farmers.
17. Visit to an organization to study the performance appraisal techniques adopted.

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AEX 623. ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT (2+1)

Objectives

- To understand the concepts of entrepreneur entrepreneurship and Agripreneurship.
- To gain expertise on small business management.
- To gain knowledge on training programme for entrepreneurship development.
- To understand the role of various institutions in entrepreneurship development.

Theory

Unit – I Entrepreneur and Entrepreneurship

Entrepreneur and Entrepreneurship – concept, meaning and definition, scope of entrepreneurship development. Theories of entrepreneurship. Agripreneurship - concept, definition, scope and importance of developing agriculture based enterprises. Agri clinics and agri business centers. Characteristics of ideal entrepreneurs. Types of entrepreneurs. Entrepreneurship development process.

Unit – II Enterprise Management

Enterprise – meaning, definition, characteristics, and types of enterprises – Stages of establishing enterprises. Profitable Agri enterprises in India – Steps in

setting up a small enterprise. SWOT analysis of agri based enterprises. Management of small business, Project management and Appraisal - market, technical, economic and financial appraisal of projects.

Unit – III Micro finance and Entrepreneurial motivation

Micro finance – meaning, definition, importance of micro finance for promoting entrepreneurship in rural areas – sources of micro finance, mobilization of micro finance - Self help groups – concept, meaning, definition, organizing and functioning of SHGs for empowerment and sustainability - Entrepreneurial motivation - need and importance – motives for entrepreneurship.

Unit – IV Product idea, Technology, Marketing and Record keeping

Product idea – meaning, definition, sources and techniques of generating product idea / business idea. Technology – meaning, characteristics and importance – Identification and accessing of technology. Manufacturing – meaning, definition, characteristics. Marketing – meaning, definition, importance, market strategy, market segmentation, market survey, target marketing, market positioning, marketing mix, product mix. Pricing – meaning, definition, types of pricing. Importance of personnel management in enterprises. Record keeping – definition, importance, types.

Unit – V Entrepreneurship Development Training and Women Entrepreneurship

Entrepreneurship Development Training Programmes (EDPs) – objectives, importance and phases of EDPs. Types and Techniques of entrepreneurial training. Organizations imparting EDPs. Institutions supporting small business enterprises – NABARD, SIDBI, NIC, KVIC, SIDCO, SIDO, NSIC, DICs, SFCs and other financial institutions. Role of NGOs in promoting entrepreneurship. Women entrepreneurship – meaning, importance, problems of women entrepreneurs, opportunities for women in entrepreneurship – organizational support for women owned enterprises.

Practical

Formulation of project proposal – Preparation of project profiles for some agro – based enterprises. Financial analysis – working out benefit cost ration (BCR), Break Event Analysis (BEP), Practicing EMT techniques – Test for achievement planning, tower building. Field visit to successful enterprises. Exercise on market survey. Visit to DIC and NGO to study their entrepreneurship development activities. Study and evaluation of women owned enterprises in agriculture. Case studies of successful enterprises.

Theory Schedule

1. Entrepreneur and Entrepreneurship – concept, meaning and definition, scope of entrepreneurship development.
2. Theories of entrepreneurship.
3. Agripreneurship - concept, definition, scope and importance of developing agriculture based enterprises.
4. Agri clinics and agri business centers.
5. Characteristics of ideal entrepreneurs and types of entrepreneurs.
6. Entrepreneurship development process.
7. Enterprise – meaning, definition, characteristics and types of enterprises.

8. Stages of establishing enterprises.
9. Profitable Agri enterprises in India.
10. Steps in setting up a small enterprise.
11. SWOT analysis of agri based enterprises.
12. Management of small business.
13. Project management and Appraisal - market, technical, economic and financial appraisal of projects.
14. Micro finance – meaning, definition, importance of micro finance for promoting entrepreneurship in rural areas
15. Sources of micro finance, mobilization of micro finance.
16. Self help groups – concept, meaning, definition, organizing and functioning of SHGs for empowerment and sustainability.
17. Mid Semester Examination.
18. Entrepreneurial motivation - need and importance – motives for entrepreneurship.
19. Product idea – meaning, definition, sources and techniques of generating product idea / business idea.
20. Technology – meaning, characteristics and importance. Identification and accessing of technology.
21. Manufacturing – meaning, definition, characteristics.
22. Marketing – meaning, definition, importance, market strategy, market segmentation.
23. Market survey, target marketing, market positioning, marketing mix, product mix.
24. Pricing – meaning, definition, types of pricing.
25. Importance of personnel management in enterprises.
26. Record keeping – definition, importance, types.
27. Entrepreneurship Development Training Programmes (EDPs) – objectives, importance and phases of EDPs.
28. Types and Techniques of entrepreneurial training.
29. Organizations imparting EDPs.
30. Institutions supporting small business enterprises – NABARD, SIDBI, NIC, KVIC
31. SIDCO, SIDO, NSIC, DICs, SFCs and other financial institutions.
32. Role of NGOs in promoting entrepreneurship.
33. Women entrepreneurship – meaning, importance, problems of women entrepreneurs, opportunities for women in entrepreneurship.
34. Organizational support for women owned enterprises.

Practical Schedule

1. Formulation of project proposal.
2. & 3. Preparation of project profiles for some agro – based enterprises.
4. Working out benefit cost ratio (BCR) for any agro – based enterprise.
5. Break even analysis (BEP) for any agro – based enterprise.
6. & 7. Capital budgeting for agro based enterprises.

8. Practicing Test for achievement planning.
9. Practicing tower building.
10. & 11. Field visit to successful enterprises.
12. Exercise on market survey.
13. Visit to DIC to study about its entrepreneurship promotion activities.
14. Visit to NGOs to study about its entrepreneurship promotion activities.
15. Study and evaluation of women owned enterprises in agriculture.
16. & 17. Case studies of successful enterprises.

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AEX 624 - GENDER SENSITIZATION AND EMPOWERMENT (2+0)

Objectives

- To understand the concepts of gender and gender sensitization.
- To gain expertise on empowerment of women.
- To gain knowledge on gender based laws.

Theory

Unit I –Gender Concepts and Roles

Gender – Femininity – masculinity - Gender discrimination - Gender inequality. Gender Sensitization – concept, need and focus on gender sensitization. Gender in community diversity - Gender roles - matriarchy - patriarchy. Implications for empowerment.

Unit II – Gender Perspectives and Women Development

Gender perspectives – development of women in social - economical perspectives social characteristics of women - role and responsibilities of women in society – resource management of women – constraints in women development.

Unit III – Gender Based Laws for empowerment

Legal issues and opportunities – educational and economical parameters. Empowerment – dimensions and methodologies for empowerment – importance for empowering women, specific laws for women empowerment - Legal provisions for women empowerment – Government policies and schemes for women empowerment.

Unit IV – Gender tools and methodologies

Gender mainstreaming – tools and techniques for gender mainstreaming. Gender budgeting – gender analysis. Importance Gender analysis frame works; context, activities and resources – programme action profile of gender analysis.

Unit V – Gender Technologies and Gender Issues

Gender specific technologies – house hold technologies interface – socio cultural interface. Women as consumer of technologies – Empowerment of women in Agriculture – Women oriented technologies in agriculture. Gender issues and development in health and nutrition – governance – education – violence. nature, victims, causes, impact, role of media in gender sensitization.

Lecture Schedule

1. Gender, femininity and masculinity.
2. Gender discrimination and Gender inequality.
3. Gender Sensitization – concept, need and focus on gender sensitization.
4. Gender in community diversity.
5. Gender roles - matriarchy and patriarchy.
6. Implications for empowerment.
7. Gender perspectives.
8. Development of women in social - economical perspectives.
9. Social characteristics of women.
10. Role and responsibilities of women in society.
11. Resource management of women and constraints in women development.
12. Legal issues and opportunities – educational and economical parameters.
13. Empowerment – dimensions and methodologies for empowerment.
14. Importance for empowering women.
15. Specific laws for women empowerment.
16. Legal provisions for women empowerment.
17. Mid Semester Examination.
18. Government polices and schemes for women empowerment.
19. Gender mainstreaming.
20. Tools and techniques for gender mainstreaming.
21. Gender budgeting.
22. Gender analysis and its importance.
23. Gender analysis frame works.
24. Context, activities and resources for gender analysis.
25. Programme action profile of gender analysis.
26. Gender specific technologies – house hold technologies interface and Socio cultural interface.
27. Women as consumer of technologies.
28. Empowerment of women in Agriculture.
29. Women oriented technologies in agriculture.
30. Gender issues and development in health and nutrition.
31. Gender issues and development in governance.
32. Gender issues and development in education.
33. Violence-Nature of violence, victims, causes of violence and impact of violence.
34. Role of media in gender sensitization.

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4. Dipti mayee sahuo. 2014. Gender sensitization violence against women. Speak foundation.
5. Kartick das & Gopal Sharma.2016. Women empowerment and socio-economic development.
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9. www.indiatogether.org/c/gener-laws-and-policy.
10. <https://www.gdrc.org/gender/framework/framework.html>.

OPC-AEX 711 FARM JOURNALISM (1+1)

Objectives

- To impart knowledge on Agricultural Journalism and its role in agricultural development
- To inculcate skills in script writing for different media.

Theory

Unit I – PRINT MEDIA

Journalism, Concept, Types, Principles, Scope, Importance, elements, qualities of News. Script writing for print media – News stories, news, success stories, features. Nature and characteristics of Newspaper – Readers’ perception – Photo journalism – importance and functions.

Unit II – MAGAZINES

General magazines – basics of writing farm articles – contents – target readers – language – writing style – pictures and illustrations – features and special articles – Tamil Agricultural Magazines.

Unit III – RADIO

Nature and characteristics of Radio – Radio for information, education and entertainment – News headlines and highlights – News features – talk shows, interviews – Radio audiences – audience participation – language and style – target audience – script writing for radio.

Unit IV - TELEVISION

Nature and characteristics of television – audio and visual elements – script writing television – time factor – information and educational programmes – general and special audience programmes – language and style of presentation – entertainment programmes – audience participation.

Unit V – WEB WRITING

Understanding and using the Internet - Online journalism – Agricultural News – Agricultural technology – Newspapers online - e-journals and e-magazine – textual – language and style - multimedia support – contents online: informational and educating market information. content developing using links and text.

Practical

Writing for the print media Preparing and Editing news items for News papers. Practicing photography and videography, Visit to a newspaper organization.

Preparation of leaflets and folders. Designing a cover for farm magazine. Preparing the radio script, Practicing the radio script, Visit to FM radio station. Practicing the script writing for television. Designing visuals, graphics and Illustrations for television. Designing a programme on Interview with farmer. Preparation of short film, Visit to local TV channel, Visit to Doordharsan Kendra. Preparation of Interview Schedule to study the preference of farmers towards mass media.

Lecture schedule

1. Journalism, Concept, Types, Principles, Scope, Importance,
2. Elements / qualities of News.
3. Script writing for print media – News stories, news, success stories, features.
4. Nature and characteristics of Newspaper – Readers’ perception.
5. Photo journalism – importance and functions.
6. General magazines – basics of writing farm articles, Contents – target readers – language.
7. Writing style – pictures and illustrations – features and special articles – Tamil Agricultural Magazines.
8. Nature and characteristics of Radio – Radio for information, education and entertainment.
9. Mid Semester Examination
10. News headlines and highlights – News features – talk shows, interviews.
11. Radio audiences – audience participation – language and style – target audience – script writing for radio.
12. Nature and characteristics of television – audio and visual elements.
13. Script writing television – time factor – information and educational programmes – general and special audience programmes.
14. Language and style of presentation – entertainment programmes – audience participation.
15. Understanding and using the Internet - Online journalism
16. Agricultural News – Agricultural technology – Newspapers online - e-journals and e-magazine – textual – language and style
17. Multimedia support – contents online: informational and educating market information. content developing using links and text.

Practical schedule

1. Writing for the print media
2. Preparing and Editing news items for News papers.
3. Practicing photography.
4. Practicing videography
5. Visit to a newspaper organization.
6. Preparation of leaflets and folders.
7. Designing a cover for farm magazine.
8. Preparing the radio script
9. Practicing the radio script
10. Visit to FM radio station.
11. Practicing the script writing for television.

12. Designing visuals, graphics and Illustrations for television.
13. Designing a programme on Interview with farmer.
14. Preparation of short film
15. Visit to local TV channel
16. Visit to Doordharsan Kendra.
17. Preparation of Interview Schedule to study the farmer preference towards mass media.

References

1. G.L. Ray and Sagar Mondal. 2010. Journalism, Farm Journalism and communication skills.
2. Jana.B.L. & Mitra K.P.2005. Farm Journalism. Agro. Tech Pull. Academy.
3. C. Bhaskaran & Kishore Kumar 2010. Farm journalism and media management, Agri. Teck, Udaipur.
4. Shrivastava, K.M. 'Radio and TV Journalism Today'. New Delhi, Sterling Publication. 1989.
5. Hilliart, Robert. 'Writing for television, radio and New media (8th Edison). Belmont. Wadsworth publication 2004.
6. www.farmjournal.com
7. www.agriculturetoday.in
8. <https://screecraft.org/education>
9. www.slideshow.net/handbookoffarmjournalism
10. www.mediacolleg.com

OPC- AEX 712 INTRODUCTION TO VISUAL COMMUNICATION AND ADVERTISING TECHNOLOGIES (2+1)

Objectives

- To learn about the principles and concepts of visual communication
- To learn the scope, concept and trends of advertising
- To learn various formats of advertising

Theory

Unit I - VISUAL COMMUNICATION

Need for and the Importance of Visual Communication. Communication as an expression, skill and process, Understanding Communication – Message, Meaning, Connotation, Denotation, Codes - Levels of communication: Technical, Semantic, and Pragmatic. The semiotic landscape: language and visual communication, narrative representation

Unit II - COLOUR PSYCHOLOGY AND TYPES OF MEDIA

Principles of Visual and other Sensory Perceptions. Colour psychology and theory - Optical / Visual Illusions - Types of Media – Print media, Electronic media and recent media in communication

Unit- III - GRAPHIC DESIGN

Basic of Graphic Design, Definition, Elements of Graphic Design. The process of developing ideas – Verbal, Visual, Combination and thematic, visual thinking, design execution and presentation.

Unit IV - IV ADVERTISING

Definition, Nature & Scope of advertising, Roles of Advertising; Societal, Communication, Marketing & Economic functions of advertising. Advertising based

on target audience, geographic area, Corporate and Promotional Advertising. Web Advertising.

Unit V - TRENDS AND TYPES OF ADVERTISING

Latest trends in advertising- Advertisement agency & its types, functions, services- Legal aspects & ethical issues. Communication Plan, Brand management – Positioning, Brand personality, Brand image, Brand equity. Conceptualization & Ideation, Visualization, Designing & Layout, Copy writing – Types of headlines, body copy base lines, slogans. Logos & trademarks. Typography, Writing styles, Scripting. Story board. Advertising campaign-from conception to execution

Practical

Geometrical Shapes - Perspectives - Light and shade - Story Board Colours - Visit to an advanced digital studio - Design ear panels - Design a visual dominant advertisement - Design a souls advertisement - Design an advertisement for a consumer product - Design a corporate advertisement - Design a public service advertisement - Design a testimonial advertisement - Design a comparative advertisement - Design an advertisement for brand promotion - Design an advertisement with emotional appeal- . Design an advertisement with fear appeal - Design an advertisement with humor appeal

Lecture Schedule

1. Need for and the Importance of Visual Communication.
2. Communication as an expression, skill and process, Understanding Communication
3. Message, Meaning, Connotation, Denotation, Codes
4. Levels of communication, Technical, Semantic and Pragmatic
5. The semiotic landscape: language and visual communication, narrative representation
6. Principles of Visual and other Sensory Perceptions.
7. Colour psychology and theory
8. Optical / Visual Illusions
9. Types of Media
10. Print media, Electronic media
11. Recent media in communication
12. Basics of Graphic Design. Definition, Elements of Graphic Design
13. Design process-research, a source of concept, the process of developing ideas
14. Verbal, visual, combination and thematic
15. Visual thinking, associative techniques, materials, tools
16. Design execution, and presentation.
17. Mid semester Examination
18. Definition, Nature & Scope of advertising
19. Roles of Advertising
20. Societal, Communication, Marketing & Economic functions of advertising
21. Advertising based on target audience, geographic area
22. Corporate and Promotional Advertising

23. Web Advertising
24. Latest trends in advertising
25. Advertisement agency & its types, functions, services
26. Legal aspects & ethical issues in advertising
27. Communication Plan and Brand management
28. Positioning, Brand personality, Brand image, Brand equity
29. Conceptualization, Ideation, Visualization designing and layout
30. Copy writing – types of headlines
31. Slogans– types of slogans
32. Logos and Trade marks
33. Typography and Writing styles, Scripting and Story board
34. Advertising campaign-from conception to execution

Practical Schedule

1. Practicing Geometrical Shapes in visual designs
2. Practicing Perspectives in visual designs
3. Practicing Light and shade in visual designs
4. Practicing Story Board Colours in visual designs
5. Visit to an advanced digital studio
6. Design ear panels
7. Design a visual dominant advertisement
8. Design a souls advertisement
9. Design an advertisement for a consumer product
10. Design a corporate advertisement
11. Design a public service advertisement
12. Design a testimonial advertisement
13. Design a comparative advertisement
14. Design an advertisement for brand promotion
15. Design an advertisement with emotional appeal
16. Design an advertisement with fear appeal
17. Design an advertisement with humorous appeal

References

1. Visual Communications, Hasan Siddiqui, Anmol Publications Pvt Ltd, 2011
2. Visual Communications, Paul Martin, Bio Green Books, 2016
3. Practice of Advertising, Adrian R Mackay, Reed Elsevier India Pvt.Ltd, 2005
4. Handbook of Advertising, Christopher Jones, Nabu Press, 2010
5. Advertising Handbook, Alistair Paterson, Routledge, 2002
6. www.iadtdesign.com
7. www.pinterest.com
8. www.vcgcorporate.com
9. www.blog.bannersnack.com
10. www.wordstream.com

**M.SC. (AG.) AGRICULTURAL ECONOMICS
DISTRIBUTION OF COURSES**

Major – 20 credits			
S. No.	Course No.	Title	Credit Hours T + P
1.	AEC 611	Micro Economic Analysis	2+1
2.	AEC 612	Macro Economics Analysis	2+0
3.	AEC 613	Agricultural Marketing and International Trade	2+1
4.	AEC 614	Research Methodology for Social Sciences	1+1
5.	AEC 621	Agricultural Production Economics	1+1
6.	AEC 622	Agricultural Finance and Project Management	2+1
7.	AEC 623	Basic Econometrics	2+1
8.	AEC 624	Agricultural Development Policy Analysis	2+0
		Total	14+6=20
Minor- 9 credits			
1.	OPC AEC 621	Natural Resource and Environmental Economics	2+1
2.	OPC AEC 711	Agri Business Analysis	2+1
3.	OPC AEC 712	Agricultural Insurance and Risk Management	2+1
		Total	6+3=9
Supporting courses- 5 credits			
1.	STA-612	Statistics for Social Sciences	2+1
2.	COM-611	Computer Applications for Agricultural Research	1+1
		Total	3+2=5
Seminar + Research - 21 credits			
1.	AEC -032	Seminar	0+1
2.	AEC -011; 021;031;041	Research 011-0+1; , 021-0+2; , 031- 0+8; , 041- 0+9	0+20
		Grand Total	22+33 = 55
Non credit compulsory course 2 + 4 = 6			
1	PGS 611	Research Data Analysis	0+1
2	PGS 612	Technical Writing and Communication Skills	0+1
3	PGS 623	Basic Analytical Techniques	0+1
4	PGS 624	Library and Information Services	0+1
5	PGS 715 (e-course)	Intellectual Property and its Management in Agriculture	1+0
6	PGS 716 (e-course)	Disaster Management	1+0
		Total	2+4=6

**M.SC. (AG.) AGRICULTURAL ECONOMICS
SEMESTER – WISE DISTRIBUTION**

S. No.	Course Code	Title	Credit Hours
First Semester			
1.	AEC 611	Micro Economic Analysis	2+1
2.	AEC 612	Macro Economics Analysis	2+0
3.	AEC 613	Agricultural Marketing and International Trade	2+1
4.	AEC 614	Research Methodology for Social Sciences	1+1
5.	STA 612	Statistics for Social Sciences	2+1
6.	COM 611	Computer Applications for Agricultural Research	1+1
7.	AEC 011	Research	0+1
8.	PGS 611	Research Data Analysis	0+1
9.	PGS 612	Technical Writing and Communication Skills	0+1
Total			10+6 = 16
Second Semester			
1.	AEC 621	Agricultural Production Economics	1+1
2.	AEC 622	Agricultural Finance and Project Management	2+1
3.	AEC 623	Basic Econometrics	2+1
4.	AEC 624	Agricultural Development Policy Analysis	2+0
5.	OPC AEC 621	Natural Resource and Environmental Economics	2+1
6.	AEC 021	Research	0+2
7.	PGS 623	Basic Analytical Techniques	0+1
8.	PGS 624	Library and Information Services	0+1
Total			9+6 = 15
Third Semester			
1.	OPC XXX 711	Minor Course - Related discipline	2+1
2.	OPC XXX 712	Minor Course - Related discipline	2+1
3.	AEC 031	Research	0+8
4.	AEC 032	Seminar	0+1
5.	PGS 715 (e-course)	Intellectual Property and its Management in Agriculture	1+0
6.	PGS 716 (e-course)	Disaster Management	1+0
Total			4+11 = 15
Fourth Semester			
1.	AEC 041	Research	0+9
Total			0+9 = 9
Grand Total			23+32 = 55

AEC 611 MICRO ECONOMIC ANALYSIS (2+1)

Objectives

To introduce the basic concepts of microeconomics to the students and teach their applications in agriculture.

Theory

Unit-I - Consumer behaviour

Meaning and nature of microeconomics - economic systems - methods of economic analysis. Theory of consumer behaviour - cardinal utility theory - ordinal utility theory - income effect and substitution effect - revealed preference hypothesis. Consumer's surplus. Theory of demand - derivation of demand curve - elasticity of demand.

Unit-II - Theory of production

Theory of production - production functions - returns to scale and economies of scale - technical progress. Theory of costs - cost curves - envelope curve - profit maximization and cost minimization. Derivation of supply curve - law of supply - producers' surplus.

Unit-III - Market equilibrium

Market equilibrium - behaviour of firms in competitive markets - perfect competition - short run and long run equilibrium - monopoly - bilateral monopoly - price discrimination - monopolistic competition - duopoly (Cournot, Stackelberg's models) - oligopoly (Kinked demand model).

Unit-IV - Factor pricing

Factor pricing in perfect and imperfect competitive markets - factor pricing and income distribution.

Unit-V - Welfare economics

General equilibrium theory - interdependence in the economy - general equilibrium and allocation of resources. Welfare economics - Pareto criterion - The Kaldor-Hicks compensation criterion. Social welfare functions.

Practical

Theory of consumer behaviour - discussion and exercises in demand analysis - derivation of elasticity of demand - estimation of various demand functions - equilibrium price analysis - production function analysis - analysis of short run and long run costs - profit function - analysis and discussions of market structure - performance under various parameters of imperfection through graphical and mathematical means - cost function - economies of size and scale - price discrimination - factor pricing analysis - income distribution analysis - discussion of economic rent - Pareto optimality concept - models on partial and general equilibrium.

Theory schedule

1. Meaning and nature of microeconomics
2. Economic systems
3. Methods of economic analysis
4. Theory of consumer behaviour
5. Cardinal utility theory
6. Ordinal utility theory - income effect and substitution effect
7. Revealed preference hypothesis

8. Consumers' surplus
9. Theory of demand - derivation of demand curve
10. Elasticity of demand
11. Theory of production
12. Production functions
13. Return to scale and economies of scale
14. Technical progress
15. Theory of costs - cost curves - envelope curve
16. Profit maximization and cost maximization
17. Mid semester examination
18. Derivation of supply curve - law of supply - producer's surplus
19. Market equilibrium - behaviour of firms in competitive markets
20. Perfect competition - short run and long run equilibrium
21. Monopoly - bilateral monopoly - price discrimination
22. Monopolistic competition
23. Duopoly (Cournot, Stackelberg's models)
24. Oligopoly (Kinked demand model)
25. Factor pricing in perfect competitive markets
26. Factor pricing in imperfect competitive markets
27. Factor pricing and income distribution
28. General equilibrium theory
29. Interdependence in the economy
30. General equilibrium and allocation of resources
31. Welfare economics
32. Pareto criterion
33. The Kaldor-Hicks compensation criterion
34. Social welfare functions

Practical schedule

1. Theory of consumer behaviour
2. Demand analysis - elasticity of demand
3. Estimation of demand functions
4. Equilibrium price analysis
5. Production function analysis
6. Analysis of short run costs
7. Analysis of long run costs
8. Price determination under perfect market situation
9. Price determination under imperfect market situation
10. Cost function
11. Economies of size and scale
12. Exercises on monopolistic competition
13. Price discrimination
14. Factor pricing analysis
15. Income distribution analysis
16. Partial and general equilibrium theory
17. Pareto optimality criteria

Reference books

1. Barthwal, R.R., 2005. *Microeconomic Analysis*, Wiley Eastern, New Delhi.
2. Hal R. Varian, 1999. *Microeconomic Analysis*, W.W. Norton and Company, New York.
3. Henderson, J.M. and R.E. Quandt, 2000. *Microeconomic Theory: A Mathematical Approach*, Tata McGraw Hill, New Delhi.
4. Koutsoyiannis, A., 2003. *Modern Microeconomics*, The Mac Millan Publication, London.
5. Dewitt K.K., 2002. *Modern Economic Theory*, Sultan Chand and Co., New Delhi.
6. <http://ocw.mit.edu/courses/economics/>
7. <http://jgc-econ.intrasun.tcnj.edu/Micro%20Links.htm>
8. <http://www.oswego.edu/~kane/econ101.htm>
9. <http://catalog.flatworldknowledge.com/bookhub/13>

AEC 612 MACRO ECONOMIC ANALYSIS (2+0)**Objectives**

To explain the basic concepts, theories and various macroeconomics indicators to the students and make them to understand the implications of the macroeconomic policy measures.

Theory**Unit-I - Macroeconomics - basic concepts**

Nature and scope of macro economics - methodology and Keynesian concepts. National income - concepts and measurement. Classical theory of employment and Say's Law - Modern theory of employment and effective demand.

Unit-II - Consumption, saving and investment

Consumption function - investment and savings - concept of multiplier and accelerator - Keynesian theory of income, output and employment. Rate of interest - Classical, Neo classical and Keynesian version - classical theory Vs Keynesian theory. Unemployment and full employment.

Unit-III - Money and prices

Money and classical theories of money and price - Keynesian theory of money and Friedman restatement theory of money - supply of money - demand for money. Inflation: nature, effects and control.

Unit-IV - Public finance

IS and LM frame work. General equilibrium of product and money markets. Monetary policy - fiscal policy- effectiveness of monetary and fiscal policy - Central banking.

Unit-V - Macroeconomic policy

Business cycles. Trade policies - balance of payments - balance of payments adjustment policy with fixed exchange rates and flexible exchange rates - international macroeconomic policies - economic growth and public policy.

Theory schedule

1. Nature and scope of macro economics
2. Methodology and Keynesian concepts
3. National income - concepts and measurement

4. Classical theory of employment
5. Say's Law
6. Modern theory of employment and effective demand
7. Consumption function
8. Investment and savings
9. Concept of multiplier and accelerator
10. Keynesian theory of income and output and employment
11. Rate of interest - Classical, Neo classical and Keynesian version
12. Classical theory Vs Keynesian theory
13. Unemployment and full employment
14. Money and classical theories of money and price
15. Keynesian theory of money
16. Friedman restatement theory of money
17. Mid semester examination
18. Supply of money
19. Demand for money
20. Inflation: nature, effects and control
21. IS and LM frame work
22. General equilibrium of product market
23. General equilibrium of money market
24. Monetary policy
25. Fiscal policy
26. Effectiveness of monetary and fiscal policy
27. Central banking
28. Business cycles
29. Trade policies
30. Balance of payments
31. Balance of payments adjustment policy with fixed exchange rates
32. Balance of payments adjustment policy with flexible exchange rates
33. International macroeconomic policies
34. Economic growth and public policy

Reference books

1. Ahuja, H.L., 2007. *Macro Economics - Theory and Policy*, S. Chand and Co. Ltd., New Delhi.
2. Branson, H. William, 1986. *Macroeconomic Theory and Policy*, Harper Collins, New Delhi.
3. Dornbusch, 2006. *Macroeconomics*, McGraw Hill Publication, New Delhi.
4. Eugene A Diulio, 2006. *Macroeconomics*, 4th Ed. Schaums' Outlines, New Delhi.
5. Shapiro, Edward, 1989. *Macroeconomic Analysis*, Galgotta Publications, New Delhi.
6. <http://ocw.mit.edu/courses/economics/14-02-principles-of-macroeconomics-fall-2009/>
7. www.uh.edu/~bsorensen/Macro_Lecture_Notes.pdf

8. <http://www.cals.ncsu.edu/course/are012/notes.html>
9. <http://getyourecon.com>
10. <http://welkerswikinomics.com/blog/>
11. <http://www.econclassroom.com>
12. <http://econphd.econwiki.com/notes.htm>
13. <https://www.coursera.org/course/macroeconomics>

AEC 613 AGRICULTURAL MARKETING AND INTERNATIONAL TRADE (2+1)

Objective

This course aims at teaching the students about the various principles and dynamic changes of agricultural marketing and price analysis with their application at both micro and macro levels.

Theory

Unit-I - Agricultural marketing

Agricultural marketing and economic development - characteristics of agricultural products. Producer's surplus - marketed and marketable surplus. Marketing efficiency - marketing costs, margins and price spread - technical and pricing efficiency.

Unit-II - Market structure

Market structure, conduct and performance. Market integration - vertical and horizontal integration - vertical co-ordination. Marketing system and sub-sector analysis. Determination of inputs and output prices under different market situations. Market research and information - sources of agricultural marketing information - role of ICT in agricultural marketing - NAM - e NAM - market linkages - public-private partnership - contract farming

Unit-III - Agricultural price analysis and policy

Price indices and parity concepts - price support programmes - subsidies - MSP - SAP - CACP. Spatial and temporal price relationships - price forecasting - price policies and economic development. Marketing institutions - cooperatives - regulated markets - state trading and government interventions - Agmark.

Unit-IV - Demand - supply relationship and prices

Role of agricultural prices - supply and demand relationships - demand and supply models - incorporation of risk. Future markets - speculation - hedging - commodity exchange. Marketing of derivatives - integration of spot and future markets - role of FMC in agricultural marketing.

Unit-V - International trade

International trade - introduction and scope - basic concepts. Foreign exchange market. Terms of trade - WTO and their role in promotion of trade - export and import policies of India - agricultural export zones - export promotion agencies in India - APEDA - MPEDA. Role of World Bank, IMF and ADB in international trade. Role of EXIM bank and commercial banks in foreign trade - IPR - international organization of standards - HACCP - organic certification.

Practical

Producer's surplus - price spread analysis - estimation of marketing efficiency - technical and allocation efficiency - estimation of index numbers - price index - WPI - time series analysis and forecasting - demand and supply estimation in single

and multimarket situation - value chain analysis for major agricultural commodities - price instability - Markov chain model - market equilibrium analysis - visit to cooperative marketing institution - visit to regulated market - visit to agro processing units - export organizations - EXIM bank - visit to patent office, Chennai - case studies on rice, wheat and other major food grains - case studies on horticultural crops.

Theory schedule

1. Agricultural marketing and economic development
2. Characteristics of agricultural products and production
3. Producer's surplus, marketed and marketable surplus
4. Marketing efficiency, marketing costs, margins and price spread - technical and pricing efficiency
5. Market structure, conduct and performance (SCP paradigm)
6. Market integration, vertical and horizontal integration - conglomeration
7. Vertical co-ordination
8. Marketing system and sub sector analysis
9. Determination of input and output prices under different market situations
10. Market research and information and sources of market information
11. Role of ICT in agricultural marketing - NAM - e - NAM
12. Market linkages - public - private partnership - contract farming
13. Price indices and parity concepts
14. Price support programmes and subsidies - MSP - SAP - CACP
15. Spatial and temporal price relationships
16. Price forecasting - price policies and economic development
17. Mid semester examinations
18. Marketing institutions - co-operative markets - regulated market
19. State trading and government intervention - Agmark
20. Role of agricultural price - supply and demand relationship
21. Demand and supply model incorporation of risk
22. Future market speculation - hedging
23. Commodity exchange - Marketing of derivatives - Integration of spot and future markets
24. Role of FMC in agricultural marketing
25. International trade - introduction and scope - basic concepts
26. Foreign exchange market
27. Terms of trade
28. WTO and the role in promotion of trade
29. Export and import policies of India
30. Agricultural export zones
31. Export promotion agencies in India - APEDA - MPEDA
32. Role of world bank, IMF and ADB in international trade
33. Role of EXIM bank and commercial banks in foreign trade - IPR
34. International organization of standards - HACCP - organic certification

Practical schedule

1. Estimation procedure for producers surplus of different agricultural commodities
2. Price spread analysis
3. Marketing efficiency - technical and allocation efficiency
4. Estimation of index number - price index - WPI
5. Time series analysis and forecasting
6. Estimation of demand and supply estimation of - single and multi market situations
7. Value chain analysis for major agricultural commodities
8. Price instability analysis for agricultural commodities
9. Markov - chain analysis
10. Market equilibrium analysis
11. Visit to co-operative market institution
12. Visit to regulated market
13. Visit to agro processing unit
14. Export organizations - EXIM bank
15. Visit to patent office - Chennai
16. Case study on rice, wheat and other major food grains
17. Case study on horticultural crops

Reference books

1. Acharya, S.S. and N.L. Agarwal, 2004. *Agricultural Prices - Analysis and Policy*, Oxford and IBH, New Delhi.
2. Acharya, S.S. and N.L. Agarwal, 2008. *Agricultural Marketing in India*, Oxford and IBH, New Delhi.
3. Dhal, C. Dale and Hammond W. Jerome, 1997. *Market and Price Analysis - The Agricultural Industries*, McGraw Hill Book Company, New York.
4. Francis Cherunilam, 2006. *International Trade and Export management*, Himalaya Publishing House, Mumbai.
5. Gulati, Ashok, 1996. *Agricultural Price Policy in India - An Econometric Approach*, Concept Publishing Company, New Delhi.
6. <https://lss.at.ufl.edu/>.
7. <http://www.oerafrica.org>.

AEC 614 RESEARCH METHODOLOGY FOR SOCIAL SCIENCES (1+1)**Objectives**

To expose the students to research methodology used in social sciences. The focus will be on providing knowledge related to research process, data collection and data analysis.

Theory**Unit-I - Research process**

Importance and scope of research in agricultural economics. Types of research - fundamental Vs. applied. Concept of researchable problem - research prioritization - selection of research problem - steps in formulation research problem. Approaches to research - research process. Hypothesis - meaning -

characteristics - types of hypothesis - setting of research objectives and hypotheses
- review of literature.

Unit-II - Research design

Research design and techniques - types of research design. Sampling theory and sampling design - sampling error - methods of sampling - probability and non-probability sampling methods - sampling under different situations - criteria to choose.

Unit-III - Data collection

Data collection - assessment of data needs - sources of data collection - Methods of collecting primary and secondary data - case study - criteria for selection of appropriate method of data collection. Mailed questionnaire and interview schedule - structured, unstructured, open ended and closed-ended questions. Preparation of schedule - selection of variables - scaling techniques and measurement - problems in measurement of variables in agriculture. Interviewing techniques and field problems - methods of conducting survey - reconnaissance survey and pre testing.

Unit-IV - Data analysis

Data processing - coding - editing - tabulation - validation of data. Tools of analysis - statistics in research - descriptive and inferential statistics - Parametric and non-parametric tests - correlation analysis - association of attributes - regression analysis - testing of hypothesis - statistical test based on normal population - small and large sample test. Use of econometric software in data analysis.

Unit-V - Report writing

Interpretation of results - techniques of interpretation - significance of report writing - layout of report writing - illustration of tables - preparing research report / thesis - universal procedures for preparation of bibliography, reference, foot notes - writing of research articles.

Practical

Exercises in problem identification. Project proposals - contents and scope. Formulation of objectives and hypotheses. Assessment of data needs - sources of data - methods of collection of data. Methods of sampling - criteria to choose - discussion on sampling under different situations. Scaling techniques - measurement of scales. Preparation of interview schedule - field testing, finalizing and coding. Methods of conducting survey. Data preparation process - exercise on coding, editing, tabulation and validation of data. Preparing for data entry into computer - statistics in research descriptive and inferential statistics. Use of econometric software in data analysis. Hypothesis testing - Parametric and non-parametric tests. Exercises on format for thesis / report writing. Presentation of the results.

Theory schedule

1. Importance and scope of research in agricultural economics - types of research - fundamental Vs. applied
2. Concept of researchable problem - research prioritization - selection of research problem - steps in formulation research problem

3. Approaches to research - research process. Hypothesis - meaning - characteristics - types of hypothesis - setting of research objectives and hypotheses - review of literature
4. Research design and techniques - types of research design
5. Sampling theory and sampling design - sampling error - methods of sampling - probability and non-probability sampling methods - sampling under different situations - criteria to choose
6. Data collection - assessment of data needs - sources of data collection - methods of collecting primary and secondary data - case study - criteria for selection of appropriate method of data collection
7. Mailed questionnaire and interview schedule - structured, unstructured, open ended and closed-ended questions
8. Preparation of schedule - selection of variables - scaling techniques and measurement - problems in measurement of variables in agriculture
9. Mid semester examination
10. Interviewing techniques and field problems - methods of conducting survey - reconnaissance survey and pre testing.
11. Data processing - coding - editing - tabulation - validation of data
12. Tools of analysis - statistics in research - descriptive and inferential statistics
13. Parametric tests - Non-parametric tests - correlation analysis - association of attributes - regression analysis
14. Testing of hypothesis - statistical test based on normal population - small and large sample test
15. Use of econometric software in data analysis
16. Interpretation of results - techniques of interpretation - significance of report writing - layout of report writing - illustration of tables - preparing research report / thesis
17. Universal procedures for preparation of bibliography, reference, foot notes - writing of research articles

Practical schedule

1. Exercises in problem identification
2. Project proposals - contents and scope
3. Formulation of objectives and hypotheses
4. Assessment of data needs - sources of data - methods of collection of data
5. Methods of sampling - criteria to choose
6. Discussion on sampling under different situations
7. Scaling techniques - measurement of scales
8. Preparation of interview schedule - field testing, finalizing and coding
9. Methods of conducting survey
10. Exercise on coding, editing, tabulation and validation of data
11. Statistics in research descriptive and inferential statistics
12. Use of econometric software in data analysis
13. Preparing for data entry into computer
14. Hypothesis testing - parametric tests
15. Non-parametric tests

16. Exercises on format for thesis / report writing
17. Presentation of the results

Reference books

1. Creswell, J.W., 1999. Research Design - Qualitative and Quantitative Approaches, SAGE Publication, New Delhi.
2. Kothari, C.R., Gaurav Gang, 2014. Research Methodology - Methods and Techniques, New Age International Publication, New Delhi.
3. Raj, G.L., Saga Mondal, 2004. Research Methods in Social Science and Extension Education, Kalyani Publication, New Delhi.
4. Rao, K.V., 1993. Research Methodology in Commerce and Management, Sterling Publication, New Delhi.
5. Singh, A.K., 1993. Tests, Measurements and Research Methods in Behavioural Sciences, Tata McGraw-Hill, New Delhi.
6. <http://ase.tufts.edu/gdae/?gclid=CPGY7pfyjL4CFU0pjgodul8AWA>
7. <https://www.iser.essex.ac.uk/study>
8. <http://www.sagepub.com/isw4/weblinks.htm>
9. <http://econpapers.repec.org/article/agsaerrae/>

AEC 621 AGRICULTURAL PRODUCTION ECONOMICS (1+1)

Objective

The objective of this course is to provide applied and practical understanding of production economics and farm management techniques with emphasis on its economic analysis.

Theory

Unit-I - Scope of agricultural production economics

Nature, scope and significance of agricultural production economics - agricultural production process - relationship between farm management and production economics. Neoclassical production function - three stages - physical and economic optimum - elasticity of production

Unit-II - Production and cost functions

Production functions - forms and types - production with two input case - production of more than one product. Cost concepts and cost functions - linkages between cost and production functions - duality of cost and production. Economies and diseconomies of scale - returns to scale.

Unit-III - Economic efficiency

Technology in agricultural production - nature, effect and measurement - measuring efficiency in agricultural production - technical, allocative and economic efficiencies. Yield gap analysis - concepts - types and measurement.

Unit-IV - Linear programming

Linear programming and marginal analysis - simplex method, maximization and minimization - duality - simulation and programming techniques in agricultural production.

Unit-V - Risk and uncertainty

Elements of risk and uncertainty in agriculture - measurement of risk and adjustment to risk - incorporation of weather uncertainty in decision making - risk constrained linear programming model - MOTAD model - game theory models.

Practical

Principle of diminishing marginal returns - estimation of different forms of production functions using farm level data - estimation of elasticity - estimation of isoquant and least cost combinations of factors - product - product relationship - cost function analysis - factor share analysis - decomposition analysis - technical efficiency estimation and frontier production functions - linear programming - maximization and minimization - MOTAD - Goal programming.

Theory schedule

1. Nature, scope, significance of agricultural production economics
2. Agricultural production process - relationship between farm management and production economics
3. Neoclassical production function - three stages - physical and economic optimum
4. Elasticity of production. Production functions - forms and types of production functions
5. Production with two input case - production of more than one product
6. Cost concepts and cost functions - linkages between cost and production functions - duality of cost and production
7. Economies and diseconomies of scale
8. Returns to scale - technology in agricultural production - nature, effect and measurement
9. Mid semester examination
10. Measuring efficiency in agricultural production – technical, allocative and economic
11. Yield gap analysis – concepts - types and measurement of yield gap
12. Linear programming and marginal analysis. Simplex method – maximization - duality
13. Simulation and programming techniques in agricultural production
14. Elements of risk and uncertainty in agriculture - measurement of risk and adjustment to risk
15. Incorporation of weather uncertainty in decision making
16. Risk constrained linear programming model - MOTAD model
17. Game theory models

Practical schedule

1. Principle of diminishing marginal returns
2. Estimation of different forms of production functions using farm level data
3. Estimation of different forms of production functions using farm level data (cont.)
4. Estimation of elasticity of production
5. Estimation of isoquant and least cost combinations of factors
6. Product - product relationship
7. Cost function analysis
8. Factor share analysis
9. Decomposition analysis

10. Technical efficiency estimation and frontier production functions
11. Technical efficiency estimation and frontier production functions (cont.)
12. Linear programming - maximization
13. Linear programming - minimization
14. Dual problems
15. Dual problems (cont.)
16. MOTAD
17. Goal programming

Reference books

1. David, L., Debertin, 2012. *Agricultural Production Economics*, (Second edition), Macmillan Publishing Company, New York.
2. Doll, John P. and Frank Orazem, 1978. *Production Economics - Theory and Applications*, John Wiley and Sons, New York.
3. Palanisami, K., P. Paramasivan and C.R. Ranganathan, 2002. *Agricultural Production Economics - Analytical Methods and Applications*, Associate Publishing Company, New Delhi.
4. Peter, B.R., Hazell and Roger D. Norton, 1986. *Mathematical Programming for Economic Analysis in Agriculture*, Macmillan Publishing Company, New York.
5. Sankhayan, P.L., 1998. *Introduction to the Economics of Agricultural Production*, Prentice Hall of India, New Delhi.
6. <http://ocw.mit.edu/courses/economics>
7. <https://www.msu.edu/course/ECO/855>
8. <http://www.uky.edu/~deberti/prod/agprod5.pdf>
9. http://www.csuchico.edu/ag/_assets/documents/syllabi/ABUS/ABUS%20301%20AG%20Production%20Econ%20Analysis.pdf

AEC 622 AGRICULTURAL FINANCE AND PROJECT MANAGEMENT (2+1)

Objective

The objective of the course is to impart knowledge on issues related to lending to priority sector. The course would also bring in the various appraisal techniques in agricultural project management.

Theory

Unit-I - Agricultural finance

Role and importance of agricultural finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending - direct and indirect financing. Financing through co-operatives - principles of co-operation - co-operative movement in India - present trend of co-operative institutions in India - NABARD, commercial banks and RRBs - District credit plans and lending to agriculture/priority sector. Micro financing - role of MFI's, NGOs and SHGs. Non-banking financial institutions in India.

Unit-II - Agricultural credit system

Lending to farmers - the concept of 3 C's, 7 P's and 3 R's of credit. Estimation of technical feasibility, economic viability and repaying capacity of borrowers - appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions - credit widening and credit deepening.

Unit-III - Financial statements and analysis

Financial decisions - investment, financing, liquidity and solvency. Preparation of financial statements - balance sheet, cash flow statement and profit and loss account. Ratio analysis and assessing the performance of farm/firm - financial literacy and lending to small and marginal farmers.

Unit-IV - Agricultural project management

Project approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Project cycle - identification, formulation, appraisal, financing, implementation and evaluation of projects. Project appraisal techniques - undiscounted measures - time value of money - use of discounted measures - BCR, NPV and IRR. Sensitivity analysis, Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Net work techniques - PERT, CPM and Grash programme methods.

Unit-V - Risk management in agriculture

Risks in financing agriculture. Risk management strategies and coping mechanisms. Crop Insurance programmes - review of different crop insurance schemes - yield loss and weather based insurance and their applications. Agriclincs and agribusiness centers.

Practical

Demand and supply of institutional agricultural credit. District credit plan. Preparation of scale of finance for selected crops. Preparation of financial statements using farm/firm level data. Farm credit appraisal techniques and farm financial analysis through financial statements. Financial instruments and methods - E-banking, kisan cards and core banking. Time value of money. Identification and formulation of investment projects. Project appraisal techniques - undiscounted measures and their limitations. Discounted measures. Sensitivity analysis. Network techniques - PERT and CPM for project management. SWOC analysis - Decision tree analysis - social cost and benefit analysis - Environmental Impact Assessment (EIA).

Theory schedule

1. Role and importance of agricultural finance
2. Financial Institutions and credit flow to rural/priority sector
3. Agricultural lending - direct and indirect financing
4. Financing through co-operatives
5. Principles of co-operation and co-operative movement in India
6. Present trend of co-operative institutions in India
7. Role of NABARD, Commercial Banks and RRBs in agricultural lending
8. District Credit Plan and lending to agriculture/priority sector.
9. Micro-financing and role of MFI's, NGOs, and SHGs - Non-banking financial institutions (NBFIs) in India
10. Lending to farmers - The concept of 3 C's, 7 P's and 3 R's of credit
11. Estimation of technical feasibility, economic viability and repaying capacity of borrowers and appraisal of credit proposals

12. Understanding lenders and developing better working relationship and supervisory credit system
13. Credit inclusions - credit widening and credit deepening
14. Financial decisions - investment, financing, liquidity and solvency
15. Preparation of financial statements
16. Balance sheet, cash flow statement
17. Mid semester examination
18. Profit and loss account and ratio analysis
19. Assessing the performance of farm/firm
20. Financial literacy and lending to small and marginal farmers
21. Project approach in financing agriculture
22. Financial, economic and environmental appraisal of investment projects
23. Project cycle identification, preparation, appraisal, financing and implementation of projects
24. Project appraisal techniques - undiscounted measures - time value of money
25. Use of discounted measures - BCR, NPV and IRR
26. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects
27. Net work techniques - PERT and CPM
28. Risks in financing agriculture
29. Risk management strategies and coping mechanisms
30. Crop insurance programmes
31. Review of different crop insurance schemes
32. Assessment of yield loss
33. Weather based insurance and their applications
34. Agriclincs and agribusiness centres

Practical schedule

1. Demand and supply of institutional agricultural credit
2. District credit plan
3. Preparation of scale of finance for selected crops
4. Preparation of financial statements using farm/firm level data
5. Farm credit appraisal techniques
6. Farm financial analysis through financial statements
7. Financial instruments and methods - E banking, kisan cards and core banking
8. Time value of money
9. Identification and formulation of investment projects
10. Project appraisal techniques - undiscounted measures and their limitations
11. Discounted measures
12. Sensitivity analysis
13. Network techniques - PERT and CPM for project management
14. SWOC analysis
15. Decision tree analysis

16. Social cost and benefit analysis
17. Environmental Impact Assessment (EIA)

Reference books

1. Dhubashi, P.R., 1986. Policy and Performance - Agricultural and Rural Development in Post Independent India. Sage Publ. New Delhi.
2. Gittinger, J.P., 1982. Economic Analysis of Agricultural Projects. The Johns Hopkins Univ. Press. London.
3. Gupta, S.C., 1987. Development Banking for Rural Development. Deep and Deep Publ. New Delhi.
4. Little IMD and Mirlees JA., 1974. Project Appraisal and Planning for Developing Countries. Oxford and IBH Publ. New Delhi.
5. Muniraj, R., 1987. Farm Finance for Development. Oxford and IBH Publ. New Delhi.
6. Subba Reddy, S. and P. Raghu ram, 2014, Agricultural Finance and Management, Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi.

AEC 623 BASIC ECONOMETRICS (2+1)

Objective

The objective of the course is to impart knowledge on econometric tools to the students of agricultural economics. This would help the students to analyze the economic problems by applying appropriate quantitative techniques.

Theory

Unit-I - Basic concepts

Econometrics - definition - methodology and types of econometrics. Nature and sources of data for econometric analysis. Basic ideas of regression analysis - PRF and SRF - linearity of regression model - significance of stochastic error term. Estimation of two variable regression model - method of Ordinary Least Square.

Unit-II - Classical linear regression model

Classical linear regression model - assumptions underlying the method of least square - Normality assumption of error term - properties of least square estimators. Gauss-Markov theorem. Goodness of fit - coefficient of determination. Method of Maximum Likelihood Estimate (MLE). Interval estimation and hypothesis testing. Extensions of two variable regression models - regression through origin. Nature of dummy variables - dummy variable regression models - test for structural stability of regression model.

Unit-III - Hypothesis testing

Estimation in multiple regression analysis - OLS estimators - multiple coefficient of determination - R^2 and adjusted R^2 - inference in multiple regression analysis. Hypothesis testing - individual regression coefficient - overall significance of the model - F-test and t-test

Unit-IV - Problems in estimation

Relaxing the assumptions of CLRM: Multicollinearity - definition, consequences, detection, remedial measures. Heteroscedasticity - definition, detection, consequences. Autocorrelation - definition, consequences, detection - remedial measures Durbin-Watson test. Model specification diagnostic tests - tests of specification errors.

Unit-V- Econometric models

Dummy variable regression models - intercept and slope dummy - estimation and interpretation. Dummy dependent variable models. Linear probability models - logit and probit models - estimation and interpretation. Simultaneous equation models - structural equations - reduced form equations - identification and approaches to estimation.

Practical

Single equation two variable model - specification and estimation - hypothesis testing - restrictions on parameters - transformations of functional forms and OLS application - estimation of multiple regression model - hypothesis testing - testing and correcting specification errors - testing and managing multicollinearity - testing and managing heteroscedasticity - testing and managing autocorrelation - estimation of regressions with dummy explanatory variables - intercept and slope dummy variable models. Estimation of regression with limited dependent variable - logit and probit models. Identification of equations in simultaneous equation models.

Theory schedule

1. Econometrics - definition, methodology and types of econometrics
2. Nature and sources of data for econometric analysis
3. Basic ideas of regression analysis: PRF and SRF
4. Linearity of regression model - significance of stochastic error term
5. Estimation of two variable regression model - method of Ordinary Least Square.
6. Classical linear regression model: assumptions underlying the method of least square
7. Normality assumption of error term in CNLRM
8. Properties of least square estimators - Gauss-Markov theorem
9. Goodness of fit - coefficient of determination
10. Method of Maximum Likelihood Estimate (MLE)
11. Interval estimation and hypothesis testing
12. Extensions of two variable regression models: regression through origin
13. Nature of dummy variables - dummy variable regression models
14. Test for structural stability of regression model
15. Estimation in multiple regression analysis: OLS estimators
16. Multiple coefficient of determination R^2 and adjusted R^2
17. Mid semester examination
18. Inference in multiple regression analysis: Hypothesis testing
19. Individual regression coefficient
20. Overall significance of the model - F-test and t-test
21. Relaxing the assumptions CLRM: Multicollinearity - definition, consequences, multicollinearity, detection - remedial measures
22. Heteroscedasticity - definition, consequences, detection
23. Autocorrelation - definition, consequences, detection - remedial measures
24. Durbin-Watson test
25. Model specification diagnostic tests

26. Tests of specification errors
27. Dummy variable regression models - intercept and slope dummy
28. Estimation and interpretation
29. Dummy dependent variable models
30. Linear probability models - logit and probit models
31. Estimation and interpretation
32. Simultaneous equation models
33. Structural equations - reduced form equations
34. Identification and approaches to estimation

Practical schedule

1. Single equation two variable model - specification and estimation
2. Hypothesis testing
3. Restrictions on parameters
4. Transformations of functional forms - OLS application
5. Estimation of multiple regression model
6. Hypothesis testing
7. Testing and correcting specification errors
8. Testing and managing multicollinearity
9. Testing and managing heteroscedasticity
10. Testing and managing autocorrelation
11. Estimation of regressions with dummy explanatory variables
12. Intercept dummy variable model
13. Slope dummy variable model
14. Estimation of regression with limited dependent variable
15. Logit model
16. Probit model
17. Identification of equations in simultaneous equation models

References books

1. Damodar, N. Gujarati, Dawn C. Porter and Sangeetha Gunasekar, 2016, (Fifth Edition), *Basic Econometrics*, Mc-Graw Hill Education (India) Private Limited, Chennai.
2. Harry, H. Kelejan, and Wallace E. Oates, 1974. *Introduction to Econometrics Principles and Applications*, Harper and Row Publication, New York.
3. Koutsoyianis, A., 1977. *Theory of Econometrics*, Barner and Noble, New York.
4. Maddala, G.S., 1992. *Introduction to Econometrics*, MacMillan, New York.
5. Robert, S. Pindyck and Daniel L. Rubinfeld, 1991. *Econometric Models and Economic Forecasts*, Mc-Graw-Hill Inc., New Delhi.
6. http://www.oswego.edu/~kane/econometrics/chap_resources.htm
7. <http://econ.la.psu.edu/~hbierens/lecnotes.htm>
8. <http://www.varsitynotes.com/economics/econometrics.html>
9. <http://www.stata.com/features/>
10. <http://www.oswego.edu/~economic/econsoftware.htm>
11. <http://ocw.mit.edu/courses/political-science/17-874-quantitative-research-methods-multivariate-spring-2004/>

AEC 624 AGRICULTURAL DEVELOPMENT POLICY ANALYSIS (2+0)

Objectives

To make the students understand the background of development economics, existing policies, their performance and guide them in framing meaningful and relevant policy models.

Theory

Unit-I - Economic development and economic growth

Development economics - scope and importance - economic development and economic growth - divergence in concept and approach - indicators and measurement of economic development. GNP as a measure of economic growth - new measures of welfare - NEW and MEW, PQLI, HDI, green GNP - criteria for under development - obstacles to economic development - economic and non economic factors of economic growth.

Unit-II - Theories of economic growth

Economic development - meaning - stages of economic development - determinants of economic growth. Theories of economic growth - Ricardian growth model - The Harrod Domar Model - The Neo classical model of growth - The Kaldor model - The Von Neumann growth model - optimal economic growth. Recent experiences of developing country - economies in transition - role of state in economic development - government measures to promote economic development - introduction to development planning.

Unit-III - Agricultural policies

Role of agriculture in economic / rural development - theories of agricultural development - population and food supply - need for sound agricultural policies - population policies resource policies - credit policies - input and product marketing policies - price policies - monetary and fiscal policies.

Unit-IV - Role of agriculture in economic development

Development issues - poverty - inequality - unemployment and environmental degradation - models of agricultural development - induced innovation model - policy options for sustainable agricultural development.

Unit-V - Agricultural development and free trade

Globalization and the relevance of development policy analysis - the dilemma of free trade - free trade versus protectionism - arguments for protection - arguments against protection - role of protection in developing countries. WTO - Agreement on Agriculture - contradictions of free trade - proponents and opponents policies in vulnerable sectors like agriculture - lessons for developing countries.

Theory schedule

1. Development economics - scope and importance
2. Economic development and economic growth - divergence in concept and approach
3. Indicators and measurement of economic development
4. GNP as a measure of economic growth
5. New measures of welfare - NEW and MEW
6. PQLI, HDI, Green GNP
7. Criteria for under development - obstacles to economic development

8. Economic and non-economic factors of economic growth
9. Economic development - meaning, stages of economic development, determinants of economic growth
10. Theories of economic growth - Ricardian growth model. The Harrod Domar Model
11. The Neo classical Model of Growth - The Kaldor Model
12. The Von Newmann growth model - Optimal Economic Growth
13. Recent experiences of developing country - economies in transition
14. Role of state in economic development - government measures to promote economic development
15. Introduction to development planning
16. Role of agriculture in economic / rural development
17. Mid semester examination
18. Theories of agricultural development - population and food supply
19. Need for sound agricultural policies - population policies
20. Resource policies - credit policies - input and product marketing policies
21. Price policies - monetary and fiscal policies
22. Development issues - poverty – inequality
23. Unemployment and environmental degradation
24. Models of agricultural development
25. Induced innovation model
26. Policy options for sustainable agricultural development
27. Globalization and the relevance of development policy analysis
28. The dilemma of free trade
29. Free trade versus protectionism - arguments for and against protection
30. Role of protection in developing countries
31. WTO - Agreement on Agriculture
32. Contradictions of free trade
33. Proponents and opponents policies in vulnerable sectors like agriculture
34. Lessons for developing countries

Reference books

1. Ellis Frank, 1992, *Agricultural Policies in Developing Countries*, Cambridge University Press, New York.
2. Ghatak S and Ingersent K., 1984. *Agriculture and Economic Development*, Select Book Service Syndicate, New Delhi.
3. Jhingan, M.L., 1998, *The Economics of Development and Planning*, Vrinda Publication, New Delhi.
4. Naqvi Syed Nawab Haider, 2002, *Development Economics - Nature and Significance*, Sage Publication, New Delhi.
5. Vyas, V.S., 1998, *Policies for Agricultural Development*, Tamil Nadu Book House, Chennai.
6. www.econlib.org
7. www.worldbank.org
8. www.world-economics-journal.com

OPC AEC 621 NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS (2+1)

Objective

To introduce economic principles related to natural resource and environmental economics, explore the concept of efficiency and the efficient allocation of natural resources, understand the economics of environmental problems, explore the concept of pollution control and pollution prevention decisions and understand the environmental policy issues and alternative instruments of environmental policies.

Theory

Unit-I - Basic concepts

Concepts, classification, problems of natural resource economics. Economy - environment interaction - the material balance principle, entropy law. Resource scarcity - limits to growth - measuring and mitigating natural resource scarcity - Malthusian and Ricardian scarcity - scarcity indices - resource scarcity and technical change.

Unit-II - Optimal use

Theory of optimal extraction of renewable resources - economic models of forestry, fisheries - logistic growth curve - maximum sustainable yield and economic yield - theory of optimal depletion of exhaustible resources - efficiency - time path of prices and extraction. Economic models of oil extraction - Hotelling's rule - Solow Harwick's rule.

Unit-III - Markets and natural resources

Efficiency and markets - market failures - externalities - types - property rights - transaction costs - Coase's theorem and its critique - public goods - common property and open access resource management - collective action.

Unit-IV - Economic instruments

Environmental regulation - economic instruments - pollution charges - Pigouvian tax - Carbon trading - tradable permits - indirect instruments - environmental legislations in India.

Unit-V - Sustainability

Concept of sustainable development - economic perspective - indicators of sustainability - relationship between development and environmental stress, poverty and environment - Environment Kuznet's Curve (EKC) - environmental accounting - resource accounting methods. International environmental issues - climate change - likely impacts - adaptation and mitigation efforts - international treaties.

Practical

Land use planning - energy use pattern - solid waste management - biodiversity, biopiracy, biosafety issues. Renewable resource management - optimum harvest of forestry/fishery. Exercise on pollution abatement-I. Exercise on pollution abatement-II. Concepts in valuing the environment. Taxonomy of valuation techniques - productivity change method - substitute cost method - hedonic pricing method - travel cost method - contingent valuation method. Discount rate in natural resource management. Environment impact assessment. Visit to Pollution Control Board. Social cost benefit analysis.

Theory schedule

1. Concepts, classification, problems of natural resource economics
2. Economy - environment interaction

3. The material balance principle, entropy law
4. Resources scarcity - limits to growth
5. Measuring and mitigating natural resource scarcity
6. Malthusian and Ricardian scarcity - scarcity indices
7. Resource scarcity and technical change
8. Theory of optimal extraction renewable resources
9. Economic models of forestry
10. Economic models of fisheries
11. Logistic growth curve - maximum sustainable yield and economic yield
12. Theory of optimal extraction of exhaustible resources
13. Efficiency - time path of prices and extraction
14. Economic models of oil extraction
15. Hotelling's rule, Solow - Harwick's Rule
16. Efficiency and markets - market failures
17. Mid semester examination
18. Externalities - types
19. Property rights - transaction costs
20. Coase's theorem and its critique
21. Public goods - common property and open access resource management
22. Collective action - environmental regulation
23. Economic instruments
24. Pollution charges - Pigouvian tax
25. Carbon trading
26. Tradable permits
27. Indirect instruments
28. Environmental legislations in India
29. Concept of sustainable development
30. Economic perspective - indicators of sustainability
31. Relationship between development and environmental stress, poverty and environment, Environment Kuznet's curve
32. Environmental accounting - resource accounting methods
33. International environmental issues - climate change - likely impacts
34. Adaptation and mitigation efforts - international treaties

Practical schedule

1. Land use planning
2. Energy use pattern
3. Solid waste management
4. Biodiversity, biopiracy, biosafety issues - case studies
5. Renewable resource management
6. Optimum harvest of forestry/fishery
7. Discount rate in natural resource management
8. Exercise on pollution abatement - I
9. Exercise on pollution abatement - II
10. Concepts in valuing the environment

11. Taxonomy of valuation techniques
12. Productivity change method - substitute cost method
13. Hedonic pricing method - travel cost method
14. Contingent valuation method - discount rate in natural resource management
15. Environment impact assessment
16. Visit to Pollution Control Board
17. Social cost, benefit analysis

Reference books

1. Conard, J.M. and W. Collin, 1987. *Natural Resource Economics*, Notes and Problems, Cambridge University Press, London.
2. Kerr, J.M., Marothia D.K., Katar Singh, Ramasamy C. and Bentley W.R., 1997. *Natural Resource Economics: Theory and Applications in India*, Oxford and IBH, New Delhi.
3. Pearce, D.W. and Turner K., 1990. *Economics of Natural Resources and the Environment*, John Hopkins Univ. Press., London.
4. Sengupta, R., 2000. *Ecology and Economy, an Indian Perspective*, Oxford Univ. Press, New Delhi.
5. Tietenberg, T., 2003. *Environmental and Natural Resource Economics*, 6th Ed., Addison Wesley.
6. <http://www.iisd.org/publications>
7. <http://www.valuing-nature.net/>
8. www.teebweb.org
9. <http://ocw.mit.edu/courses/environment-courses/>
10. <http://www.colorado.edu/Economics/morey/4545/4545lnts.html>
11. <http://pubs.iied.org/>
12. <http://www.unep.org/publications/>
13. <http://www.env-econ.net/>
14. <http://environment.yale.edu/TEEB>

OPC AEC 711 AGRI BUSINESS ANALYSIS (2+1)

Objective

The objective of this course is to teach the students the basic concepts, principles and tools of agri/farm business management.

Theory

Unit-I - Agribusiness – basic concepts

Definition - basic concepts - structure of agribusiness - agribusiness sectors - special features of agribusiness - importance of agribusiness in Indian economy - role of farm business management - farm management decisions - farm management problems.

Unit-II - Principles of management

Management - definitions and importance - management functions - nature, roles, skills, levels and functional areas of management. Forms of business

organization - sole proprietorship - partnership - private and public limited - cooperatives.

Unit-III - Elements of management

Planning - definition - types of plans - steps in planning - advantages of planning. Organizing - structure, departmentation - line and staff functions - centralization and decentralization - formal and informal organizations. Staffing - human resource planning - process. Directing - concept, principles, techniques, supervision - motivation - communication - leadership. Controlling - concept, steps, types, process.

Unit-IV - Approaches in agribusiness management

Approaches to management - Management By Objectives (MBO) - Quality Circle (QC) - profit center approach - Strength, Weakness, Opportunity and Threat (SWOT) - Management Information System (MIS) - agribusiness management - future prospects.

Unit-V - Tools of farm management

Principle of variable proportion - cost principle - factor substitution, opportunity cost principle. Farm business analysis - valuation of farm assets and depreciation - net worth statement - income statement - cash flow statement. Farm planning and budgeting - complete budget, partial budget, enterprise budget. Farm records and accounts - types of farm record. Management of farm resources - land, labour, farm machinery, farm building etc., - break even analysis.

Practical

Agribusiness opportunities - business project preparation - business project scheduling - inventory management - production management - working capital management - repayment schedule of loans - feasibility control network analysis - project evaluation - visit to agro processing units and agribusiness units - consumer survey - market potential assessment. Farm survey - methods of data collection - estimation of cost of cultivation for annual and perennial crops - estimation of cost of production of milk, egg, broiler, fish - valuation of farm assets - depreciation of farm assets - farm financial statements - balance sheet - income statement - cash flow statement - budgeting - complete budgeting and partial budgeting - break even analysis.

Theory schedule

1. Definition - basic concepts - structure of agribusiness
2. Agribusiness sectors - special features of agribusiness
3. Importance of agribusiness in Indian economy
4. Role of farm business management
5. Farm management decision
6. Farm management problems
7. Management - definitions and importance
8. Management functions - nature, roles, skills, levels
9. Functional areas of management
10. Forms of business organization
11. Sole proprietorship, partnership
12. Private and public limited, cooperatives

13. Planning - definition - types of plans
14. Steps in planning - advantages of planning
15. Organizing - structure, departmentation - line and staff functions
16. Centralization and decentralization
17. Mid semester examination
18. Formal and informal organizations
19. Staffing - human resource planning process
20. Directing - concept, principles, techniques, supervision
21. Motivation - communication - leadership
22. Controlling - concept, steps, types, process
23. Approaches to management - Management By Objectives (MBO)
24. Quality Circle (QC) - profit center approach
25. Strength, Weakness, Opportunity and Threat (SWOT)
26. Management Information System (MIS) - agribusiness management - future prospects
27. Principle and variable proportion - cost principle
28. Factor substitution, opportunity cost principle
29. Farm business analysis - valuation of farm assets and depreciation
30. Net worth statement - income statement - cash flow statement
31. Farm planning and budgeting - complete budget, partial budget, enterprise budget
32. Farm records and accounts - types of farm records
33. Management of farm resources, land, labour, farm machinery, farm building
34. Break even analysis

Practical schedule

1. Agribusiness opportunities
2. Business project preparation
3. Business project scheduling
4. Inventory management
5. Production management
6. Working capital management
7. Repayment schedule of loans
8. Feasibility control network analysis - project evaluation
9. Visit to agro processing units and agribusiness units
10. Consumer survey - market potential assessment
11. Farm survey - methods of data collection
12. Estimation of cost of cultivation for annual and perennial crops
13. Estimation of cost of production of milk, egg, broiler, fish
14. Valuation of farm assets - depreciation of farm assets - budgeting
15. Farm financial statements - balance sheet - income statement - cash flow statement
16. Complete budgeting and partial budgeting
17. Break even analysis

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OPC AEC 712 AGRICULTURAL INSURANCE AND RISK MANAGEMENT (2+1)

Objective

The aim of this course is to provide the students a thorough knowledge on the principles of insurance, practices of risk management and various insurance policies and schemes available for agri business.

Unit-I - Agricultural finance

Role and importance of agricultural finance. Financial institutions and credit flow to rural/priority sector. Agricultural lending - direct and indirect financing - financing through co-operatives, NABARD, Commercial Banks and RRBs. District Credit Plan- and lending to agriculture/priority sector. The concept of 5 C's, 7 P's and 3 R's of credit.

Unit-II - Classification of risks

The concept of risk - kinds and classification of risks - assessment - the concept of insurance - types of general insurance - agriculture, fire, marine, engineering - insurance of property. Insurance professionals and intermediaries.

Unit-III - Principles of insurance

Basic principle of insurance - utmost good faith - insurable interest - material facts - economic principles - sharing - subrogation - contribution - legal principles - the Indian Contract, 1872 - insurable interest - nomination and assignment - financial principles - premium funds - investments.

Unit-IV - Agricultural risks

Agricultural risks - sources of risk - production and technical risk, output and input price risk, financial risk, political risk, legal risk, personal risk. Risk management tools. Low risk investments. Enterprise diversification - excess - debt capacity, liquid financial reserves. Off - farm Income, shared ownership or leasing risk transfer insurance products. Contracts - hedging and options market.

Unit-V - Agricultural insurance

Agricultural insurance - importance of agricultural insurance - scope - genesis - crop insurance development in India - Comprehensive Crop Insurance Scheme

(CCIS) - advantages - livestock insurance - agencies of agricultural insurance - General Insurance Corporation - New India Assurance - Agricultural Insurance Corporation - National Agricultural Insurance Scheme - business loss estimation - appraisal - claiming and repayment. Types of insurance products - stakeholders.

Practical

Estimation of cost of cultivation for major crops. Procedure on scale of finance for major crops. Estimation of technical feasibility, economic viability of farmers - Repaying capacity of borrowers and appraisal of credit proposals. Analysis of trend in farm lending and over dues - assessment of farm credit needs. Collection of farm level data on yield and crop losses. Visit to commercial bank, insurance agency - processes and procedure for agricultural insurance - crop loss assessment - estimation of indemnity - actuarial method of premium calculation - pure risk rate liability - case study on insurance development - case study on problem and prospect of insurance in India - role of government in farm insurance.

Theory schedule

1. Agricultural finance
2. Role and importance of agricultural finance
3. Financial institutions and credit flow to rural/priority sector
4. Agricultural lending - direct and indirect financing
5. Financing through co-operatives
6. Role of NABARD, Commercial Banks and RRBs
7. District credit plan and lending to agriculture/priority sector
8. The concept of 5 C's, 7 P's and 3 R's of credit
9. The concept of risk - kinds and classification of risks - assessment
10. The concept of insurance - types of general insurance - agriculture, fire, marine, engineering
11. Insurance of property - insurance professionals and intermediaries
12. Basic principle of insurance - utmost good faith - insurable interest - material facts
13. Economic principles - sharing - subrogation - contribution
14. Legal principles - the Indian contract, 1872
15. Insurable interest - nomination and assignment
16. Financial principles - premium funds - investments
17. Mid semester examination
18. Agricultural risks - sources of risk - production and technical risk
19. Output and input price risk
20. Financial risk - political risk - legal risk - personal risk
21. Risk management tools
22. Low risk investments - enterprise diversification
23. Excess - debt capacity - liquid financial reserves off - farm income - shared ownership or leasing
24. Risk transfer insurance products - contracts - hedging and options market
25. Agricultural insurance importance of agricultural insurance - scope
26. Genesis - crop insurance development in India

27. Comprehensive Crop Insurance Scheme (CCIS) - advantages
28. Livestock insurance - agencies of agricultural insurance
29. General Insurance Corporation. New India Assurance
30. Agricultural insurance corporation
31. National agricultural insurance scheme
32. Business loss estimation - appraisal
33. Claiming and repayment
34. Types of insurance products - stakeholders

Practical schedule

1. Estimation of cost of cultivation for major crops
2. Procedure on scale of finance for major crops
3. Estimation of technical feasibility, economic viability of farmers
4. Repaying capacity of borrowers and appraisal of credit proposals
5. Analysis of trend in farm lending and over dues
6. Assessment of farm credit needs
7. Collection of farm level data on yield and crop losses
8. Visit to commercial bank
9. Visit to insurance agency
10. Processes and procedure for agricultural insurance
11. Crop loss assessment
12. Estimation of indemnity
13. Actuarial method of premium calculation
14. Pure risk rate liability
15. Case study on insurance development
16. Case study on problem and prospect of insurance in India
17. Role of government in farm insurance

Reference books

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3. *General Insurance*, 2004. Publication of United India Insurance Co, Ltd., Chennai.
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FACULTY OF AGRICULTURE
REGULATIONS FOR Master of Business Administration (Agri Business) PROGRAMME
OFFERED BY Department of agricultural economics, FACULTY OF AGRICULTURE
With Effect From 2018-2019

1. Short title and commencement

- 1.1. These rules and regulations shall govern the post graduate studies leading to the award of degree of Master of Business Administration (Agri Business) in the Faculty of Agriculture.
- 1.2 They shall come into force with effect from the academic year 2018 – 2019.

2. Definitions

- 2.1 An “Academic Year” shall consist of two semesters.
- 2.2 “Semester” means an academic term consisting of 110 working days including final theory examinations.
- 2.3 “Subject” means a unit of instruction to be covered in a semester having specific No., title and credits.
- 2.4 “Credit hour” means, one hour lecture plus two hours of library or home work or two and half hours of laboratory/field practical per week in a semester.
- 2.5 “Grade Point of a subject” means the value obtained by dividing the percentage of marks earned in a subject by 10 and the Grade Point is expressed on a 10 point scale.
- 2.6 “Credit Point” means the grade point multiplied by credit hours.
- 2.7 “Grade Point Average” (GPA) means the quotient of the total credit points obtained by a student in various subjects at the end of each semester, divided by the total credit hours taken by the student in that semester. The grading is done on a 10 point scale and the GPA has to be corrected to two decimals.
- 2.8 “Overall Grade Point Average” (OGPA) means the quotient of cumulative credit points obtained by a student in all the subjects taken from the beginning of the first semester of the year divided by the total credit hours of all the subjects which he/she had completed up to the end of a specified semester and determines the overall performance of a student in all subjects during the period covering more than one semester. The OGPA has to be arrived at the second decimal place.

3. Eligibility for admission

Candidates for admission to the M.B.A. (Agri Business) programme should satisfy the following requirements.

- 3.1. Candidates seeking admission to the M.B.A. (Agri Business) Degree programme should have completed any one of the following four year degree programmes from Universities recognized by Annamalai University.
 B.Sc. (Hons.) Agriculture / B.Sc. (Hons.) Horticulture / B.Sc. (Ag.) / B.Sc. (Hort.) / B.Sc. (Agri. Mark and Co-op.) / B. Tech. (Hort.) / B. Tech. (Ag. Engg.) / B. Tech. (Agri. Biotech.) / B.Sc. (Forestry) / B.F.Sc. / B.Sc. (Sericulture) / B.Sc. (Home Science) / B.E. (Ag.) / B.V.Sc / B.Sc (Dairy Science) any other degree offered by Agriculture/ Veterinary/Fisheries Universities.
- 3.2. Candidates who have undergone the programme under conventional system should possess not less than a second class Bachelor’s degree. The candidates

under 4 point grade systems should possess a minimum OGPA of 2.5 out of 4.00 and 2.75 out of 4.00 in the subject concerned. For those under 10 point system a minimum OGPA of 6.00 out of 10.00 and 6.50 out of 10.00 in the subject concerned is required. However, this will not apply to SC/ST candidates for whom a pass in the degree concerned is sufficient.

- 3.3. An entrance test will be held separately for each Degree programme. Candidates shall be required to be present on the specified date and time for written test and interview at their own expenses.

4.1. Duration of the programme

The duration for the M.B.A. (Agri Business) programme will be of two years with four semesters. A student registered for Full- time M.B.A. (Agri Business) programme should complete the course within four years from the date of his/her admission.

4.2 Credit and GPA requirements

A student enrolled for the M.B.A. (Agri Business) programme to earn eligibility for the degree is required to complete 55 credits as detailed below.

i) Core subjects	21
ii) Electives	8
iii) Supporting subjects	5
iv) Seminar	1
v) Research	12
vi) In-plant training	6
vii) Study tour	<u>2</u>
Total credits	<u>55</u>

The core subjects are mandatory for a student. These subjects should be offered by the Department of Agricultural Economics.

4.3 Non- credit Compulsory courses

Subject code	Course title	Departments offer the subjects	Credit
PGS 611	Research data analysis	Agricultural Economics	0+1
PGS 612	Technical writing and communication skills	English	0+1
PGS 623	Basic analytical techniques	Agricultural Economics	0+1
PGS 624	Library and information services	Library science	0+1
PGS 715 e-course	Intellectual property and its management in agriculture	Agri. Economics	1+0
PGS 716 e-course	Disaster management	Agronomy	1+0
Total Credits			2 + 4=6

4.4. Minimum Grade point requirement

A M.B.A. (Agri Business) student should maintain a minimum Grade Point of 6.00 out of 10 to secure a pass in a subject. In the subjects in whom a student fails, he/she has to reappear for the examination to get a pass in that subject. Overall Grade Point Average (OGPA) of 6.50 out of 10 is required to secure a degree.

5. Attendance requirement

- 5.1. One hundred per cent attendance is expected of each student. A student, who fails to secure a minimum of 80 per cent of attendance in each subject separately for theory and practical, shall not be permitted to appear for the final examination in that subject and will be required to repeat the subject when ever offered.

In case of new admission, who are permitted to join late due to administrative reasons, the attendance will be calculated from the date of joining of the student. However, for genuine reasons, condonation of attendance deficiency may be considered by the Vice-Chancellor on the recommendation of the Head of the Department and The Dean, Faculty of Agriculture on payment of condonation fee prescribed by the University.

- 5.2 Students absenting from the classes with prior permission of the Head of the Department/Dean, Faculty of Agriculture on official University business shall be given due consideration in computing attendance.

6. Advisory Committee

- 6.1. Each M.B.A. (Agri Business) student shall have an Advisory Committee to guide him/her in carrying out the research programme. The Advisory Committee shall comprise a Major Adviser (Chairman) and two members. Of the two members, one will be from the same Department and the other in the related field from the other Departments of Faculty of Agriculture. The Advisory Committee shall be constituted within three weeks from the date of commencement of the first semester.

6.2. Major Adviser (Chair person)

Every student shall have a Major Adviser who will be from his/her major field of studies. The appointment of Major Advisers (Chairman) shall be made by the Head of the Department concerned. The chairman in consultation with the Head of the Department will nominate the other two members. In the event of the Major Adviser being away on other duty/leave for a period of more than three months, the member of the Advisory Committee from the same Department will officiate as the Major Adviser.

6.3. Guidelines on the duties of the Advisory Committee

- i. Guiding students in drawing the outline of project work
- ii. Guidance throughout the programme of study of the students.
- iii. Evaluation of project and seminar credits.
- iv. Correction and finalization of project draft.
- v. Conduct of qualifying and final Viva-Voce examination.
- vi. The proceedings of the Advisory Committee will be sent to the Head of the Department concerned within 10 working days.
- vii. Periodical review of the Advisory Committee proceedings will be made by the Head of the Department concerned.

7. Programme of Study

- 7.1 The student's plan for the M.B.A. (Agri Business) work, drawn up by the Advisory Committee, shall be finalized before the end of the first semester.

- 7.2 The programme shall be planned by the Advisory Committee taking into account his/her previous academic training and interest.

7.3 Programme of project work

The outline of project work of the student, in the prescribed manner and as approved by the Advisory Committee, shall be forwarded by the Chairman to the Head of the Department concerned by the end of the third semester.

8. Evaluation of Students' Performance

8.1. Mid-semester examination (MSE)

- 8.1.1. Every teacher handling a subject shall conduct Mid-Semester Examination (MSE) as per the scheme drawn by the Head of the Department concerned /PG coordinator, and evaluate. The answer scripts will be shown to the student after valuation, and returned to the course teacher. The Head of the Department will be responsible to ensure the distribution of answer papers to the students. The marks obtained by the students should be sent to the Controller of Examinations through the Head of the Department concerned within fifteen working days.
- 8.1.2. Writing the mid-semester examination is a pre-requisite for writing the final theory and practical examinations. If a student does not appear for MSE, he/she is not eligible to appear for the final examinations. Such candidate has to reappear for the MSE as and when the respective examinations are conducted only after getting permission from the Dean, Faculty of Agriculture on payment of fee prescribed by the University.
- 8.1.3 The MSE marks will not be shown separately in the grade sheet but will be combined with the respective final theory and practical marks. MSE marks awarded in a course will be added to the supplementary examinations also.
- 8.1.4 The MSE marks will be furnished to the Head of the Department within 10 days after the conduct of MSE. If the student is not satisfied with the award of the marks, he/she shall appeal to the Dean, through Head of the Department within three working days after the announcement of marks. The appeal will be considered and the results reviewed by a Cell consisting of the Dean and the Head of the Department concern. The decision of the Review Cell shall be final. If the Head of the Department himself is the course teacher, one senior member of the department concern shall be nominated by the Dean.
- 8.1.5 The MSE will be of one hour duration
- 8.1.6 If the student is not able to write the MSE due to deputation by the University, he/she may be permitted to take up missing MSE. Such examination should be completed ordinarily within 15 working days after the respective MSE.
- 8.1.7 A student who fails to attend a mid-semester examination due to unavoidable circumstances shall be permitted with prior approval of the Dean to take up missing examination of the particular course, on payment of fee prescribed by the University. Such tests should be completed ordinarily within 15 working days after the respective MSE.

The distribution of marks will be as indicated below.

Test	Subjects with Practical	Subjects without Practical	Subjects without Theory
Mid emester	20	30	30
Final theory	40	70	-
Final practical	40	-	70
Total	100	100	100

The question paper model and distribution of marks for Mid Semester examinations are as follows.

Mid-Semester Examinations
For Subjects with practicals (20 marks)

1. Objective Type	10 out of 12	(10 x 0.5)	5 Marks
2. Definitions/Concepts	5 out of 7	(5 x 1)	5 Marks
3. Short Notes	2 out of 3	(2 x 2 ½)	5 Marks
4. Essay Type	1 out of 2	(1 x 5)	5 Marks

For Subjects without practicals (30 marks)

1. Objective Type	10 out of 12	(10 x 0.5)	5 Marks
2. Definitions/Concepts	5 out of 7	(5 x 1)	5 Marks
3. Short Notes	4 out of 5	(4 x 2 ½)	10 Marks
4. Essay Type	2 out of 3	(2 x 5)	10 Marks

8.2. Final examinations

8.2.1. The final theory and practical examinations will be of three hours duration each conducted separately by the University.

8.2.2. Theory examinations will be conducted before practical examinations.

8.2.3. The final theory and practical examinations will be evaluated by two examiners (one will be the internal and another will be external)

8.2.4. The question papers for the final theory examinations will be set by the external examiners.

The question paper model and distribution of marks for final theory examinations are as follows.

Final Theory Examinations

For subjects with practical (40 marks)

1. Definitions	5 out of 7	(5x1)	5 marks
2. Short notes	5 out of 7	(5x2)	10 marks
3. Essay type	either or type (one question from each unit)	(5x5)	25 marks

For subjects without practical (70 marks)

1. Definitions	5 out of 7	(5x2)	10 marks
2. Short Notes	5 out of 7	(5x4)	20 marks
3. Essay Type	either or type (one question from each unit)	(5x8)	40 marks

8.2.5. Practical Examination

Practical examinations will be conducted separately towards the end of each semester. Proper maintenance and regular submission of practical records are required. Those who do not bring with them the certified practical records/assignments will not be allowed to appear for the practical examination. The marks awarded for assignments shall be noted in the record, at the time of first appearance and will be taken into account for subsequent appearances.

The distribution of marks for final practical examination for courses with theory and practical and only practical is as follows

S.No.	Particulars	Courses with theory and practical	Courses with only practical
1	Practical part	25	55
2	Assignment/specimen collection	5	5
3	Record	5	5
4	Viva voce	5	5
Total		40	70

The pattern of practical part should be uniform in each Department

8.3. Grading

- i. The student should secure 60 per cent marks separately in theory and practical and 65 per cent marks in aggregate to secure a pass in the subject. Students who secure marks below 65 per cent in a subject will be treated as Reappearance (RA).
- ii. Each subject shall carry a maximum of 100 marks for purpose of grading. The grading shall be done as grade point, i.e., the percentage of marks earned in a subject is divided by ten. The grade point is expressed on a 10 point scale up to two decimals.
- iii. The reappearance examinations for the candidates who fail in a subject or subjects will be held in the subsequent semester.
- iv. Students who did not fulfill the required minimum attendance of 80 per cent will be awarded 'E' grade and has to repeat the subject.

8.4. Class ranking

In calculation of class equivalent for OGPA the following classification shall be adopted.

OGPA	Class
9.00 and above	- Distinction
8.00 to 8.99	- I Class
7.00 to 7.99	- II Class
6.50 to 6.99	Pass

8.5. Non- Credit Compulsory Subjects

For Non-Credit Compulsory subjects the evaluation processes will be as that of the regular subjects, however, the marks obtained will not be taken into account to calculate the OGPA.

9. Credit Seminar

Seminar is compulsory for all the students and each student should present a seminar of 0+1 credit in the third semester.

- 9.1 The seminar topic should be only from the major field and should not be related to the area of project work.
The seminar topics are to be assigned to the students by the Chairman of the Advisory Committee in consultation with the Head of the Department concerned within 2 weeks after the commencement of the semester.
- 9.2. Under the guidance and supervision of the Chairman of the Advisory Committee, the student will prepare the seminar paper after reviewing all the available literature and present the seminar 2 weeks after completion of Mid-Semester Examination in the presence of the Head of the Department, Advisory Committee, staff members and PG students.
- 9.3. The circular on the seminars by the post-graduate students shall be sent to other Departments to enable those interested to attend the same.
- 9.4. The Chairman will monitor the progress of the preparation of the seminar paper and correct the manuscript containing not less than 25 typed/printed pages with a minimum number of 50 references, covering the recent 10 years time. The student will submit two copies of the corrected manuscript

to the Head of the Department concerned through the Chairman before presentation.

The student will incorporate suggestions and carry out corrections made during the presentation and resubmit three fair copies to the Head of the Department concerned through the Chairman (one copy each to Dept. Library, Chairman and the student) within 10 days after presentation.

- 9.5 The performance of the student has to be evaluated for 100 marks and Grade Point awarded by the Head of the Department concerned along with Advisory Committee. The Grade Point may be given based on the following norms.

Coverage of Literature	40
Presentation	30
Use of Audio-Visual Aids	10
Capacity to Participate in the discussion and answer the Questions	20
Total	100

10. Term paper / Special assignment

This has to be assigned to the student by the teacher in subject with theory and practical. Term papers should cover a wide range of topics within the subject limits. The topic should be different from that of the credit seminar. Term papers / special assignments will be evaluated during practical examination.

11. Qualifying Examination

Only those students who successfully completed the qualifying examination will be admitted to candidacy of the degree. The qualifying examination consists of written and oral examination.

11.1. Minimum requirement for Qualifying Examination

The students who have **passed** major courses will be permitted to appear for the qualifying examination. The qualifying examination will be conducted during III semester after mid semester examination and before the end of the III semester.

11.2. Selection of Examiner

A panel of five external examiners for qualifying examinations shall be given by the HOD at the end of III semester within 15 days of the start of III semester to the Controller of Examinations, who will nominate as per need from the panel of the examiner.

11.3. Written Examination

The written examination consists of one paper covering major subjects only. The Controller of Examination will conduct the examination by getting the question paper from external. The external examiner will evaluate the answer papers during his visit to conduct the viva-voce examination.

The question paper for the written examination will be of 3 hours duration and each question (Essay type) need not be restricted to any particular topic in a course but it should be comprehensive. The written examination will be conducted at the same time in all discipline.

Qualifying marks for passing the written examination will be 60.

11.4. Qualifying viva-voce Examination

The advisory committee shall conduct the qualifying viva-voce examination with the external member, who shall be a specialist in the subject from outside the university

- 11.5. The Heads of departments will monitor and coordinate the conduct of the qualifying viva. The performance of the candidate will be Graded as Satisfactory / Unsatisfactory.

11.6. Communication of Results of Qualifying Examination

The chairman of the advisory committee shall act as chairman for the examination committee and shall be responsible for communicating the results of the examination to the Controller of Examination through HOD in the prescribed format.

11.7. Failure /Absence in Qualifying Examination

When a student fails or absents for the qualifying examination, he/she may apply again for permission to appear for re-examination to the Controller of Examination with the recommendation of the chairman of the advisory committee and Head of the Department. A student, who apply for re-examination should attend written examination and viva-voce. Re-examination shall not take place earlier than three months after the first examination and it will be conducted by the advisory committee as previously indicated. If a student fails in the re-examination, further re-examination will be considered on the recommendation of the Advisory Committee, HOD and Dean, Faculty of Agriculture.

If the students fail in the qualifying examination, the project credits registered in the final semester should not be evaluated unless he / she successfully completes the qualifying examination.

11.8 Absence of advisory committee member during qualifying/final viva-voce examination:

5. Conducting qualifying and final viva voce examination in the absence of advisory committee members is not allowed.
6. Under extra-ordinary circumstances if the qualifying/final viva-voce examination to postgraduate student has to be conducted in the absence of one or two advisory committee members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Dean in advance through the Head of the Department. The Chairman of the advisory committee in consultation with the concerned member and Head of the Department will co-opt another member.
7. The co-opted member should be from the same department of the member who is not attending the examinations.
8. In the absence of the Chairman of advisory committee, respective Heads of Departments should act as Co-chairman with prior permission of Dean.

12. Project Work

- 12.1. The topic of project to be carried out by the student will be assigned by the Chairman of the Advisory Committee in consultation with the Head of the Department concerned. After assigning the topic, each student may be instructed to submit a detailed programme of work to be carried out by him/her during the semester in the prescribed proforma. After scrutiny and approval, a copy of the programme may be given to the student for carrying out

the work during the semester in the prescribed proforma. The evaluation of project work done by the student should be based on the approved programme.

12.2. The distribution of project credits will be as follows:

III Semester	0+ 4
IV Semester	<u>0+ 8</u>
Total	<u>0+12</u>

13. Evaluation of Project

- 13.1. Attendance register must be maintained in the department by HOD/chairman for all the students to monitor whether the student has 80% of attendance in research.
- 13.2. The student has to submit his/her project observation note book to the major Adviser. The major Adviser will scrutinize the progress and sign the note book with remarks as frequently as possible. This note book will form the basis for evaluation of project progress.
- 13.3. After completion of 80% attendance for project and on or before the last day of the semester, the advisory committee should evaluate the progress of project work as per the approved programme and monitoring register and award SATISFACTORY OR UNSATISFACTORY depending upon quantity and quality of work done by the student during the semester.
- 13.4. The procedure of evaluating project credits under different situations are explained hereunder.

Situation - I

The students has completed the project credits as per the approved program and awarded 'SATISFACTORY' by the advisory committee. Under the said situation the student can be permitted to register fresh credits in the subsequent semester. If the student is awarded 'UNSATISFACTORY' he/she has to register afresh the same block of the project credits in the subsequent semester.

Situation - II

The student who does not satisfy the required 80 per cent attendance shall be awarded grade 'E'.

Situation - III

The student who could not complete the project work as per the approved programme of work for reasons beyond his/her control such as any other impeding/unfavourable situation for satisfying the advisory committee.

Under the situations (II&III) grade 'E' should be awarded The student has to reregister the same block of project credits for which 'E' grade was awarded in the following semester. The student should not be allowed to register for fresh (first time) project credits.

In the mark sheet, it should be mentioned that 'E' grade was awarded due to lack of attendance or want for favourable conditions.

Situation - IV

The student who fails to complete the project work after repeating the registration for the second time the student will be awarded 'not satisfactory' and in the the mark sheet the 'second time' should be mentioned.

For the registration of project credits for the third time permission has to be obtained from the Dean of the Faculty and permission for further registration for the fourth time has to be obtained from the University.

Re-registration of further project credits shall be decided by the University based on the recommendation of the Advisory Committee, Head of the Department concerned and the Dean, Faculty of Agriculture.

Situation - V

If a student could not complete qualifying examination till the end of the final semester/grace period 'E' grade should be awarded for the final block of the project credits registered in the final semester. He has to re-register the same block of project credits in the next semester and attend the qualifying examination when conducted by the controller of examination.

14. Submission of Project

- 14.1. The project for his/her Master's degree should be of such a nature as to indicate a student's potentialities for conduct of independent project. The project shall be on topic falling within the field of the major subject and shall be the result of the student's own work. A certificate to this effect duly endorsed by the Major Adviser (Chairman) shall accompany the project.
- 14.2 The project credits registered in the last semester of post graduate programmes should be evaluated only at the time of the submission of project, by the advisory committee. Students can submit the project at the end of the final semester. If a post graduate student has completed the project before the closure of the final semester, the chairman can convene the advisory committee meeting and take decision on the submission of project provided the student satisfies 80 per cent attendance requirement. Two copies of the project should be submitted in paper pack for evaluation to the HOD.

15. Grace period

- 15.1 Students can avail a grace period up to a month for submission of project report after the closure of final semester by paying necessary fine as prescribed by the University. If a student is not able to submit the thesis within a month grace period, the student has to re-register the credits in the forth coming semester. The student (s) who re-register the credits after availing the grace period will not be permitted to avail grace period.
- 15.2 Based on the recommendation of advisory committee and the Head of the Department, the Dean, can sanction the grace period. A copy of the permission letter along with the receipt for payment of fine as prescribed by the University should accompany the thesis while submission.

16. Submission of project after re-registration

The minimum of 80 per cent attendance requirement for submitting the project after, re-registration need not be insisted for those students who have fulfilled the minimum academic and residential requirement i.e. 2 years (4 semesters) and completed the minimum credit requirements for getting Degree.

17. Publication of articles

Part of the project may also be published in advance with the permission of the HOD. If any part is published the fact should be indicated in the certificate given by the chairman that the work has been published in part/full in the scientific or popular journals, proceedings, etc. The copies are to be enclosed in the project at the time of submission.

18. Evaluation of Project

- 18.1 The project submitted in partial fulfillment of a M.B.A. (Agri Business) shall be evaluated by an external examiner. The external examiner shall be a specialist in the student's major field of study from outside Annamalai University and shall be appointed by the University as per the recommendation of the Head of the Department.
- 18.2 The external examiner will send the evaluation report in duplicate one marked to the Controller of Examination and another to the Head of the Department along with the corrected copy of the thesis. If the report is favourable, Viva-Voce will be arranged by the Head of the Department concerned and conducted by the Advisory Committee. The chairman of the advisory committee shall send the recommendations of the examining committee to the Controller of Examinations through Head of the Department after the student duly carries out the corrections/ suggestions mentioned by the external examiner (a certificate to be enclosed along with the recommendation). On the unanimous recommendation of the committee and with the approval of the University, the degree shall be awarded to the candidate.
- 18.3 In case of rejection of the project by the external examiner, the Controller of Examinations may on the recommendation of the Head of the Department concerned and Advisory Committee refer the project for valuation by a second external examiner chosen by the University. If the second external examiner recommends the project for acceptance, Viva-Voce will be conducted.
- 18.4 If the revision of the project is recommended, resubmission must be done by the candidate concerned after a minimum of six months. The revised version should be sent to the examiner who recommended revision.
- 18.5 After incorporating the suggestions of the examiners and those received at the time of viva-voce, two hard bound copies of thesis should be submitted to the Department (one to the scholar and one to the chairperson) and two soft copies in CDs to the University. At the time of final submission, the advisory committee members should certify the corrections and suggestions carried out as indicated by the examiners. However, fellowship holder has to submit a hard bound copy also as per the need, 3 copies of abstract of thesis (in 10-15 lines), 2 copies of the summary of the findings both in Tamil and English and also in C.D. form.

19. Revision of project

If an examiner recommends for revision of project the following norms will be adopted.

- 19.1 For revision of draft, the thesis should be resubmitted after a minimum of one month from the date of communication from the controller of examination
- 19.2 At the time of submission, the advisory committee should give certificate for carrying out the corrections/recommendations. The resubmitted copies of project should be got corrected carrying out the necessary corrections indicated by the external examiner and necessary certificates obtained from the chairman and HOD before the conduct of the final viva-voce.
- 19.3 A fine prescribed by the University to be collected from the students at the time of resubmission of project.

20. Failure to appear for final Viva-voce/ Non submission of project after viva-voce.

- 20.1 If a candidate fails to appear before the examining committee for final viva-voce, on the date fixed by the HOD the following are the time frame and penalty.
- 20.2 The re-viva-voce must be completed within two years. An amount of penalty of fine prescribed by the University must be charged to the candidate.
- 20.3 After successful completion of project final viva-voce if a student fails to submit the corrected version of the thesis within 15 days he/she will be levied a fine prescribed by the University at the time of sending the proposal for result declaration.

21. In-plant training

In plant training is compulsory for all the students and each student should register 0+2 credits each I, II & III semesters. The students will be placed in different Agro business units for a period of 2 weeks.

The students will be evaluated as follows:

Observation note book - 20 marks	}	By the teacher-in charge
Discussion record - 20 marks		
Project report - 40 marks	}	By the Examiner
Viva-voce - 20 marks		

22. Study tour

Study tour is compulsory for all the students and each student should register 0+1 credit in II and III semesters. A short trip of 7-10 days will be arranged with an objective to expose the students to the various business activities of agro industries/firm.

Attendance - 10 marks	}	By the teacher-in charge
Management Aptitude - 10 marks		
Tour dairy - 20 marks	}	By the Examiners
Tour Record - 30 marks		
Viva - voce - 30 marks		

23. Result notification

- 23.1 After the completion of each semester, the student will be given the statement of marks by the controller of examinations
- 23.2 The transcript will be prepared by controller of examinations. The various subjects taken by a student along with the credits and the grade obtained shall be shown on his transcript. Based on the total credits admitted, the final Grade Point Average shall be calculated and given.

24. Award of Medals

Medal should be awarded only if the student secures at least 8.0 OGPA, clears all courses in first attempt and in the programme having a batch of at least three students.

M.B.A. (AGRI BUSINESS)
COURSES –WISE DISTRIBUTION

Major - 21 Credits				
S. No.	Course No.	Title	Credit Hr. T+P	
1.	ABM 611	Principles of Management and Organizational Behaviour	2+0	
2.	ABM 612	Managerial Economics	2+0	
3.	ABM 613	Human Resource Management	2+0	
4.	ABM 614	Production and Material Management	1+1	
5.	ABM 615	Research Methodology in Business Management	1+1	
6.	ABM 621	Agricultural Marketing Management	2+0	
7.	ABM 622	Managerial Accounting and Control	1+1	
8.	ABM 623	Agricultural Project Management	1+1	
9.	ABM 624	Agribusiness Financial Management	2+0	
10.	ABM 625	Operations Research	1+1	
11.	ABM 626	Agri Business Environment, Business Law and Policy	1+0	
Total			16+5=21	
Electives - 8 Credits				
1.	ABM 711E1	Logistics and Supply Chain Management	} } } } } } } } } } } }	
2.	ABM 711E2	Farm Business Management		2+0
3.	ABM 711E3	Sales and Distribution Management in Agri Business		
4.	ABM 712E1	Entrepreneurship Development		
5.	ABM 712E2	Rural and Service Marketing		2+0
6.	ABM 712E3	Food Retail Management		
7.	ABM 713E1	Insurance and Risk Management		
8.	ABM 713E2	Communication for Management and Business		2+0
9.	ABM 713E3	Management of Agricultural Input Marketing		
10.	ABM 714E1	International Trade and Sustainability Governance		
11.	ABM 714E2	Commodity Futures Trading		2+0
12.	ABM 714E3	Capital and Commodity Markets		
Total			8+0 = 8	
Supporting Courses - 5 Credits				
1.	STA 613	Statistics for Business Management	2+1	
2.	COM 611	Computer Applications for Agricultural Research	1+1	
Total			3+2=5	
Seminar/In-plant Training/Study Tour/Project - 21 Credits				
1.	ABM 011; 021; 031	In-plant Training 011-0+2; 021-0+2; 031-0+2	0+6	
2.	ABM 022; 032	Study Tour 022-0+1; 033-0+1	0+2	
3.	ABM 033	Seminar	0+1	
4.	ABM 034; 044	Project 034-0+4; 044-0+8	0+12	
Total			0+21 = 21	
Grand Total			27+28=55	
Non Credit Compulsory Courses 2 + 4 = 6				
1.	PGS 611	Research Data Analysis	0+1	
2.	PGS 612	Technical Writing and Communication Skills (English)	0+1	
3.	PGS 623	Basic Analytical Techniques	0+1	
4.	PGS 624	Library and Information Services (Library Science)	0+1	
5.	PGS 715 (e-course)	Intellectual Property and its Management in Agriculture	1+0	
6.	PGS 716 (e-course)	Disaster Management (Agronomy)	1+0	
Total			2+4=6	

**M.B.A. (AGRI BUSINESS) DEGREE PROGRAMME
SEMESTER - WISE DISTRIBUTION**

S. No.	Course Code	Title	Credit Hours
First Semester			
1.	ABM 611	Principles of Management and Organizational Behaviour	2+0
2.	ABM 612	Managerial Economics	2+0
3.	ABM 613	Human Resource Management	2+0
4.	ABM 614	Production and Material Management	1+1
5.	ABM 615	Research Methodology in Business Management	1+1
6.	STA 613	Statistics for Business Management	2+1
7.	COM 611	Computer Applications for Agricultural Research	1+1
8.	ABM 011	In-plant Training	0+2
9.	PGS 611	Research Data Analysis	0+1
10.	PGS 612	Technical Writing and Communication Skills (English)	0+1
Total			11+6 = 17
Second Semester			
1.	ABM 621	Agricultural Marketing Management	2+0
2.	ABM 622	Managerial Accounting and Control	1+1
3.	ABM 623	Agricultural Project Management	1+1
4.	ABM 624	Agribusiness Financial Management	2+0
5.	ABM 625	Operations Research	1+1
	ABM 626	Agri Business Environment, Business Law and Policy	1+0
6.	ABM 021	In-plant Training	0+2
7.	ABM 022	Study Tour	0+1
8.	PGS 623	Basic Analytical Techniques	0+1
9.	PGS 624	Library and Information Services (Library Science)	0+1
Total			8+6 = 14
Third Semester			
1.	ABM 711 E1,E2,E3	Elective course	2+0
2.	ABM 712 E1,E2,E3	Elective course	2+0
3.	ABM 713 E1,E2,E3	Elective course	2+0
4.	ABM 714 E1,E2,E3	Elective course	2+0
5.	ABM 031	In-plant Training	0+2
6.	ABM 032	Study Tour	0+1
7.	ABM 033	Seminar	0+1
8.	ABM 034	Project	0+4
9.	PGS 715 (e-course)	Intellectual Property and its Management in Agriculture	1+0
10.	PGS 716 (e-course)	Disaster Management (Agronomy)	1+0
Total			8+8 = 16
Fourth Semester			
1.	ABM 044	Project	0+8
Total			0+8 = 8
Grand Total			27+28 = 55

ABM 611 PRINCIPLES OF MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR (2+0)**Objective**

To make the students understand the basic management concepts, theories and the role of management practices in agri business. Also, to acquaint the learner with meaning and concepts of organizational behaviour.

Theory**Unit-I - Basics in management**

Nature, scope and significance of management - evolution of management thought - approaches to management - functions of a manager. Planning - types, steps, process, strategies, policies, MBO, strategic planning process, SWOT analysis. Organizing - structure and process, line staff, authority and responsibility.

Unit-II - Management functions

Staffing - selection process, span of control, delegation. Directing - training, communication and motivation. Controlling - significance, process, techniques, standards and benchmarks - management audits.

Unit-III - Basic organizational behaviour

Nature, scope and significance of organizational behaviour - evolution and historical background of organizational behaviour - models of organizational behaviour - foundations of individual behaviour - diversity. Micro organizational behaviour - personality, self-concept, self-esteem and self-efficacy, attitudes, perception, power - types and structures.

Unit-IV - Motivation and leadership

Motivation - types of motivation - theories of motivation - applications of motivation. Transactional analysis - interpersonal relations - understanding determinants and developing leadership styles and influence process. Leadership theories - types of leaders - effective leader. Group dynamics - types of groups - group formation - group decision making - team building.

Unit-V - Organizational culture

Organizational culture or climate - concepts, dimensions, ethos, determinants. Organizational conflicts - concepts, sources, implications and management. Organizational changes - types, resistances to change - role of change agents - organizational effectiveness - achieving organizational effectiveness.

Theory schedule

1. Nature, scope and significance of management
2. Evolution of management thought
3. Approaches to management
4. Functions of a manager
5. Planning - types, steps, process, strategies, policies
6. MBO, strategic planning process, SWOT analysis
7. Organizing - structure and process, line staff, authority and responsibility
8. Staffing - selection process
9. Span of control - delegation
10. Directing - training, communication and motivation
11. Controlling - significance, process, techniques

12. Standards and benchmarks, management audits
13. Nature, scope and significance of organizational behaviour
14. Evolution and historical background of organizational behaviour
15. Models of organizational behaviour
16. Foundations of individual behaviour - diversity
17. Mid semester examination
18. Micro organizational behaviour
19. Personality, self-concept, self-esteem and self-efficacy
20. Attitudes, perception, power - types and structures
21. Motivation - types of motivation
22. Theories of motivation
23. Applications of motivation
24. Transactional analysis
25. Interpersonal relations-understanding, determinants and developing leadership styles and influence process
26. Leadership theories
27. Types of leaders and effective leader
28. Group dynamics - types of groups, group formation
29. Group decision making, team building
30. Organizational culture or climate - concepts
31. Dimensions, ethos, determinants of organizational culture
32. Organizational conflicts - concepts, sources, implications and management
33. Organizational changes - types, resistances to change, role of change agents
34. Organizational effectiveness - achieving organizational effectiveness

Reference books

1. Fred Luthans, 1998. *Organizational Behaviour*, Tata McGraw Hill, New Delhi.
2. Gupta, C.B., 2000. *Management Theory and Practice*, Sultan Chand and Sons, New Delhi.
3. Harold Koontz and Keing Weighhrich, *Essentials of Management*, McGraw Hill, New Delhi.
4. Prasad, L.M., 1998. *Principles and Practices of Management*, Sultan Chand and Sons, New Delhi.
5. Rao, V.S.B., and P.S. Narayana, 1998. *Principles and Practices of Management*, Konark Publishing Pvt. Ltd., New Delhi.
6. Singh, S.K., 2006. *Agricultural Management (Vol. I)*, Mittal Publications, New Delhi.
7. Stephen P Robbins, 2007. *Organizational Behaviour*, Prentice Hall, New Delhi.

ABM 612 MANAGERIAL ECONOMICS (2+0)

Objective

To equip the students with the basic micro and macro economic concepts and theories with special reference to agri business. Also, to develop analytical skills of the students in solving agri business problems.

Theory

Unit-I - Managerial economics - introduction

Scope of managerial economics - objectives of the firm and basic economic principles - mathematical concepts used in managerial economics.

Unit-II - Demand analysis

Indifference curve - consumer's surplus. Demand analysis - meaning, types - determinants of demand - demand function - demand elasticity - demand forecasting techniques.

Unit-III - Production, cost concepts and supply functions

Diminishing marginal returns - profit maximization - production functions - least cost input combination - factor productivities and returns to scale. Cost concepts - cost output relationship - short and long run supply functions.

Unit-IV - Market structure and pricing analysis

Pricing - determinants of price - pricing under different market structures - pricing of joint products - pricing methods in practice. Barriers to entry - strategic versus structural, switching costs - network effects - capital requirements - learning curve - control of resources. Legal barriers - patents, copyrights, trademarks, licenses. Competitive advantage - positioning strategy - cartels - welfare cost of monopoly - government policies and pricing.

Unit-V - Macroeconomic concepts related to agri business

The national income - circular flow of income - consumption, investment and saving - money - functions - demand and supply - inflation - economic growth - business cycles and business policies - business decisions under uncertainty.

Theory schedule

1. Scope of managerial economics
2. Objectives of the firm and basic economic principles
3. Mathematical concepts used in managerial economics
4. Indifference curve - consumer's surplus
5. Demand analysis - meaning, types
6. Determinants of demand
7. Demand function
8. Demand elasticity
9. Demand forecasting techniques
10. Diminishing marginal returns
11. Profit maximisation
12. Production functions
13. Least - cost input combination
14. Factor productivities and returns to scale
15. Cost concepts
16. Cost-output relationship
17. Mid semester examination
18. Short and long run supply functions
19. Pricing - determinants of price
20. Pricing under different market structures
21. Pricing of joint products - pricing methods in practice
22. Barriers entry - strategic versus structural, switching costs
23. Network effects - capital requirements

24. Learning curve - control of resources
25. Legal barriers - patents, copyrights, trademarks, licenses.
26. Competitive advantage - positioning strategy - cartels - welfare cost of monopoly
27. Government policies and pricing
28. The national income - circular flow of income
29. Consumption - investment and saving
30. Money - functions
31. Demand and supply
32. Inflation - economic growth
33. Business cycles and business policies
34. Business decisions under uncertainty

Reference books

1. Dwivedi, D.N., 2002. *Managerial Economics*, Vikash Publication, New Delhi.
2. Gupta, G.S., 1997. *Managerial Economics*, Tata McGraw Hill, New Delhi.
3. Jhingan, M.L, 2001. *Macro Economic Theory*, Konark Publishers, Pvt. Ltd., Chennai.
4. Mehtha, P.L., 2000. *Managerial Economics - Analysis, Problems and Cases*, Sultan Chand and Sons, New Delhi.
5. Sankaran, 2001. *Business Economics*, Progressive Corporation Pvt. Ltd., Bombay.
6. <http://cengagesites.com/academic/?site=5215>
7. <http://www.pearsonhighered.com/keat/>

ABM 613 Human Resource Management (2+0)

Objective

The objective of this course is to expose the learner to the field of human resource management. The focus will be on human resource practices and their utility for managers.

Theory

Unit-I - Introduction to human resource management

Introduction to human resource management - human resource planning - nature and significance - job analysis, job description, job specification, job enlargement, job enrichment, job rotation, job evaluation.

Unit-II - Recruitment and selection

Recruitment and selection process - induction. Training and human resource development - nature, significance process, techniques - strategic human resource management - process and techniques - internal mobility including transfers, promotions, employee separation - building employee commitment - promotion from within sources - induction.

Unit-III - Performance appraisal

Performance appraisal - significance and methods - compensation management - wage and salary administration - wage fixation, fringe benefits, incentive payment, bonus and profit sharing - 360 degree appraisal.

Unit-IV - Industrial relations

Industrial relations - role and status of trade unions - collective bargaining - worker's participation in management - career planning and employee retention - employee security.

Unit-V - Employee welfare measures

Quality of work life - employee welfare measures - disputes and grievance handling procedures - arbitration and adjudication - health and safety of human resource - human resource accounting - human resource outsourcing - talent management.

Theory schedule

1. Introduction to human resource management
2. Human resource planning - nature and significance
3. Job analysis - job description
4. Job specification - job enlargement
5. Job enrichment - job rotation - job evaluation
6. Recruitment and selection process - induction
7. Training and human resource development - nature, significance, process and techniques
8. Strategic human resource management - process and technique
9. Internal mobility including transfers, promotions, employee separation
10. Building employee commitment
11. Promotion from within sources - induction
12. Performance appraisal - significance and methods
13. Compensation management
14. Wage and salary administration
15. Wage fixation - fringe benefits
16. Incentive payment, bonus
17. Mid semester examination
18. Profit sharing
19. 360 degree appraisal
20. Industrial relations
21. Role and status of trade unions
22. Collective bargaining
23. Worker's participation in management
24. Career planning
25. Employee retention
26. Employee security
27. Quality of work life
28. Employee welfare measures
29. Disputes and grievance handling procedures
30. Arbitration and adjudication
31. Health and safety of human resource
32. Human resource accounting
33. Human resources outsourcing
34. Talent management

Reference books

1. Ashwathapa, K., 1997. *Human Resource Management*, Tata McGraw, New Delhi.
2. Garry, D., 2001. *Human Resource Management*, 7th Ed., Prentice-Hall of India, New Delhi.
3. Mamoria, C.B., 1996. *Personnel Management*, Himalaya Publication House, New Delhi.
4. Subba Rao, P., 2004. *Essentials of Human Resource Management and Industrial Relations*, Himalaya Publication House, New Delhi.
5. Venkantavatnam, C.S. and Srivastav B.K., 1991. *Personnel Management and Human Resources*, Tata McGraw-Hill, New Delhi.
6. www.ximb.ac.in/library/e-Resources1.html
7. www.hrmguide.com
8. www.humanresources.about.com
9. www.managementhelp.org/hr_mgmnt/hr_mgmnt.htm

ABM 614 Production and Material Management (1+1)

Objective

To expose the learner to the field of production and material management. The focus will be on imparting knowledge of the basic concepts, tools and functions of production management and material management.

Theory

Unit-I - Introduction - production management

Production management - meaning, nature and scope - historical evolution - process planning - plant capacity - product design and development - make or buy decisions - use of cross over chart for selection processes - plant location - factors - multiplant location decision.

Unit-II - Production planning

Productivity variables and productivity measurement - production planning - types of plans - sales forecasting - economic batch quantity. Production control - scheduling - dispatching - routing - process control - flow control of materials - inspection - evaluation - line of balance.

Unit-III - Maintenance management

Maintenance management - objectives, types, maintenance schedule. Quality control - purpose - sampling by variables and attributes - work study - methods - work environment industrial safety - purpose of time study - stop watch time study.

Unit-IV - Material management

Nature and scope of material management - determinants of right materials - forecasting - purchase management - value analysis - purchase negotiations - vendor rating - costing and storing of materials - procurement methods and process techniques - indenting - planning - codification - quality specification - TQM, ISO standards and their importance - introduction to re-engineering - value engineering.

Unit-V - Inventory management

Inventory management - inventory models - control techniques - location of warehouses - stores - procedures - inspection - safety management - issues and reorders checking.

Practical

Plant layout - types, factors - visit to an industrial plant - exercises on production management - case analysis on production management - exercise on production planning - control - case analysis on production planning - control - exercises on PERT - exercises on CPM - exercises on quality control - exercises on inventory management - vendor rating - EOQ - control systems - visit to organizations - presentation of case analysis.

Theory schedule

1. Production management - meaning, nature and scope - historical evolution
2. Process planning - plant capacity - product design and development
3. Make or buy decisions - use of cross over chart for selection processes
4. Plant location - factors - multiplant location decision
5. Productivity variables and productivity measurement - production planning - types of plans - sales forecasting - economic batch quantity
6. Production control - scheduling - dispatching - routing - process control - flow control of materials - inspection - evaluation - line of balance
7. Maintenance management - objectives, types, maintenance schedule
8. Quality control - purpose - sampling by variables and attributes - work study - methods - work environment industrial safety - purpose of time study - stop watch time study
9. Mid semester examinations
10. Nature and scope of material management
11. Determinants of right materials – forecasting
12. Purchase management - value analysis - purchase negotiations - vendor rating
13. Costing and storing of materials
14. Procurement methods and process technique
15. Indenting - planning - codification - quality specification - TQM, ISO standards and their importance - introduction to re-engineering, value engineering
16. Inventory management - inventory models - control techniques
17. Location of warehouse - stores - procedures - inspection - safety management - issues and reorders checking

Practical schedule

1. Plant layout - types - factors
2. Visit to an industrial plants
3. Case study on product planning
4. Exercises on production management
5. Case analysis on production management
6. Exercise on production planning
7. Case analysis on production planning - control

8. Exercises on PERT
9. Exercises on CPM
10. Exercises on quality control
11. Exercises on quality control (contd.)
12. Exercises on inventory management I - vendor rating
13. Exercises on inventory management II - EOQ
14. Exercises on inventory management III - control systems
15. Visit to organization related to agribusiness
16. Visit to organization related to agribusiness
17. Presentation of case analysis

Reference books

1. Alan Muhlemann, John Oakland and Keith Lockyer, 2000. *Production and Operations Management*, Macmillan India Ltd., New Delhi.
2. Chary, S.N., 2001. *Production and Operational Management*, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
3. Gopalakrishnan, P and Sundaram. M., 2002. *Materials Management - An Integrated Approach*, Prentice Hall of India Ltd., New Delhi.
4. Lal, A.B., 2000. *Inventory Models and the Problems of Price Fluctuations*, Shree Publishing House, Bombay.
5. Verma, M.M., 2001. *Materials Management*, Sultan Chand and Sons Educational Publishers, New Delhi.

ABM 615 Research Methodology in Business Management (1+1)

Objectives

The objective of this course is to develop an understanding of research methodology. The focus will be on process and techniques of research.

Theory

Unit-I - Research process

Meaning, types, and process of research - research methodology in management - exploratory, descriptive, experimental, diagnostic method - problem formulation, setting of objectives, formulation of hypotheses.

Unit-II - Data collection

Scales of measurement - nominal, ordinal, interval, ratio, likert scale and other scales - primary and secondary data - sources of data - instruments of data collection - data editing - classification - coding - validation - tabulation - presentation - analysis.

Unit-III - Sampling procedure

Concept of sampling, Sampling design - probability and non-probability sampling techniques including simple random sampling, stratified sampling, multi-stage sampling, systematic sampling, purposive sampling, quota sampling, judgment sampling, and convenience sampling - sample size determination - sampling and non-sampling errors.

Unit-IV - Tools of analysis

Role and uses of quantitative techniques in business decision making - use of equations - use of determinants and matrices in business decisions - frequency

distribution - measures of central tendency - measures of variation - skewness and kurtosis - simple, partial, and multiple correlation - rank correlation - simple and multiple regression - discriminant and dummy variable analysis.

Unit-V - Report writing

Index numbers - hypothesis testing - ANOVA - factor analysis - cluster analysis - conjoint analysis - multi-dimensional analysis. Report writing - types of reports, essentials and contents of good report writing.

Practical

Exercises in problem identification. Project proposals - contents and scope. Formulation of objective and hypotheses. Assessment of data needs - sources of data - methods of collection of data. Methods of sampling - criteria to choose - discussion on sampling under different situations. Scaling techniques - measurement of scales. Preparation of interview schedule - field testing. Methods of conducting survey. Exercises on coding, editing, tabulation and validation of data. Preparing of data entry into computer. Hypothesis testing. Parametric and non-parametric tests. Exercises on format for thesis / report writing. Presentation of the results.

Theory schedule

1. Meaning, types, and process of research - research methodology in management - exploratory, descriptive, experimental, diagnostic methods
2. Problem formulation - setting of objectives, formulation of hypotheses
3. Scales of measurement - nominal, ordinal, interval, ratio - likert scale and other scales
4. Primary and secondary data - sources of data - instruments of data collection
5. Data editing, classification, coding, validation, tabulation, presentation, analysis
6. Concept of sampling - sampling design - probability and non-probability sampling techniques including simple random sampling, stratified sampling
7. Multi-stage sampling, systematic sampling, purposive sampling, quota sampling, judgment sampling, and convenience sampling
8. Sample size determination, sampling and non-sampling errors
9. Mid semester examination
10. Role and uses of quantitative techniques in business decision making - use of equations
11. Use of determinants and matrices in business decisions
12. Frequency distribution, measures of central tendency
13. Measures of variation, skewness and kurtosis, simple, partial, and multiple correlation, rank correlation
14. Simple and multiple regression, discriminant and dummy variable analysis
15. Index numbers, hypothesis testing, ANOVA
16. Factor analysis, cluster analysis, conjoint analysis, multi-dimensional analysis etc
17. Report writing: types of report, essentials and contents of good report writing

Practical schedule

1. Exercises in problem identification
2. Project proposals - contents and scope
3. Formulation of objective and hypotheses
4. Assessment of data needs - sources of data - methods of collection of data
5. Methods of sampling - criteria to choose
6. Discussion on sampling under different situations - scaling techniques
7. Measurement of scales
8. Preparation of interview schedule
9. Field testing
10. Methods of conducting survey
11. Exercises on coding, editing, tabulation and validation of data
12. Preparing of data entry into computer
13. Hypothesis testing
14. Parametric tests
15. Non-parametric tests
16. Exercises on format for thesis / report writing
17. Presentation of the results

Reference books

1. Cooper D.R and Schindler P.S., 2006. *Marketing Research Concepts and Cases*, Tata McGraw Hill, New Delhi.
2. Dwivedi D.N., 2002. *Managerial Economics*, Vikash Publication, New Delhi.
3. Gupta G.S., 1997. *Managerial Economics*, Tata McGraw Hill, New Delhi.
4. Jhingan, M.L, 2001. *Macro Economic Theory*, Konark Publishers, Pvt. Ltd., Chennai.
5. Mehtha P.L., 2000. *Managerial Economics - Analysis, Problems and Cases*, Sultan Chand and Sons, New Delhi.
6. Sankaran, 2001. *Business Economics*, Progressive Corporation Pvt. Ltd., Bombay.

ABM 621 Agricultural Marketing Management (2+0)

Objective

The objective of this course is to impart the students an understanding of concepts, various policies, strategies and decisions relating to agricultural marketing management.

Theory

Unit-I - Introduction to marketing management

Meaning and scope - agricultural marketing and economic development. Agricultural market structure - meaning, components and dynamics of market structure. Marketing strategy - meaning and significance - formulation of marketing strategy. Agribusiness marketing environment - design of marketing mix - market segmentation and targeting.

Unit-II - Customer behaviour and competitive strategies

Building customer value - satisfaction and loyalty. Consumer behaviour - meaning, factors influencing consumer behaviour and stimuli response model. Organizational

buying - participants, process, managing business to business customer relationships. Identifying and analyzing competition - benchmarking and competitive strategies. Brand management - strategy, extensions and portfolio.

Unit-III - Product management

Product management - product management process - decisions - new product development - significance and classification of new product - stages and estimation of demand of new product - product life cycle.

Unit-IV - Pricing policies and promotional management

Pricing policies and practices for agribusiness - determinants of price - objectives of pricing policies and pricing methods. Marketing communication - objectives, factors. Promotional management - advertising, planning and execution - sales promotion, grading and standardization.

Unit-V - Distribution management

Distribution management - storage, warehousing and transportation management for agricultural products - marketing agencies/intermediaries - roles and functions. Distribution channels involved in agribusiness.

Theory schedule

1. Meaning and scope - agricultural marketing and economic development
2. Agricultural market structure - meaning, components
3. Dynamics of market structure
4. Marketing strategy - meaning and significance, formulation of marketing strategy
5. Agribusiness marketing environment
6. Design of marketing mix
7. Market segmentation and targeting
8. Determinants of consumer's behaviour
9. Building customer value, satisfaction and loyalty
10. Consumer behaviour - meaning, factors influencing consumer behaviour
11. Stimuli response model
12. Organizational buying - participants, process, managing business to business customer relationships
13. Identifying and analyzing competition
14. Benchmarking and competitive strategies
15. Brand management - strategy, extensions and portfolio
16. Product management
17. Mid semester examination
18. Product management process - decisions
19. New product development
20. Significance and classification of new product
21. Stages and estimation of demand of new product
22. Product life cycle
23. Pricing policies and practices for agribusiness
24. Determinants of price
25. Objectives of pricing policies and methods
26. Marketing communication - objectives, factors

27. Promotional management - concepts
28. Advertising, planning and execution
29. Sales promotion, grading and standardization
30. Distribution management
31. Storage and warehousing management for agricultural products
32. Transportation management for agricultural products
33. Marketing agencies/intermediaries - roles and functions
34. Distribution channels involved in agribusiness

Reference books

1. Acharya, S.S. and Agarwal N.L., 2004. *Agricultural Marketing in India*, 4th Ed., Oxford and IBH, New Delhi.
2. Kohls, R.L. and Uhj J.N., 2005. *Marketing of Agricultural Products*, 9th Ed., Prentice Hall, New Delhi.
3. Kotler, P., 2002. *Marketing Management - Analysis, Planning, Implementation and Control*, Pearson Edu., New Delhi.
4. Krishnamacharyulu, C. and Ramakrishan L., 2002. *Rural Marketing*, Pearson Edu., New Delhi.
5. Ramaswamy, V.S. and Nanakumari S., 2002. *Marketing Management*, 2nd Ed., Mac Millan India, New Delhi.
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ABM 622 Managerial Accounting and Control (1+1)

Objective

The objective of this course is to expose the learner to the concept and methods of management accounting. Focus will be on understanding techniques, uses and applications of management accounting.

Theory

Unit-I - Financial accounting

Financial accounting - meaning, need, principles, concepts and conventions - branches of accounting - internal and external users of accounting - advantages and limitations of financial accounting - accounting standards.

Unit-II - Journal entry

The double entry system - its meaning and scope - the journal - cash book - ledger - trial balance - trading account - profit and loss account - balance sheet - entries and adjustments of different heads in different books and accounts. Introduction to company accounts.

Unit-III - Management accounting

Managing accounting - meaning, functions, scope, utility - limitations and tools of management accounting - analysis of financial statements - ratios - comparative and common size statements - cash flow and funds flow analysis - management audit and financial audit.

Unit-IV - Cost accounting

Cost accounting - nature, significance of cost accounting - classification of cost - costing for material, labour and overheads - marginal costing. Break even analysis - Cost volume profit analysis - its significance, uses and limitations. Standard costing - its meaning, uses and limitations - determination of standard cost - variance analysis - material, labour and overhead.

Unit-V - Budgeting

Responsibility accounting - its meaning and significance - cost profit and investment centers - accounting for price level changes - concepts - CPP and CCA methods. Budget and budgetary control - its meaning, uses and limitations - budgeting and profit planning - different types of budgets and their preparations - sales budget, purchase budget, production budget, cash budget, flexible budget, master budget, zero based budgeting.

Practical

Preparation of journal - ledger - day book. Preparation of balance sheet - financial ratio analysis - income statement - depreciation methods - comparative statement - trend analysis - percentage analysis - standard costing - variance analysis - break even analysis - analysis of case studies - cash budget analysis - port folio management - investment analysis - capital market operations analysis - case studies.

Theory schedule

1. Financial accounting - meaning, need, principles
2. Concepts and conventions - branches of accounting - internal and external users of accounting
3. Advantages and limitations of financial accounting - accounting standards
4. The double entry system - its meaning and scope - the journal - cash book - ledger
5. Trial balance - trading account - profit and loss account - balance sheet
6. Entries and adjustments of different heads in different books and accounts
7. Introduction to company accounts - managing accounting - meaning, functions, scope, utility
8. Limitations and tools of management accounting
9. Mid semester examination
10. Analysis of financial statements - ratios - comparative and common size statements - cash flow analysis - funds flow analysis - management audit and financial audit
11. Cost accounting - nature, significance of cost accounting - classification of cost - costing for material - labour and overheads
12. Marginal costing - break even analysis - cost volume profit analysis - its significance, uses and limitations
13. Standard costing - its meaning, uses and limitations - determination of standard cost, variance analysis - material, labour and overhead
14. Responsibility accounting - its meaning and significance - cost, profit and investment centers - accounting for price level changes
15. Concepts - CPP and CCA methods - budget and budgetary control - its meaning, uses and limitations

16. Budgeting and profit planning - different types of budgets and their preparations
17. Sales budget - purchase budget - production budget - cash budget - flexible budget - master budget - zero based budgeting

Practical schedule

1. Preparation of journal, ledger, day book
2. Preparation of balance sheet
3. Financial ratio analysis
4. Income statement
5. Depreciation methods
6. Comparative statement
7. Trend analysis
8. Percentage analysis
9. Standard costing
10. Variance analysis
11. Break-even analysis
12. Analysis of case studies
13. Cash budget analysis
14. Port folio management
15. Investment analysis
16. Capital market operations analysis
17. Case studies

Reference books

1. Chandra Prasanna, 2001. *Financial Management - Theory and Practice*, Tata Mc Graw Hill Publishing Company Ltd., New Delhi.
2. Kuchhal, S.C., 2000. *Financial Management*, Chaitanya Publishing House, Allahabad.
3. Maheswari, S.N., 2000. *Financial Management: Principles and Practice*, Sultan Chand and Sons, Educational Publishers, New Delhi.
4. Maheswari, S.N and Maheswari, S.K., 2007. *Financial Accounting*, 3rd Ed., Vikas Publ. House, New Delhi.
5. Pandey, I.M., 2002. *Financial Management*, Vikas Publishing House Pvt. Ltd., New Delhi.
6. www.en.wikipedia.org/wiki/Financial_ratio
7. www.referenceforbusiness.com
8. <http://ocw.mit.edu/courses/economics>
9. <https://www.msu.edu/course/ECO/855>
10. <http://www.uky.edu/~deberti/prod/agprod5.pdf>
11. http://www.csuchico.edu/ag/_assets/documents/syllabi/ABUS/ABUS%20301%20AG%20Production%20Econ%20Analysis.pdf

ABM 623 Agricultural Project Management (1+1)

Objective

The objective of this course is to provide the students a thorough understanding on agricultural project selection, formulation, financial feasibility analysis, monitoring and evaluation techniques with special reference to agri business sector.

Theory

Unit-I - Agricultural projects - Introduction

Project - definition - agricultural projects - project preparation and analysis - project cycle - identification, formulation, appraisal, implementation and evaluation - criteria for selection of agricultural projects.

Unit-II - Project identification and formulation

Project identification - entrepreneurs area of interest - background, land, building, water, investment. Sources of projects - resources - own and institutional. Enterprise - project cost, break even point, infrastructure, machinery, power, water, manpower requirement. Procedures for preparation of project proposal on crops, dairy, poultry, horticulture crops, forest, fisheries - data requirements and their format.

Unit-III - Project appraisal

Project appraisal - meaning and scope - types of project appraisal - technical, commercial, financial, economic and management appraisal - methodological issues in financial and economic evaluation of projects - measuring intangible costs and benefits - social cost and benefits analysis - choice among mutually exclusive projects.

Unit-IV - Project monitoring and evaluation

Methods of project monitoring and evaluation - cash flow analysis and discounting procedures - use of decision criteria NPV, BCR, Pay back period and IRR in decision making. Network techniques - PERT, CPM and crash programme methods - SWOT techniques. Analyzing risk in agricultural projects - sensitivity analysis - Decision tree analysis - Environment Impact Assessment (EIA).

Unit-V - Project management

Project management - project ranking - preparation of case studies - review of world bank aided projects - planning and preparation of macro level projects - irrigation, power, agricultural credit, input supply, cropping systems, animal husbandry, plantations, forestry, fisheries and agro-processing units.

Practical

Developing skills in identification of agricultural development projects - formulation of projects - appraisal of projects using undiscounted and discounted techniques - review of world bank aided projects - market feasibility of the projects - use of sensitivity analysis - selection methods among mutually exclusive projects - repayment methods in projects - discussion of agricultural development projects - case studies - social cost benefit analysis - developing network techniques for project management - use of management tools in project monitoring - Analyzing risk in projects - project evaluation - project ranking - macro level agricultural development projects - agro processing projects - project presentation.

Theory schedule

1. Project - definition - agricultural projects - project preparation and analysis
2. Project cycle - identification, formulation, appraisal, implementation and evaluation - criteria for selection of agricultural projects
3. Project identification - entrepreneurs area of interest - background, land, building, water, investment
4. Sources of projects - resources - own and institutional
5. Enterprise - project cost, break even point, infrastructure, machinery, power, water, manpower requirement
6. Procedures for preparation of project proposal on crops, dairy, poultry, horticulture crops, forest, fisheries - data requirements and their format
7. Project appraisal - meaning and scope - types of project appraisal - technical, commercial, financial, economic and management appraisal
8. Methodological issues in financial and economic evaluation of projects
9. Mid semester examination
10. Measuring intangible costs and benefits
11. Methods of project monitoring and evaluation
12. Cash flow analysis and discounting procedures - use of decision criteria NPV, BCR, Pay back period and IRR in decision making
13. Network techniques - PERT, CPM and crash programme methods
14. SWOT techniques
15. Analyzing risk in agricultural projects
16. Project management - project ranking - preparation of case studies
17. Review of world bank aided projects - planning and preparation of macro level projects - irrigation, power, agricultural credit, input supply, cropping systems, animal husbandry, plantations, forestry, fisheries and agro-processing units

Practical schedule

1. Developing skills in identification of agricultural development projects
2. Formulation of projects
3. Appraisal of project using undiscounted and discounted techniques
4. Review of world bank aided projects
5. Market feasibility of the projects
6. Use of sensitivity analysis
7. Selection methods among mutually exclusive projects
8. Repayment methods in project
9. Discussion of agricultural development projects - case studies
10. Social cost benefit analysis
11. Developing network techniques for project management
12. Use of management tools in project monitoring
13. Analyzing risk in projects
14. Project evaluation - project ranking
15. Macro level agricultural development projects
16. Agro processing projects
17. Project presentation

Reference books

1. Chandra, Prasanna, 1995. *Projects: Preparation, Appraisal, Budgeting and Implementation*, Tata Mc - Graw Hill Publications, New Delhi.
2. Gopal Krishan, P. and K. Nagarajan, 2005. *Project Management*, New Age Publishing, New Delhi.
3. Goel, B.B., 1989. *Project Management*, Deep and Deep Publications, New Delhi.
4. Gittinger, Price J., 1982. *Economic Analysis of Agricultural Projects*, The John Hopkins University Press, London.
5. Ramamoorthy, V.E., 2005. *Textbook of Project Management*, Macmillan, New Delhi.
6. www.edc-iitd.org
7. www.ediindia.org
8. www.projectmanagement.com
9. www.projectscenter.com

ABM 624 AGRIBUSINESS FINANCIAL MANAGEMENT (2+0)

Objective

To impart knowledge to the students regarding various aspects of financial management for agribusiness.

Theory

Unit-I - Introduction to financial management

Importance, need and scope of financial management - classification of credit - credit needs in changing agriculture scenario - finance functions - investment financing - balance sheet - income statement - cash flow statement for agribusiness.

Unit-II - Financial planning

Financial planning and control - assessment of financial requirement of a agribusiness unit. Leverage - concept of leverage, financial and operating leverage - factor affecting capital structure - features of an optimal capital structure.

Unit-III - Working capital management

Working capital management - concept and components of working capital - need for working capital in agribusiness - management of cash and accounts receivables - inventory for agribusiness.

Unit-IV - Capital budgeting

Capital budgeting - steps and concept of capital budgeting - appraisal criteria - payback period, average rate of return, net present value, benefit-cost ratio and internal rate of return - sensitivity analysis.

Unit-V - Agribusiness finance system

Agri-business financing system in India - functioning of cooperative credit institutions, commercial banks, regional rural banks, NABARD, agro-industries corporation, etc in agribusiness financing.

Theory schedule

1. Importance, need and scope of financial management
2. Classification of credit

3. Credit needs in changing agriculture scenario
4. Finance functions
5. Investment financing
6. Balance sheet for agribusiness
7. Income statement for agribusiness
8. Cash flow statement for agribusiness
9. Financial planning and control
10. Assessment of financial requirement of a agribusiness unit
11. Leverage - concept of leverage
12. Financial leverage - operating leverage
13. Factor affecting capital structure
14. Features of an optimal capital structure
15. Working capital management
16. Concept and components of working capital
17. Mid semester examination
18. Need for working capital in agribusiness
19. Management of cash - accounts receivables
20. Inventory for agribusiness
21. Capital budgeting
22. Steps and concept of capital budgeting
23. Appraisal criteria
24. Payback period, average rate of return
25. Net present value
26. Benefit-cost ratio
27. Sensitivity analysis
28. Agri-business financing system in India
29. Internal rate of return
30. Functioning of cooperative credit institutions
31. Commercial banks in agribusiness financing
32. Regional rural banks in agribusiness financing
33. NABARD in agribusiness financing
34. Agro-Industries Corporation in agribusiness financing

Reference books

1. Chandra, P., 2000. *Financial Management*, Tata McGraw Hill, New Delhi.
2. Khan, M.Y. and Jain P.K., 2004. *Management Accounting*, Tata McGraw Hill, New Delhi.
3. Nelson, A.G and Murrey W.G., 1988. *Agricultural Finance*, Kalyani Publication, New Delhi.
4. Pandey, I.M., 1997. *Financial Management*, Vikas Publication House, New Delhi.
5. Van Horne, J.C., 1997. *Financial Management and Policy*, Prentice Hall of India, New Delhi.
6. www.logisticsmgmt.com
7. www.managementhelp.org

ABM 625 OPERATIONS RESEARCH (1+1)

Objectives

The objective of this course is to acquaint the learner with the applications of some important operations research techniques. Focus will be on understanding the use of these techniques in solving business problems.

Theory

Unit-I - Linear programming

Linear programming - objective, assumptions, formulation of linear programming problems - graphical method - simplex method - applications of operations research in functional areas of management.

Unit-II - Transportation and assignment problem

Transportation problem - formulation - initial basic feasible solution - degeneracy in transportation problem. Assignment problem - formulation algorithm - routing problems - sequencing problems.

Unit-III - Waiting line models

Waiting line problem - characteristics of a waiting line system - single channel model - multiple channel model - constant service time model - finite population model - sequencing and replacement models.

Unit-IV - Decision making under risk

Decision making under risk and uncertainties - decision problem - maximax criterion - maximin criterion - minimax regret criterion - laplace criterion - pay off tables - decision trees - expected value of perfect information - decision making environment.

Unit-V - Game theory

Game theory - two person zero sum game - competitive situations - characteristics competitive games simulation - network analysis - PERT and CPM.

Practical

Linear programming - formulation - graphical solution - simplex method - artificial variable technique - problem of degeneracy - concept of duality - formulation of primal - dual problems - dual simplex method - revised simplex method. Transportation problem - formulation - initial basic feasible solution and optimal solution - degeneracy in transportation problem. Assignment problem - routing problems - sequencing problems - waiting line problem - single channel model - multiple channel model - constant - service time model - finite population model - sequencing and replacement models. Game theory - two person zero sum games - problem solving in game theory using saddle points and dominance property. Network problems - Critical Path Method (CPM) - Project Evaluation Review Technique (PERT) - time calculations.

Theory schedule

1. Linear programming - objective, assumptions
2. Formulation of linear programming problems - graphical method - simplex method
3. Applications of operations research in functional areas of management
4. Transportation problem - formulation

5. Initial basics feasible solution - degeneracy in transportation problem
6. Assignment problem - formulation algorithm
7. Routing problems - sequencing problems
8. Waiting line problem - characteristics of a waiting line system, single channel model - multiple channel model
9. Mid semester examination
10. Constant service time model - finite population model
11. Sequencing and replacement models
12. Decision making under risk and uncertainties - decision problem - maximax criterion - maximin criterion
13. Minimax regret criterion - laplace criterion - pay off tables - decision trees - expected value of perfect Information, decision making - environment
14. Game theory - introduction - two person zero sum games
15. Competitive situations and characteristics of competitive games simulation
16. Net work analysis - basic components - rules
17. Critical Path Method (CPM), Project Evaluation Review Technique (PERT), time calculations in net work problems

Practical schedule

1. Linear programming problems - formulation
2. Graphical solution - simplex method
3. Artificial variable technique - problem of degeneracy
4. Concept of duality - formulation of primal - dual problems
5. Dual simplex method - revised simplex method
6. Transportation problem - formulation
7. Initial basic feasible solution and optimal solution
8. Degeneracy in transportation problem
9. Assignment problem
10. Routing problems - sequencing problems
11. Waiting line problem - single channel model - multiple channel model
12. Constant service time model - finite population model
13. Sequencing and replacement models
14. Game theory - two person zero sum games
15. Problem solving in game theory using saddle points and dominance property
16. Net work problems - Critical Path Method (CPM)
17. Project Evaluation Review Technique (PERT) - time calculations

Reference books

1. Gupta, P.K. and D.S. Hira, 2004. *Operations Research*, Sultan Chand and Sons, New Delhi.
2. Kanji Swarup, P.K. Gupta and Man Mohan, 1999. *Operations Research*, Sultan Chand and Sons, New Delhi.
3. Taha, H.A., 1982. *Operations Research - An Introduction*, Macmillan, India Ltd, New Delhi.
4. Vohra, N.D., 2006. *Quantitative Techniques in Management*, Mc Graw Hill, New Delhi.
5. Wagner, H.M., 2005. *Principles of Operations Research*, Prentice Hall, New Delhi.

ABM 626 AGRI BUSINESS ENVIRONMENT, BUSINESS LAW AND POLICY (1+0)
Objectives

To expose learners to the environment in which the agribusiness is conducted and on various ethical issues and laws affecting business. Focus will be on understanding micro and macro environmental forces and their impact on agribusiness, provisions of various business laws and ethical practices to conduct the business properly with special reference to India.

Theory

Unit-I - Agri business environment

Role of agriculture in Indian economy - problems and policy changes in India relating to - farm supplies - farm production - agro processing and agricultural marketing.

Unit-II - Agri business sector

Structure of agriculture - linkages among sub sectors of the agribusiness sector - economic reforms in Indian agriculture - impact of liberalization, privatization and globalization on agri business sector.

Unit-III - Agri business policy

Agribusiness policies - concept and formulation - new dimensions in agri business environment and policy - public distribution systems and other policies.

Unit-IV - Introduction to India business law

Introduction to Indian legal system - The Indian Contract Act 1872. Contract - meaning, nature, significance, types of contract - essentials of a valid contract - acceptance - capacity to contract - free consent - performance of contract.

Unit-V - Legal acts

Companies Act 1956 incorporation - sale of goods act - commencement of business - types of companies management - winding of companies - negotiable instruments act - essential commodities act - APMC act - Consumer protection act - RTI act - MRTP act - major provisions and implications. Factory act - labour laws - Industrial dispute act - law of insurance.

Theory schedule

1. Role of agriculture in Indian economy
2. Problems and policy changes in India relating to farm supplies and farm production
3. Problems and policy changes in India relating to agro processing and agricultural marketing
4. Structure of agriculture - linkages among sub-sectors of the agribusiness sector
5. Economic reforms in Indian agriculture - impact of liberalization, privatization and globalization on agri business sector
6. New dimensions in agri business environment and policy
7. Public distribution systems and other policies
8. Introduction to Indian legal system
9. Mid semester examination
10. The Indian Contract Act 1872. Contract - meaning - nature - significance
11. Types of contract - essentials of a valid contract acceptance

12. Capacity to contract - free consent - performance of contract
13. Companies act 1956 incorporation - sale of goods act and commencement of business
14. Types of companies - management - winding of companies
15. Negotiable instruments act - essential commodities act
16. APMC act - consumer protection act
17. RTI act - MRTP act - major provisions and implications - factory act - labour laws - industrial dispute act - law of insurance

Reference books

1. Adhikary, M., 1986. *Economic Environment of Business*, Sulthan Chand and Sons, New Delhi.
2. Aswathappa, K., 1997. *Essentials of Business Environment*, Himalaya Publication, New Delhi.
3. Gulshan, S.S. and Kapoor, G.K., 2003. *Business Law Including Company Law*, 10th Edition, New Delhi.
4. Kapoor, N.D., 2005. *Business Law*, Tata McGraw Hill, New Delhi.
5. Tulsain, P.C., 2006. *Business Law*, Tata McGraw Hill, New Delhi.
6. www.taxinfo.com www.mca.gov.in
7. www.laws4india.com
8. www.indialaw.com
9. www.allbookez.com/nd-kapoor-business-la

ABM 711 E1. LOGISTICS AND SUPPLY CHAIN MANAGEMENT (2+0)

Objective

The course introduces the students to the concepts and processes of agricultural supply chain management, framework for structuring supply chain drivers; network designs, demand forecasting, inventory planning, sourcing decisions and IT enablement of supply chain.

Theory

Unit-I - Concept of supply chain management

Supply chain: changing business environment - supply chain management - present need - conceptual model of supply chain management - evolution of supply chain management - supply chain management approach - traditional agri supply chain management approach - modern supply chain management approach - elements in supply chain management.

Unit-II - Demand management in supply chain

Demand management in supply chain - types of demand, demand planning and forecasting - operations management in supply chain - basic principles of manufacturing management.

Unit-III - Procurement management in supply chain

Procurement management in agri. supply chain. Purchasing Cycle - types of purchases - contract/corporate farming - classification of purchases: Goods or

services. Traditional inventory management - material requirements planning, Just in Time (JIT), Vendor Managed Inventory (VMI).

Unit-IV - Logistic management in supply chain

Logistics management - history and evolution of logistics - elements of logistics management - distribution management - distribution strategies - pool distribution - transportation management - fleet management - service innovation - warehousing - packaging for logistics - Third-party logistics (TPL/3PL) - GPS Technology.

Unit-V - Information technologies

Concept of information technology - IT application in supply chain management - advanced planning and scheduling - supply chain management in electronic business - role of knowledge in supply chain management - performance measurement and controls in agri. supply chain management. Benchmarking - introduction, concept and forms of benchmarking.

Theory schedule

1. Supply chain - changing business environment - supply chain management - present need
2. Conceptual model of supply chain management
3. Evolution of supply chain management
4. Supply chain management approach - traditional agri. supply chain management approach
5. Modern supply chain management approach
6. Elements in supply chain management
7. Demand management in supply chain
8. Types of demand, demand planning and forecasting
9. Operations management in supply chain
10. Basic principles of manufacturing management
11. Procurement management in agri. supply chain - purchasing cycle
12. Types of purchases
13. Contract/corporate farming
14. Classification of purchases: goods or services
15. Traditional inventory management
16. Material requirements planning
17. Mid semester examination
18. Just in Time (JIT)
19. Vendor Managed Inventory (VMI)
20. Logistics management
21. History and evolution of logistics
22. Elements of logistics management
23. Distribution management, distribution strategies
24. Pool distribution
25. Transportation management
26. Fleet management
27. Service innovation - warehousing - packaging for logistics
28. Third-party logistics (TPL/3PL) - GPS technology

29. Concept of information technology - IT application in supply chain management
30. Advanced planning and scheduling
31. SCM in electronic business
32. Role of knowledge in supply chain management
33. Performance measurement and controls in agriculture - supply chain management
34. Benchmarking: introduction, concept and forms of benchmarking

Reference books

1. Altekhar, R.V., 2006. *Supply Chain Management: Concepts and Cases*. Prentice Hall of India.
2. Monczka, R., Trent R and Handfield R., 2002. *Purchasing and Supply Chain Management*. Thomson Asia.
3. Van Weele, A.J., 2000. *Purchasing and Supply Chain Management Analysis Planning and Practice*. Vikas Publ. House, New Delhi.
4. Gibson, G. Vedamani., 2003. *Retail Management*, Jaico Publishing House, Mumbai.
5. Jishnu Hazra and Janat Shah, 2005. *Supply Chain Management*, Indian Institute of Management (Publications), Bangalore.
6. www.logisticsonline.com
7. www.supplychainmarket.com

ABM 711E2. FARM BUSINESS MANAGEMENT (2+0)

Objective

To acquaint the students with the basic principles of farm management dealing with the analysis of farm resources having alternatives within the framework of resource restrictions.

Theory

Unit-I - Scope of farm business management

Nature, scope, characteristics and role of farm business management - farm management decisions - farm management problems.

Unit-II - Principles of farm management

Principles of farm management decisions - principle of variable proportion - cost principle - principle of factor substitution - law of equi-marginal returns - opportunity cost principle - time comparison principle - principle of comparative advantage.

Unit-III - Tools of farm management

Tools of farm management and farm business analysis - valuation of farm assets - depreciation - net worth statement - income statement - cash flow statement. Farm planning and budgeting - enterprises budgeting - partial budgeting - complete budgeting - steps in whole farm planning and budgeting. Farm records and accounts - types and problems in farm records and accounts.

Unit-IV - Management of farm resources

Management of farm resources - land, labour, farm machinery, farm building, etc.
Farm efficiency measures - physical efficiency, financial efficiency measures - break even point analysis.

Unit-V - Risk and uncertainty

Risk and uncertainty in farming - sources of uncertainty in farming, management strategy to counteract uncertainty and decision making process in farm business management under risk and uncertainty.

Theory schedule

1. Nature, scope, characteristics and role of farm business management
2. Farm management decisions
3. Farm management problems
4. Principles of farm management decisions
5. Principle of variable proportion
6. Cost principle
7. Principle of factor substitution
8. Law of equi-marginal returns
9. Opportunity cost principle
10. Time comparison principle
11. Principle of comparative advantage
12. Tools of farm management and farm business analysis
13. Valuation of farm assets
14. Depreciation methods
15. Networth statement
16. Income statement
17. Mid semester examination
18. Cashflow statement
19. Farm planning and budgeting
20. Enterprises budgeting
21. Partial budgeting
22. Complete budgeting
23. Steps in whole farm planning and budgeting
24. Farm records and accounts
25. Types and problems in farm records and accounts
26. Management of farm resources
27. Land, labour, farm machinery, farm building, etc
28. Farm efficiency measures
29. Physical and financial efficiency measures
30. Break even point analysis
31. Risk and uncertainty in farming
32. Sources of uncertainty in farming
33. Management strategy to counteract uncertainty
34. Decision making process in farm business management under risk and uncertainty

Reference books

1. Heady, E.O. and Jensen H., 1960. *Farm Management Economics*. Prentice Hall, New Delhi.
2. Johl, S.S., and Kapoor T.R., 1973. *Fundamentals of Farm Business Management*. Kalyani Publication, New Delhi.
3. Kahlon, A.S., and Singh K., 1992. *Economics of Farm Management in India*. Allied Publication, New Delhi.
4. Panda, S.C., 2007. *Farm Management and Agricultural Marketing*. Kalyani Publication, New Delhi.
5. Raju, V.T., and Rao S., 2000. *Economics of Farm Production and Management*, Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.
6. Dhondyal, S.P., Singh G.N., 2011. *Production Economics and Farm Management*, Aman Publishing Company, Meerut.

ABM 711E3. SALES AND DISTRIBUTION MANAGEMENT IN AGRI BUSINESS
(2+0)

Objectives

The objective of this course is to provide knowledge to students on the theory and practices of sales promotion and product management in agri business.

Theory

Unit-I - Introduction to sales management

Selling and marketing - selling and advertising - sales objectives - functions of sales management - duties and responsibilities of sales manager. Salesmanship - art, science and profession - types of salesmanship - advantages and limitations of salesmanship - qualities of a good salesman.

Unit-II - Sales management functions, selling process

Sales management - functions - sales planning, sales policy - sales organization - structuring and managing sales force - designing sales territories - fixing sales quota - controlling and motivating sales force. Selling processes - sizing up customers - AIDAS formula - sales promotion techniques - dealer and consumer promotion.

Unit-III - Training of salesman and methods of appraisal

Recruitment and selection of sales force - the need for sales - selection process. Training of salesman - importance, objectives, methods of training. Supervision of salesman - executive sales training programme. Appraising salesman's performance - methods of appraisal - indices of salesman's performance - compensation of sales force - principles of compensation to salesman - methods of compensation - additional compensator scheme.

Unit-IV - Distribution channels and marketing risk

Physical distribution - meaning - distribution mix - role of distribution in marketing. Transport - kinds, functions, advantages and limitations, managing transport - criteria for selecting good transport. The channels of distribution - its importance - selection of right channel - types of channels - dealer network. Managing marketing risk - types of risk - controlling risk - minimizing and managing risk.

Unit-V - Distribution environment - intermediaries

Distribution environment - competitors, extensive distribution - franchise selling, Public distribution - its special features. Distribution intermediates - their role and importance - types of intermediates - wholesaler and retailers - kinds of retailers - small scale and large scale retailers. Other intermediaries - brokers, commission agents, dealers, sole selling agents.

Theory schedule

1. Selling and marketing - selling and advertising - sales objectives
2. Functions of sales management - duties and responsibilities of sales manager
3. Salesmanship - art, science and profession, types of salesmanship
4. Advantages and limitations of salesmanship - qualities of a good salesman
5. Sales management - functions - sales planning, sales policy
6. Sales organization, structuring and managing sales force
7. Designing sales territories - fixing sales quota, controlling and motivating sales force
8. Selling processes - sizing up customers - AIDAS formula
9. Sales promotion techniques - dealer and consumer promotion
10. Recruitment and selection of sales force
11. The need for sales - selection process
12. Training of salesman - importance, objectives, methods of training
13. Supervision of salesman - executive sales training programme
14. Appraising salesman's performance - methods of appraisal
15. Indices of salesman's performance
16. Compensation of sales force - principles of compensation to salesman
17. Mid semester examination
18. Methods of compensation - additional compensator scheme
19. Physical distribution - meaning - distribution mix - role of distribution in marketing
20. Transport - kinds, functions, advantages and limitations
21. Managing transport - criteria for selecting good transport
22. The channels of distribution - its importance
23. Selection of right channel
24. Types of channels - dealer network
25. Managing marketing risk - types of risk
26. Controlling risk - minimizing and managing risk
27. Distribution environment
28. Competitors, extensive distribution - franchise selling
29. Public distribution - its special features
30. Distribution intermediates - their role and importance
31. Types of intermediates
32. Wholesaler and retailers - kinds of retailers
33. Small scale and large scale retailers
34. Other intermediaries - brokers, commission agents, dealers, sole selling agents

Reference books

1. Acharya and Govekar, 2001. *Marketing and Sales Management*, Himalaya Publishing House, Mumbai.
2. Bellur, V.V., 2001. *Sales Management*, Himalaya Publishing House, Bombay.
3. Philip Kotler, 2006. *Principles of Marketing*, Prentice Hall of India, New Delhi.
4. Ramasamy, V.S., 2001. *Marketing Management*, Macmillan, New Delhi.
5. Rom Markin, 2000. *Marketing Strategy and Management*, John Wiley Sons Inc., New York.

ABM 712 E1. ENTREPRENEURSHIP DEVELOPMENT (2+0)

Objective

To make the students understand the concept of entrepreneurship development skills for agri business and its application.

Theory

Unit-I - Concept of entrepreneurship development

Introduction - agri business - entrepreneur - qualities of entrepreneur - entrepreneurial process - entrepreneurial competencies and orientation. Innovation levels - types, process and drivers to improve the innovation competencies. Identification of business opportunities and guidelines for starting farm enterprises.

Unit-II - Classification of entrepreneurship

Types of entrepreneurship - food processing - export oriented units - agri inputs - organic product entrepreneurship - service entrepreneurs - certification entrepreneurs - clearing and forwarding entrepreneurs - machinery manufacturers.

Unit-III - Significance of entrepreneurship

Entrepreneurship - significance of entrepreneurship in economic development - entrepreneurship development programs - role of various institutions in developing entrepreneurship - life cycles of new business, environmental factors affecting success of a new business - reasons for the failure and visible problems of business.

Unit-IV - Business plan preparation

Developing effective business plans - procedural steps in setting up of an industry. Business feasibility analysis - techno, economic, financial and social cost benefit analysis. Network analysis - PERT and CPM.

Unit-V - Government schemes and social entrepreneurship

Government schemes and incentives for promotion of entrepreneurship - institutional support to business entrepreneurs - business incubation and entrepreneurship. Social entrepreneurship - concept and opportunities.

Theory schedule

1. Introduction to agri business
2. Entrepreneur - qualities of entrepreneurs
3. Entrepreneurial process
4. Entrepreneurial competencies and orientation

5. Innovation levels, types, process and drivers to improve the innovation competencies
6. Identification of business opportunities
7. Guidelines for starting farm enterprises
8. Types of entrepreneurship
9. Food processing
10. Export oriented units
11. Agri inputs entrepreneurship
12. Organic product entrepreneurship
13. Service entrepreneur
14. Certification entrepreneurs
15. Clearing and forwarding entrepreneurs
16. Machinery manufacturers
17. Mid semester examination
18. Entrepreneurship - significance of entrepreneurship in economic development
19. Entrepreneurship development programs
20. Role of various institutions in developing entrepreneurship
21. Life cycles of new businesses
22. Environmental factors affecting success of a new business
23. Reasons for the failure and visible problems of business
24. Developing effective business plans
25. Procedural steps in setting up of an industry
26. Business feasibility analysis
27. Techno, economic, financial and feasibility analysis
28. Social cost benefit analysis
29. Network analysis - PERT and CPM
30. Government schemes and incentives for promotion of entrepreneurship - I
31. Government schemes and incentives for promotion of entrepreneurship - II
32. Institutional support to business entrepreneurs
33. Business incubation and entrepreneurship
34. Social entrepreneurship - concept and opportunities

Reference books

1. Badi, R.V and N.V. Badi, 2007. *Entrepreneurship*, Vrinda Publication (p) Ltd, New Delhi.
2. David H. Holt., 2008. *Entrepreneurship*, New Venture Creation, PHI, New Delhi.
3. Nandan, H., 2007. *Fundamentals of Entrepreneurship Management*, Prentice Hall, New Delhi.
4. Peter F. Drucker, 2006. *Innovation and Entrepreneurship Practice and Principles*, 2006. HarperCollins, London.
5. Sahay, A., and M.S. Chhikara, 2007. *New Vistas of Entrepreneurship Challenges and Opportunities*, Excel Books, New Delhi.

ABM 712 E2. RURAL AND SERVICE MARKETING (2+0)

Objectives

The objective of this course is to develop an understanding on the issues in rural markets, marketing environment, consumer behaviour, distribution channels, marketing strategies, etc.

Theory

Unit-I - Overview of rural marketing

Concept and scope of rural marketing - nature and characteristics of rural markets - potential of rural markets in India - rural communication and distribution.

Unit-II - Factors affecting rural marketing

Environmental factors, socio-cultural, economic, demographic, technological and other environmental factors affecting rural marketing.

Unit-III - Consumer's behaviour

Rural consumer's behaviour - behaviour of rural consumers and farmers - buyer characteristics and buying behaviour. Rural Vs urban markets - customer relationship management - rural market research - implications of rural market research.

Unit-IV - Rural marketing strategy

Rural marketing strategy - marketing of consumer durable and non-durable goods - services in the rural markets with special reference to product planning - product mix - pricing policy and pricing strategy - distribution strategy.

Unit-V - Promotion strategy

Promotion and communication strategy - media planning - planning of distribution channels - organizing personal selling in rural market in India - innovations in rural marketing.

Theory schedule

1. Concept and scope of rural marketing
2. Nature of rural markets
3. Characteristics of rural markets
4. Potential of rural markets in India
5. Rural communication and distribution
6. Environmental factors affecting rural marketing
7. Socio-cultural factors affecting rural marketing
8. Economic factors affecting rural marketing
9. Demographic factors affecting rural marketing
10. Technological factors affecting rural marketing
11. Other environmental factors affecting rural marketing
12. Rural consumer's behaviour
13. Behaviour of rural consumers
14. Behaviour of rural farmers
15. Buyer characteristics and buying behaviour
16. Rural Vs urban markets
17. Mid semester examination
18. Customer relationship management
19. Rural market research

20. Implication of rural market research
21. Rural marketing strategy
22. Marketing of consumer durable goods
23. Marketing of non-durable goods
24. Marketing of services in the rural markets with special reference to product planning
25. Product mix
26. Pricing policy and pricing strategy
27. Distribution strategy
28. Promotion strategy
29. Communication strategy
30. Media planning
31. Planning of distribution channels
32. Organizing personal selling in rural market in India
33. Innovations in rural marketing - I
34. Innovations in rural marketing - II

Reference books

1. Acharya, S.S. and N.L. Agarwal, 2008. *Agricultural Marketing in India*, Oxford and IBH, New Delhi.
2. Krishnamacharyulu, C. and Ramakrishan L., 2002. *Rural Marketing*, Pearson Edu., New Delhi.
3. Ramaswamy, V.S. and Nanakumari S., 2006. *Marketing Management*. 3rd Ed., MacMillan Publications, New Delhi.
4. Singh, A.K. and Pandey S., 2005. *Rural Marketing*, New Age Publications, New Delhi.
5. Singh Sukhpal, 2004. *Rural Marketing*, Vikas Publ. House., New Delhi.
6. <http://miteshk.webs.com/RURALMARKETING.pdf>
7. <http://www.slideshare.net/>
8. <http://www.ijars.in/iJARS%20506.pdf>
9. <http://www.rmai.in/publication.html>
10. <http://www.bms.co.in/rural-marketing-notes/>

ABM 712 E3. FOOD RETAIL MANAGEMENT (2+0)

Objectives

The objective of this course is to assist the students in understanding the structure and working of food marketing system in India, to examine how the system affects farmers, consumers and middlemen and to illustrate the response of this dynamic marketing system to technological, socio-cultural, political and economic forces over time.

Theory

Unit-I - International food market

Introduction to international food market - India's competitive position in the world food trade - foreign investment in global food industry - retail management and food retailing - the nature of change in retailing - organized retailing in India - retailing and understanding food preferences of Indian consumers - food consumption and

expenditure pattern - demographic and psychographic factors affecting food pattern of Indian consumer.

Unit-II - Value chain

Value chain in food retailing - principal trends in food wholesaling and retailing - the changing nature of food stores - various retailing formats - competition and pricing in food retailing - market implications of new retail developments - value chain and value additions across the chain in food retail - food service marketing.

Unit-III - Pricing strategies

4 P's in food retail management - brand management in retailing - merchandise pricing - pricing strategies used in conventional and non-conventional food retailing - public distribution system - promotion mix for food retailing - management of sales promotion and publicity - advertisement strategies for food retailers.

Unit-IV - Retail operations

Managing retail operations - managing retailers' finance - merchandise buying and handling - merchandise pricing - logistics - procurement of food products and handling transportation of food products.

Unit-V - Retail selling

Retail sales management types of retail selling - salesperson selection - salesperson training - evaluation and monitoring - customer relationship management - managing human resources in retailing - legal and ethical issues in retailing.

Theory schedule

1. Introduction to international food market
2. India's competitive position in world food trade
3. Foreign investment in global food industry
4. Retail management and food retailing
5. The nature of change in retailing
6. Organized retailing in India
7. Retailing and understanding food preferences of Indian consumers
8. Food consumption and expenditure pattern
9. Demographic and psychographic factor affecting food pattern of Indian consumer
10. Value chain in food retailing
11. Principal trends in food wholesaling and retailing
12. The changing nature of food stores
13. Various retailing formats
14. Competition and pricing in food retailing
15. Market implications of new retail developments
16. Value chain and value additions across the chain in food retail
17. Mid semester examination
18. Food service marketing
19. 4 P's in food retail management
20. Brand management in retailing
21. Merchandise pricing, pricing strategies used in conventional and non-conventional food retailing
22. Public distribution system

23. Promotion mix for food retailing
24. Management of sales promotion and publicity
25. Advertisement strategies for food retailers
26. Managing retail operations and retailers' finance
27. Merchandise buying and handling, merchandise pricing
28. Logistics, procurement of food products and handling transportation of food products
29. Retail sales management
30. Types of retail selling
31. Salesperson selection, training, evaluation and monitoring
32. Customer relationship management
33. Managing human resources in retailing
34. Legal and ethical issues in retailing

Reference books

1. Acharya, S.S., and N.L., Agarwal, 2004. *Agricultural Marketing in India*, Oxford and IBH, New Delhi.
2. Berman and Evans, 2008. *Retail Management: A Strategic Approach*, 10th Ed., Prentice Hall of India, New Delhi.
3. Cox, 2006. *Retailing: An Introduction*, 5th Ed. Pearson Edu, New Delhi.
4. Levy, M., and Weitz B.W, 2004. *Retailing Management*, 5th Ed. McGraw Hill Publishing, New Delhi.
5. Potly, V.H., and M.J. Mulky, 1993. *Food Processing*, Oxford and IBH, New Delhi.
6. www.fssai.in
7. www.qavi.org/nabcb/accreditation/reg_bod_qms.php
8. www.qcin.org

ABM 713 E1. INSURANCE AND RISK MANAGEMENT (2+0)

Objective

The aim of this course is to provide the students a thorough knowledge on the principles of insurance, practices of risk management in agri business and various insurance policies and schemes available for agri business.

Theory

Unit-I - Concept of risk and insurance

The concept of risk - kinds and classification of risks - assessment - the concept of insurance - types of general insurance, agriculture, fire, marine, engineering - insurance of property. Insurance professionals and intermediaries.

Unit-II - Principles of insurance

Basic principles of insurance - utmost good faith - insurable interest - material facts. Economic principles - sharing - subrogation - contribution. Legal principles - the Indian Contract Act, 1872 - nomination and assignment. Financial principles - premium funds - investments.

Unit-III - Agricultural insurance

Agricultural situation - types of agricultural insurance - scope and practices. Crop insurance - problems and remedies - crop insurance in other countries. Cattle

insurance policy - valuation of cattle loans assessment - settlement of claims. Poultry insurance - miscellaneous insurance - shrimp culture, sericulture, apiculture, plantations, bio-gas, animal driven cart, agricultural pump sets.

Unit-IV - *Basics in risk management*

Risk and uncertainty - acceptable risks versus unacceptable risks - classification of risk - the cost of risk - handling risks. The scope and objective of risk management - measurement of risk and adjustment to risk - linear programming and marginal analysis - MOTAD - personal risk management.

Unit-V - *Techniques of risk management*

Risk identification - risk evaluations - statistical methods and probability concepts - decision taken under conditions of risk and uncertainty - risk avoidance - risk reduction and loss control - insurance - benefits and limitations - partial insurances - risk management and corporate objectives.

Theory schedule

1. Concept of risk in the context of agri business
2. Kinds and classification of risk - risk assessment
3. The concept of insurance
4. Types of general insurance - agriculture
5. General insurance - fire, marine, engineering insurance of property
6. Insurance professionals and intermediaries
7. Basic principles of insurance - utmost good faith - insurable interest - material facts
8. Economic principles of - sharing - subrogation - contribution
9. Legal principles of insurance
10. The Indian contract act 1872 - nomination and assignment
11. Financial principles - premium funds - investments
12. Agricultural situation in India
13. Types of agricultural insurance - scope and practices
14. Problems in crop insurance and remedies
15. Crop insurance in other countries
16. Cattle insurance policy - valuation of cattle loans assessment - settlement of claims
17. Mid semester examination
18. Poultry insurance - valuation - loss assessment - settlement
19. Insurance for sericulture, apiculture
20. Insurance for shrimp culture
21. Insurance for plantations
22. Insurance for bio - gas, pump sets and other miscellaneous insurance
23. Basics in risks and uncertainty
24. Acceptable risks versus unacceptable risks
25. Classification of risks relevant to agri business
26. The cost of risks and handling of risk
27. The scope and objective of risk management, measurement and adjustment to risk
28. Linear programming and marginal analysis

29. MOTAD
30. Personal risk management
31. Risk identification - risk evaluation - statistical methods and probability
32. Decision taken under conditions of risks and uncertainty
33. Risk avoidance - risk reduction and loss control - insurance - benefits and limitations
34. Partial insurance - risk management and corporate objectives

Reference books

1. *Crop Insurance*, 1998. Publication of Insurance Institution of India, Mumbai.
2. David, C. and Debertin, 1986. *Agricultural Production Economics*, Mac Millan Publishing Company, New York.
3. *General Insurance*, 2004. Publication of United India Insurance Co, Ltd., Chennai.
4. *General Insurance*, 2004. Publication of Insurance Institution of India, Mumbai.
5. Sankhayan, P.L., 1988. *Introduction to the Economics of Agricultural Production*, Prentice Hall of India, New Delhi.

ABM 713 E2. COMMUNICATION FOR MANAGEMENT AND BUSINESS (2+0)

Objectives

The course aims to make the students proficient in written as well as oral communication. The focus will be on business related communication aspects.

Theory

Unit - I - Communication - introduction

Introduction to communication - communication process - barriers to communication - effective communication. Communication in organisations - downward - upward - horizontal - static vs dynamic communication.

Unit - II - Types of communication

Non-verbal communication - communication through clothes / colours / space / symbol - body language and etiquettes - interpersonal communication - self-concept and communication - assertive communication.

Unit - III - Business writing

Types of business writing - news letters - reports - folders - fact sheets - press release - readership and writing style - human aspects of writing.

Unit - IV - Meetings

Meetings - planning for meeting - tips for chairing, opening - progress and ending - behaviour of ordinary members - the character of business meeting - energies for meetings - group discussions - brain storming sessions and presentations.

Unit - V - Personal communication

Handling personal communication - letters - dictation - reading - problem solving - listening skills - self talk - self reflection - steps to personal creativity - public speaking.

Theory schedule

1. Introduction to communication
2. Communication process
3. Barriers to communication
4. Effective communication
5. Communication in organizations
6. Downward, upward, horizontal, static Vs dynamic communication
7. Types of communication - non-verbal communication
8. Communication through clothes / colours / space / symbol
9. Body language and etiquettes
10. Interpersonal communication
11. Self-concept and communication
12. Assertive communication
13. Types of business writing
14. News letters, reports
15. Folders, fact sheets
16. Press release
17. Mid semester examination
18. Readership and writing style
19. Human aspects of writing
20. Meetings - planning for meeting
21. Tips for chairing, opening, progress and ending
22. Behaviour of ordinary members
23. The character of business meeting
24. Energies for meetings
25. Group discussions
26. Brain storming sessions
27. Presentations
28. Handling personal communication
29. Letters, dictation, reading, problem solving
30. listening skills
31. Self-talk
32. Self-reflection
33. Steps to personal creativity
34. Public speaking

Reference books

1. Bovee, 2008. *Business Communication Today*, 7th Ed., Pearson Edu., New Delhi.
2. Brown L., 2006. *Communication Facts and Ideas in Business*, Prentice Hall, New Delhi.
3. James O'Brien, 1999. *Management Information System*, Tata McGraw Hill, New Delhi.
4. Lesikar, 2004. *Basic Business Communication*, McGraw Hill, New Delhi.
5. Ramchandran, K.K., Lakshmi K.K. and K.K. Karthik, 2007. *Business Communication*, MacMillan Publications, New Delhi.

ABM 713 E3. MANAGEMENT OF AGRICULTURAL INPUT MARKETING (2+0)

Objectives

The objective of this course is to impart the students an understanding of different marketing concept and marketing system in context of agricultural inputs.

Theory

Unit-I - Agricultural input marketing

Agricultural input marketing - meaning and importance - management of distribution channels for agricultural input marketing. Agricultural Inputs and their types - farm and non-farm - role of cooperatives, public and private sectors in agricultural input marketing.

Unit-II - Seed marketing

Seed - Importance of seed input - types of seeds - hybrid, high yielding and quality seeds - demand for and supply of seeds - seed marketing channels - pricing - export and import of seeds - role of NSC and State Seed Corporation.

Unit-III - Fertilizer Marketing

Chemical fertilizer - production, export-import - supply of chemical fertilizers, demand/consumption - prices and pricing policy - subsidy on fertilizers - marketing system - marketing channels - problems in distribution - role of public, private and cooperative sector in fertilizer marketing.

Unit-IV - Plant protection chemicals and fuel marketing

Plant protection chemicals - production, export/import - consumption, marketing system - marketing channels - electricity/diesel oil - marketing and distribution system - pricing of electricity for agriculture use - subsidy on electricity.

Unit-V - Farm machinery marketing

Farm machinery - production, supply, demand - marketing and distribution channels of farm machines - agro-industries corporations and marketing of farm machines / implements / equipments.

Theory schedule

1. Agricultural input marketing - meaning and importance
2. Management of distribution channels for agricultural input marketing
3. Agricultural inputs and their types - farm and non-farm inputs
4. Role of cooperatives in agri input marketing
5. Role of public sectors in agri input marketing
6. Role of private sectors in agri input marketing
7. Seed - importance of seed input
8. Types of seeds - hybrid, high yielding and quality seeds
9. Demand for and supply of seeds
10. Seed marketing channels
11. Pricing of seeds
12. Export and import of seeds
13. Role of NSC and state seed corporation
14. Chemical fertilizers - production
15. Export-import of chemical fertilizers

16. Supply of chemical fertilizers
17. Mid semester examination
18. Demand/consumption of fertilizers
19. Prices and pricing policy of fertilizers
20. Subsidies on fertilizers
21. Marketing system - marketing channels
22. Problems in distribution of fertilizers
23. Role of public, private and cooperative sector in fertilizer marketing
24. Plant protection chemicals - production
25. Export/import of plant protection chemicals
26. Consumption of plant protection chemicals
27. Marketing system - marketing channels in PPC
28. Electricity/diesel oil - marketing and distribution system
29. Pricing of electricity for agriculture use
30. Subsidy on electricity
31. Farm machinery - production, supply, demand
32. Marketing and distribution channels of farm machines
33. Agro-industries corporations
34. Marketing of farm machines / implements / equipments

Reference books

1. Acharya, S.S. and Agarwal N.L., 2004. *Agricultural Marketing in India*, 4th Ed., Oxford and IBH, New Delhi.
2. Broadway, A.C. and Broadway Arif A., 2003. *A Text Book of Agri-Business Management*, Kalyani Publishers, New Delhi.
3. Singh, A.K. and Pandey S., 2005. *Rural Marketing*, New Age Publishers, New Delhi.
4. Singh Sukhpal, 2004. *Rural Marketing- Focus on Agricultural Inputs*, Vikas Publ. House, New Delhi.
5. Philip Kotler, 2006. *Principles of Marketing*, Prentice Hall of India, New Delhi.

ABM 714 E1. INTERNATIONAL TRADE AND SUSTAINABILITY GOVERNANCE
(2+0)

Objective

To impart knowledge to the students on international trade in agriculture and various provisions under WTO in the new trade regime.

Theory

Unit-I - WTO and agriculture

International trade - basic concepts - WTO and its implications for Indian economy in general and agriculture sector in particular.

Unit-II - Trade agreements

TRIPS, TRIMS, quotas, anti dumping duties - quantitative and qualitative restrictions - tariff and non-tariff measures - trade liberalization - subsidies - green and red boxes - issues for negotiations in future in WTO - CDMs and carbon trade.

Unit-III - Foreign trade

Importance of foreign trade for developing economy - absolute and comparative advantage - foreign trade of India.

Unit-IV - Foreign trade policy

Composition of India's foreign trade policy - India's balance of payments - inter regional Vs international trade - tariffs and trade control - exchange rates - the foreign trade multiplier.

Unit-V - Export procedures

Foreign demand - supply side analysis - opportunity cost - trade and factor prices - implications for developing countries - market entry methods - export procedures and documentations.

Theory schedule

1. International trade - basic concepts
2. WTO and its implications for Indian economy in general
3. Impact of WTO on agriculture sector
4. TRIPS
5. TRIMS
6. Quotas - anti dumping duties
7. Quantitative restrictions on trade
8. Qualitative restrictions on trade
9. Tariff measures
10. Non-tariff measures
11. Trade liberalization
12. Subsidies in trade
13. Green and red boxes
14. Issues for negotiations in future in WTO
15. CDMs and carbon trade
16. Importance of foreign trade for developing economy
17. Mid semester examination
18. Absolute and comparative advantage
19. Foreign trade of India
20. Composition of India's foreign trade policy
21. India's balance of payments
22. Inter regional Vs international trade
23. Tariffs and trade control
24. Exchange rates
25. The foreign trade multiplier
26. Foreign demand
27. Supply side analysis
28. Opportunity cost
29. Trade prices
30. Factor prices
31. Implications for developing countries
32. Market entry methods
33. Export procedures
34. Documentations

Reference books

1. Aran Goyal, and Moor Mohamed, 2001. *WTO in the New Millennium*, Academy of Business Studies, New Delhi.
2. Chadha, G.K., 2003. *WTO and Indian Economy*, Deep and Deep, New Delhi.
3. Francis Cherunilam, 2006. *International Trade and Export management*, Himalaya Publishing House, Mumbai.
4. Jhingam, J.L., 2002. *International Economics*, Vrinda Publications, New Delhi.
5. Vasisht, A.K. and Singh Alka., 2003. *WTO and New International Trade Regime-Implication for Indian Agriculture*, Advance Publ. Concept.

ABM 714 E2. COMMODITY FUTURES TRADING (2+0)

Objectives

This course is aimed at providing a basic understanding on the mechanics and value of futures markets for speculators and hedgers, which in turn will serve as price risk management activities of agribusiness firms.

Theory

Unit-I - Commodity markets

History and evolution of commodity markets - terms and concept - spot, forward and futures markets - factors influencing spot and future markets. Speculatory mechanism in commodity futures.

Unit-II - Trading strategies

Transaction and settlement - delivery mechanism - role of different agents - trading strategies - potential impact of interest rate. Foreign exchange - FDI in commodity markets.

Unit-III - Risks in commodity trading

Risks in commodity trading - importance and need for risk management measures - managing market price risk - hedging, speculation, arbitrage, swaps - pricing and their features.

Unit-IV - Commodity exchanger

Importance of global and Indian commodity exchanges - contracts traded - special features - regulation of Indian commodity exchanges - FMC and its role.

Unit-V - Technical analysis

Fundamental Vs technical analysis - construction and interpretation of charts and chart patterns for analyzing the market trend - market indicators - back testing. Introduction to technical analysis software - analyzing trading pattern of different commodity groups.

Theory schedule

1. History and evolution of commodity markets
2. Terms and concept
3. Spot markets
4. Forward and future markets
5. Factors influencing spot markets
6. Factors influencing future markets
7. Speculatory mechanism in commodity futures
8. Transaction and settlement

9. Delivery mechanism
10. Role of different agents in trading
11. Trading strategies
12. Potential impact of interest rate
13. Foreign exchange
14. FDI in commodity markets
15. Risks in commodity trading
16. Importance and need for risk management measures
17. Mid semester examination
18. Managing market price risk
19. Hedging, speculation
20. Arbitrage, swaps
21. Pricing and their features
22. Importance of global commodity exchanges
23. Importance of Indian commodity exchanges
24. Contracts traded
25. Special features
26. Regulation of Indian commodity exchanges
27. FMC and its role
28. Fundamental Vs technical analysis
29. Construction and interpretation of charts
30. Chart patterns for analyzing the market trend
31. Market indicators
32. Back testing
33. Introduction to technical analysis software
34. Analyzing trading pattern of different commodity groups

Reference books

1. Kaufman, P.J., 1986. *The Concise Handbook of Futures Markets*, John Wiley and Sons, New Delhi.
2. Leuthold, R.M., Junkus J.C. and Cordier J.E., 1989. *The Theory and Practice of Futures Markets*, Lexington Books, London.
3. Lofton, T., 1983. *Getting Started in Futures*, 3rd Ed., John Wiley and Sons, New Delhi.
4. Purcell, W.D., 1991. *Agricultural Futures and Options: Principles and Strategies*, Macmillan Publishing, New Delhi.
5. Wasendorf, R.R. and Mc Cafferty, 1993. *All about Commodities from the Inside Out*, McGraw-Hill, New Delhi.

ABM 714 E3. CAPITAL AND COMMODITY MARKETS (2+0)

Objective

To enable the students to acquire an overview of the different aspects of capital and commodity trading. To teach the fundamentals and other factors which determine the investment behaviour, supply and demand of capital market instruments and commodities as well as their prices.

Theory

Unit-I - Introduction to capital markets

The basic investment portfolio theory and models - stock exchange and stock trading regulator, securities, participants issue of shares - Initial Public Offering (IPO) and FPO - foreign capital issuance - introduction to secondary markets - products in secondary markets.

Unit-II - Debt investments

Debt investments - derivatives, depository, corporate actions. Index - its calculations, clearing, settlement and redressal, concepts and modes of analysis - ratio analysis.

Unit-III - Introduction to commodity markets

History and evolution of commodity markets - spot, forward and futures market - options, derivative markets - managing market price risk. Hedging, speculation, arbitrage, swaps - concepts of open interest, close out - mark to market practice - margins and its types, strategies using options to hedge risks.

Unit-IV - Commodity exchange regulation

Important global and Indian commodity exchanges - regulation of Indian commodity exchanges - sources of commodity market information - Forward Market Commission (FMC) and its role - Multi Commodity Exchange (MCX) - National Multi Commodity Exchange (NMCE) - National Commodity and Derivatives Exchange Limited (NCDEX) - Risk in commodity trading - importance and need for risk management measures.

Unit-V - Fundamental and technical analysis

Fundamental analysis - demand and supply, trade volume of capital market instruments and commodities - technical analysis - chart reading - candle stick charts (Doji, Marbozu, Hammer) - pie charts, line charts, bar charts, histogram, moving averages, exponential, simple weighted average.

Theory schedule

1. The basic investment portfolio theory
2. The basic investment models
3. Stock exchange and stock trading regulator, securities, participants issue of shares
4. Initial Public Offering (IPO) and FPO
5. Foreign capital issuance
6. Introduction to secondary markets
7. Products in secondary markets
8. Debt investments
9. Derivatives, depository, corporate actions, index - its calculations, clearing, settlement and redressal
10. Concepts and modes of analysis
11. Ratio analysis
12. History and evolution of commodity markets
13. Spot, forward and futures market
14. Options, derivative markets, managing market price risk
15. Hedging, speculation, arbitrage, swaps

16. Concepts of open interest, close out
17. Mid semester examination
18. Mark to market practice
19. Margins and its types
20. Strategies using options to hedge risks.
21. Important global and Indian commodity exchanges
22. Regulation of Indian commodity exchanges
23. Sources of commodity market information
24. Forward Market Commission (FMC) and its role
25. Multi Commodity Exchange (MCX)
26. National Multi Commodity Exchange (NMCE)
27. National Commodity and Derivatives Exchange Limited (NCDEX)
28. Risk in commodity trading
29. Importance and need for risk management measures
30. Fundamental Analysis of demand and supply
31. Trade volume of capital market instruments and commodities
32. Technical analysis chart reading, candle stick charts (Doji, Marbozu, Hammer)
33. Pie charts, line charts, bar charts
34. Histogram, moving averages, exponential, simple weighted average

Reference books

1. Carter, Colin A., 2003. *Futures and Options Market: An Introduction*, Prentice-Hall: Upper Saddle River, New Jersey.
2. Hull, John C., 2005. *Fundamentals of Futures and Options Markets*, 5th Edition. Prentice Hall: Upper Saddle River, New Jersey.
3. McDonald, Robert L., 2006. *Derivatives Markets*, 2nd Edition, Addison Wesley: Boston.
4. Wayne Purcell and Stephen Koontz., 1999. *Agricultural Futures and Options, Principles and Strategies* (2nd Edition), Prentice-Hall, New Delhi.
5. Wasendorf, R.R., and Mc Cafferty, 1993. *All about Commodities from the Inside Out*, McGraw-Hill, New Delhi.
6. www.ncdex.com
7. www.moneycontrol.com
8. www.commodityonline.com

OPC-GPB 621 CONCEPTS OF CROP PHYSIOLOGY (2+1)

Objectives

- To impart knowledge in understanding the physiological processes taking place during growth and development of plants.
- To understand source sink relationship in different groups of plants and also hormonal, environmental and stress physiology in crop plants.

Theory

Unit I - Photo physiology

Role of physiology in different branches of agriculture. Physiological processes on productivity – Photosynthesis – Mechanism of light interaction. Physiological processes influenced by radiation. Light and phytochrome mediated processes. –

CO₂ reduction – utilization of assimilatory power and carbohydrate synthesis - C₃, C₄ and CAM mechanisms – Major differences.

Unit II - Growth and Development

Growth Vs Development.. Dry Matter Accumulation and Harvest Index – components of Dry Matter Accumulation and Harvest Index and their role in productivity. Growth analysis. Photorespiration and dark respiration.

Unit III - Source sink relationship

LAI and its components –interception of solar energy. Photosynthates partitioning – source – sink relationship – mode of partitioning at different stages in different species. Role of growth regulators in monitoring source and sink.

Unit IV - Environmental physiology

Green house effect and Global warming. Ozone layer depletion - Causes, effects. CO₂ enrichment and plant productivity. Physiology of crops under high altitude and flooding – air pollution and plant growth – effect of effluent on plant growth.

Unit V - Stress physiology

Mechanisms of drought, salt, cold, heat and UV radiation stress tolerance – adaptation of crop plants – crop management practices under unfavourable situations – Importance of selection indices for crop productivity – recent advances in physiological research.

Practical

Leaf Area measurement – measurement of leaf angle and interception of solar radiation – light transmission ratio – measurement of photosynthesis – difference in the photosynthetic rate between the leaves at different position – photosynthetic efficiency of C₃ and C₄ plants – estimation of chlorophyll – RuBP case and PEP case – Measurement of respiration – Growth regulation – response to source and sink relationship – Measurement of water potential and its component. Measurement of leaf temperature, diffusive resistance and transpiration rate – use of antitranspirants – yield component analysis – study of selection indices.

Lecture Schedule

Theory

1. Role of physiology in different branches of agriculture
2. Physiological processes on productivity
3. Photosynthesis – Mechanism of light interaction
4. Photo Physiology
5. Physiological processes influenced by radiation
6. Light and phytochrome mediated processes
7. Utilization of assimilatory power and CH₂O synthesis
8. C₃-C₄ and CAM mechanisms and major differences
9. Photosynthetic measurements
10. Germination, growth and development
11. DMA and HI. Components of DMA and HI.
12. Role of DMA, LAI and HI in crop productivity
13. Growth analysis
14. Photorespiration and dark respiration
15. Oxidative phosphorylation.

16. Release and utilization of energy for various metabolisms.
17. MID-SEMESTER EXAMINATION
18. Interception of solar energy
19. Source-sink relationship
20. Photosynthate partitioning
21. Mode of partitioning at different stages and different species
22. Role of growth regulators in monitoring source-sink relationship
23. Growth regulators – auxins, gibberellins and cytokinins, biosynthesis, functions and agricultural role.
24. Abscisic acid and ethylene. Biosynthesis, functions and agricultural role.
25. Growth retardants. Role in agricultural and horticultural crops
26. Green house effect and plant productivity.
27. CO₂ enrichment and plant productivity.
28. Physiology of crops under high altitude flooding, air and water pollution
29. Water stress, effect of water stress on various physiological processes
30. Mechanisms of adaptation to stress condition.
31. Salt stress, classifications and its effects on physiological processes of plant
32. Temperature stress – cold tolerance – adaptation
33. Heat stress – Heat shock proteins – heat tolerance – adaptation.
34. Recent advances in physiological research

Practical Schedule

1. Leaf area index measurement. Measurement of leaf angle and interception of solar radiation
2. Measurement of photosynthesis
3. Determination of Photosynthetic efficiency of various crop plants
4. Estimation of soluble protein content
5. Estimation of chlorophyll contents
6. Estimation of water potential
7. Determination of chlorophyll stability index
8. Estimation of relative water content
9. Estimation of leaf proline content
10. Measurement of leaf temperature, diffusive resistance and transpiration
11. Growth analysis of field crops
12. Determination of nitrate reductase activity
13. Determination of IAA oxidase activity
14. Estimation of total phenolics
15. Estimation of peroxidase activity
16. Estimation of catalase activity
17. FINAL PRACTICAL EXAMINATION

References

1. Devlin, B. 1983. Plant Physiology. Narosa Publishing House, New Delhi.
2. Franklin P. Gardner, R. Brent Pearce and Roger L. Mitchell, 1988. Physiology of crop plants. Scientific Publishers, Jodhpur.

3. Gupta, U.S. 1988. Progress in Crop Physiology. Oxford IBH Publishing Co. Pvt., Ltd., New Delhi.
4. Kumar, A. and S.S. Purohit. 1996. Plant Physiology. Agro Botanical Publishers, Bikaner.
5. Lincoln Taiz, Eduardo Zeiger. 2002. Plant Physiology 2nd Edition. Replica press Pvt. Ltd., Delhi.
6. Noggle, G.R. and G.J. Fritz. 1986. Introductory Plant Physiology. Prentice Hall of India Ltd., New Delhi.
7. Panday, S.N. and B.K.Sinha. 1972. Plant Physiology. Vikas Publishing House Pvt. Ltd., New Delhi.
8. Price, C.A. 1974. Molecular approaches to plant physiology. Tata MCGraw Hill Publishing Co. Ltd., New Delhi.
9. Purohit, S.S. 2005, Plant Physiology. Student Edition Agrobios, Jodhpur.
10. Purohit, S.S., Q.J. Shammi, and A.K. Agrawal, 2005. A Text book of Environmental sciences, Student Edition, Agrobios, Jodhpur.
11. Salisbury, F.B. and C.M.Ross. 2004. Plant Physiology. Thomson and Wadsworth publications, Belmont, California.

SUPPORTING COURSES

STA 611 STATISTICAL METHODS AND DESIGN OF EXPERMENTS (2+1)

Objectives

To acquaint the students about the basics of statistics and design of experiments.

Theory

Unit I Concepts in statistics

Population and sample, parameter and statistic -concept of sampling – simple random sampling – concept of probability distribution – binominal, poisson and normal distributions - F and Chi square distribution- estimation -point estimation- interval estimation- degrees of freedom- concept of sampling distribution – standard error- tests of significance based on t, z, (mean and equality of means only)- χ^2 test for goodness of fit.

Unit II Correlation and Regression

Definition, types and methods of studying correlation – properties of correlation coefficient- regression – measuring and uses of regression analysis – properties- differences between correlation and regression. regression co – efficient – simple-linear – multiple linear regression co - efficient – standard error of estimate – test of significance of observed regression co - efficient and co - efficient of determination – non linear regression- misuses of correlation and regression in agricultural research.

Unit III Basic designs

Agricultural experiments: concepts – field studies – pot-culture – quantitative and qualitative variables- errors: sources of errors and estimate of errors- basic principles of design of experiments – CRD – RBD – LSD layout and their analysis – efficiency.

Unit IV Mean comparison and missing data

Comparison of treatments – least significant difference method – duncan’s multiple range test (DMRT)- missing plot technique in RBD and LSD (one and two missing)- concept of analysis of covariance- data transformation: logarithmic square root and arc sine.

Unit V Factorial experiments

Concept of factorial experiments – 2^n , 3^2 factorial experiments- principle of confounding in factorial experiments – confounding in 2^3 factorial experiments- split-plot design and strip – plot design.

Practical

Estimation of samples statistic *viz.*, means, sd, se and cv. z-test, t-test and paired t-test- comparison of two variances using F-test-bartlett’s test for homogeneity of variances- Chi-square test for test of goodness of fit and homogeneity of ratio test for independence of attributes.computation of correlation co-efficient and its significance- fitting of simple linear regression and testing the significance of regression co-efficient- multiple linear regressions fitting and testing -determination of optimum plot size using uniformity trial-aanalysis of CRD, RBD, LSD and DMRT-analysis of multi-observation data (sampling in rbd) -missing plot technique in RBD with one or two missing values -analysis of factorial experiments conducted in RBD- analysis of split-plot and strip-plot design- analysis of data with transformations.

Lecture schedule

1. Definition of population and sample
2. Difference between parameter and statistic
3. Concept of sampling – simple random sampling
4. Concept of probability distribution – Binominal, Poisson and Normal distributions.
5. F and Chi square distribution
6. Estimation - point estimation, interval estimation, degrees of freedom.
7. Concept of sampling distribution – Standard Error.
8. Tests of significance based on t, z, (mean and equality of means only). X^2 test for goodness of fit.
9. Definition of correlation, significance and types
10. Properties of correlation coefficient
11. Definition of regression – measuring and uses of regression analysis properties.
12. Differences between correlation and regression.
13. Regression co – efficient - simple, linear.
14. Multiple linear regression co - efficient – standard error of estimate.
15. Test of significance of observed regression co -efficient and co - efficient of determination.
16. Non linear regression-misuses of correlation and regression in agricultural research.
17. Mid- semester examination
18. Characteristics of agricultural experiments: concepts – field studies.

19. Characteristics of agricultural experiments -pot-culture – quantitative and qualitative variables.
20. Sources of errors and estimate of errors
21. Design of Experiments– Basic principles of CRD
22. Design of Experiments– Basic principles of RBD
23. Design of Experiments– Basic principles of LSD
24. Efficiency of designs -layout and their analysis
25. Comparison of treatments – least significant difference method
26. Duncan's Multiple Range Test (DMRT).
27. Missing plot technique in RBD and LSD (one and two missing).
28. Concept of analysis of covariance
29. Data transformation: logarithmic square root and arc sine.
30. Concept of factorial experiments
31. 2^n , 3^2 Factorial experiments,
32. Principle of confounding in factorial experiments
33. Confounding in 2^3 Factorial experiments.
34. Split-pot design and strip – plot design.

Practical schedule

1. Estimation of samples statistic *viz.*, means, SD, SE and CV.
2. Z-test, t-test and paired t-test.
3. Comparison of two variances using F-test
4. Bartlett's test for homogeneity of variances.
5. Chi-square test for test of goodness of fit and homogeneity of ratio test for independence of attributes.
6. Computation of correlation co-efficient and it's significance.
7. Fitting of simple linear regression and testing the significance of regression co-efficient.
8. Multiple linear regressions fitting and testing
9. Determination of optimum plot size using uniformity trial.
10. Analysis of CRD.
11. Analysis of RBD
12. Computation of LSD and DMRT
13. Analysis of multi-observation data (sampling in RBD)
14. Missing plot technique in RBD with one or two missing values.
15. Analysis of Factorial experiments conducted in RBD
16. Analysis of Split-plot and Split-plot design.
17. Analysis of data with transformations.

Reference books

1. Bhattacharyya, G.K. and R.A. Johnson. 1997. Statistical concepts and methods, John Wiley and Sons, New York.
2. Crozon, F.E. and D.J. Cowden . 1986. Applied General Statistics, Prentice Hall of India, New Delhi.
3. Gomez, K.A. and A.A. Gomez. 1984. Statistical procedure for Agricultural Research, John Wiley and Sons, New York.

4. Panse, V.G. and P.V. Sukhatme. 1961. Statistical methods for Agricultural Workers, ICAR, New Delhi.
5. Ramaswamy, R. 1995. A text book of Agricultural Statistics, Wiley Limited, New Delhi.

STA 612 STATISTICS FOR SOCIAL SCIENCES (2+1)

Objectives

To expose the students to the concept of statistical methods and inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in computation, analysis and interpretation of research data.

Theory

Unit - I- Theory of sampling

Basic concepts - unit and frame, population and sample - sampling and complete enumeration - probability and non-probability sampling - sampling and non-sampling errors - measurement and control of non-sampling errors. Simple Random Sampling (SRS) - with and without replacement - methods of selection of SRS - lottery method and random number table method. Systematic sampling. Stratified random sampling - stratification - types of allocation - equal, proportional allocation. Cluster sampling. Determination of sample size in SRS, stratified random sampling, systematic and cluster sampling, probability proportional to size (PPS) sampling.

Unit - II - Descriptive statistics and distributions

Measures of central value - measures of dispersion and its relative measures - applications of binomial, poisson and normal distributions.

Unit - III- Correlation and regression analysis

Simple correlation - meaning - assumptions - positive and negative correlation - scatter diagram - computation of correlation coefficient - properties, testing and interpretation of correlation coefficient - coefficient of determination. Regression theory - simple linear regression - meaning assumptions - fitting of simple linear regression - properties of regression coefficients - interpretation of regression coefficients and intercept. Multiple linear regression - assumptions - standardized and partial regression coefficients - fitting of multiple linear regression equation - interpretation of regression coefficients - multiple correlation - coefficient of multiple determination (R^2) - interpretation.

Unit - IV- Test of significance

Test of significance - basic ideas - Type I error, Type II error - test of significance based on small sample - 't' test - testing the significance of single mean - testing the significance of two means for independent samples and paired samples. Large sample tests - testing the significance of single mean, two means. Test for regression coefficient - Chi-square - test for homogeneity of variance. Goodness of fit tests - 'F' test - one way ANOVA and two way ANOVA.

Unit - V- Time series analysis and non parametric test

Time series analysis - components of time series - trend, seasonal, cyclical and irregular movements - elimination of trend - moving average method - least square method - seasonal movement - simple average and ratio to trend method - link relative method. Non parametric tests (Distribution free tests) - advantages - disadvantages - run test - test for randomness - median test - sign test - Mann - Whitney U test for two samples - Kolmogorov - Smirnov one sample and two sample test, Kruskal - Walli's test.

Practical

Simple random sample - selection - estimation - determination of sample size in simple random sampling. Systematic sampling - stratified random sampling - cluster sampling - selection - estimation. Multistage sampling - selection - estimation of parameters in two stage sampling - determination of sample size in two stage sampling. Tests of significance based on small and large sample tests. Simple correlation - computation of correlation coefficient and it's testing - coefficient of determination. Rank correlation coefficient Simple linear regression - fitting of simple linear regression equations - testing and interpretation of regression coefficient and intercept. Multiple linear regression equation - interpretation of regression coefficients. Forecasting using regression techniques.

Theory schedule

1. Basic concepts - unit and frame, population and sample
2. Sampling and complete enumeration - probability and non-probability sampling
3. Sampling and non-sampling errors - measurement and control of non-sampling errors
4. Simple random sampling (SRS) - with and without replacement - methods of selection of SRS - lottery method and random number table method
5. Systematic sampling. Stratified random sampling - stratification - types of allocation - equal, proportional allocation
6. Cluster sampling
7. Determination of sample size in SRS, stratified random sampling, systematic and cluster sampling - probability proportional to size (PPS) sampling
8. Measures of central value - measures of dispersion and its relative measures - applications of binomial, poisson and normal distributions
9. Simple correlation - meaning - assumptions - positive and negative correlation - scatter diagram
10. Computation of correlation coefficient - properties
11. Testing and interpretation of correlation coefficient - coefficient of determination
12. Regression theory - simple linear regression - meaning assumptions
13. Fitting of simple linear regression - properties of regression coefficients - interpretation of regression coefficients and intercept
14. Multiple linear regression - assumptions - standardized and partial regression coefficients

15. Fitting of multiple linear regression equation - interpretation of regression coefficients
16. Multiple correlation - coefficient of multiple determination (R^2) - interpretation
17. Mid semester examination
18. Test of significance - basic ideas - Type I error, Type II error
19. Test of significance based on small sample - 't' test
20. Testing the significance of single mean
21. Testing the significance of two means for independent samples and paired samples
22. Large sample tests - testing the significance of single mean, two means
23. Test for regression coefficient - Chi-square - test for homogeneity of variance
24. Goodness of fit tests
25. F' - test, one way ANOVA and two way ANOVA
26. Time series analysis - components of time series - trend, seasonal, cyclical and irregular movements
27. Elimination of trend - moving average method - least square method
28. Seasonal movement - simple average and ratio to trend method - link relative method
29. Non parametric tests (Distribution free tests) - advantages - disadvantages
30. Run test - test for randomness
31. Median test - sign test
32. Mann-Whitney U test for two samples
33. Kolmogrov - Smirnov one sample and two sample test
34. Kruskal - Walli's test

Practical schedule

1. Simple random sample - selection - estimation
2. Determination of sample size in simple random sampling
3. Systematic sampling - selection, estimation
4. Stratified random sampling - selection, estimation
5. Cluster sampling - selection - estimation
6. Multistage sampling - selection - estimation of parameters in two stage sampling
7. Determination of sample size in two stage sampling
8. Tests of significance based on small sample tests
9. Tests of significance based on large sample tests
10. Simple correlation - computation of correlation coefficient and it's testing
11. Co-efficient of determination
12. Rank correlation coefficient
13. Simple linear regression - fitting of simple linear regression
14. Testing and interpretation of regression coefficient and intercept
15. Multiple linear regression equation
16. Interpretation of regression coefficients
17. Forecasting using regression techniques

Reference books

1. Agarwal, B.M., 1995. *Basic Statistics*, New Age International Ltd, New Delhi.
2. Gupta, S.P., 2005. *Statistical Methods*, Sultan Chand and Sons, New Delhi.
3. Kapoor, V.K., and S.C. Gupta, 2006. *Fundamentals of Applied Statistics*, Sultan Chand and Sons, New Delhi.
4. Rangasamy, R., 2009. *A Textbook of Agricultural Statistics*, Wiley Eastern Ltd., New Delhi.
5. Senthamarai Kannan, K. and D. Venkatesan, 2005. *Introduction to Statistical Methods*, Scitech Publications (India) Private Ltd., Chennai.

STA 613 STATISTICS FOR BUSINESS MANAGEMENT (2+1)

Objective

To make the students conversant about the applications of statistics in agri business analysis.

Theory

Unit - I- Sampling and data collection

Business statistics - definition - scope - functions - limitations - applications. Basic concepts - unit and frame, population and sample - sampling and complete enumeration - probability and non-probability sampling - sampling and non-sampling errors - measurement and control of non-sampling errors. Simple random sampling (SRS) - with and without replacement - Systematic sampling - Stratified random sampling - stratification - cluster sampling - determination of sample size. Collection of data - primary and secondary - methods of collection - drafting questionnaire - sources of data - editing - classification and tabulation of data - diagrammatic and graphical representation.

Unit - II- Theories of distributions

Measures of central value - measures of dispersion - methods of studying variation. Distributions - binomial distribution - poisson distribution - normal distribution - their applications.

Unit - III- Correlation and regression

Simple correlation - meaning - assumptions - positive and negative correlation - scatter diagram - computation of correlation coefficient - properties, testing and interpretation of correlation coefficient - coefficient of determination. Regression theory - simple linear regression - meaning, assumptions - fitting of simple linear regression - properties of regression coefficients - interpretation of regression coefficients and intercept. Multiple linear regression - assumptions - standardized and partial regression coefficients - fitting of multiple linear regression equation - interpretation of regression coefficients - multiple correlation - coefficient of multiple determination (R^2) - interpretation.

Unit - IV- Tests of significance

Test of significance - basic ideas - Type I error, Type II error - test of significance based on small sample - 't' test - testing the significance of single mean - testing the significance of two means for independent samples and paired samples. Large sample tests - testing the significance single mean, two means. Test

for regression coefficient - Chi square - test for homogeneity of variance. Goodness of fit tests - 'F' test- one way ANOVA and two way ANOVA.

Unit - V- Nonparametric tests and time series models

Non parametric tests (Distribution free tests) - advantages - disadvantages - run test - test for randomness - median test - sign test - Mann Whitney U test for two samples - Kolmogrov - Smirnov one sample and two sample test, Kruskal - Walli's test - Chi-square. Introduction to time series models - AR - MA - ARMA models - forecasting using SPSS.

Practical

Simple random sample - selection - estimation - determination of sample size in simple random sampling. Systematic sampling - stratified random sampling - cluster sampling - selection - estimation. Frequency distribution - graphical representation - measures of central values - measures of dispersions - applications of binomial distribution - poisson distribution and normal distribution - problems in correlation and regression analysis - partial correlation - multiple correlation and multiple regression. Rank correlation coefficient. Tests of significance for small and large samples and problems - non parametric test - time series analysis - AR, MA and ARMA Models - Forecasting using SPSS - LIMDEP

Theory schedule

1. Business statistics - definition - scope - functions - limitations - applications
2. Basic concepts - unit and frame, population and sample - sampling and complete enumeration
3. Probability and non-probability sampling - sampling and non-sampling errors - measurement and control of non-sampling errors
4. Simple random sampling (SRS) - with and without replacement
5. Systematic sampling - Stratified random sampling - stratification - cluster sampling - determination of sample size
6. Collection of data - primary and secondary
7. Methods of collection - drafting questionnaire
8. Sources of data - editing - classification and tabulation of data
9. Diagrammatic and graphical representation
10. Measures of central value
11. Measures of dispersion
12. Methods of studying variation
13. Binomial distribution - poisson distribution
14. Normal distribution - their applications
15. Simple correlation - meaning - assumptions - positive and negative correlation
16. Mid semester examinations
17. Scatter diagram - computation of correlation coefficient
18. Properties, testing and interpretation of correlation coefficient
19. Coefficient of determination
20. Regression theory - simple linear regression - meaning, assumptions
21. Fitting of simple linear regression - properties of regression coefficients
22. Interpretation of regression coefficients and intercept

23. Multiple linear regression - assumptions - standardized and partial regression coefficients
24. Fitting of multiple linear regression equation - interpretation of regression coefficients
25. Multiple correlation - coefficient of multiple determination (R^2) - interpretation
26. Test of significance - basic ideas - Type I error, Type II error - test of significance based on small sample - 't' test - testing the significance of single mean
27. Testing the significance of two means for independent samples and paired samples
28. Large sample tests - testing the significance single mean, two means
29. Test for regression coefficient - Chi square - test for homogeneity of variance
30. Goodness of fit tests - 'F' test- one way ANOVA and two way ANOVA
31. Non-parametric tests (Distribution/free/tests) - advantages - disadvantages
32. Run test - test for randomness - median test - sign test
33. Mann - Whitney U test for two samples - Kolmogorov - Smirnov one sample and two sample test, Kruskal - Walli's test - chi-square
34. Introduction to time series models - AR - MA - ARMA models - forecasting using SPSS.

Practical schedule

1. Simple random sample - selection - estimation
2. Determination of sample size in simple random sampling
3. Systematic sampling - stratified random sampling
4. Cluster sampling - selection - estimation
5. Frequency distribution - graphical representation
6. Measures of central values measures of dispersions
7. Applications of binomial distribution
8. Poisson distribution and normal distribution
9. Problems in correlation and regression analysis
10. Partial correlation
11. Multiple correlation and multiple regression
12. Rank correlation coefficient
13. Tests of significance for small and large samples and problems
14. Non-parametric tests
15. Time series analysis - AR, MA and ARMA Models
16. Forecasting using SPSS
17. LIMDEP

Reference books

1. Agarwal, B.M., 1995. *Basic Statistics*, New Age International Ltd, New Delhi.
2. Gupta, S.C. and V.K. Kapoor, 2004. *Fundamentals of Statistics*, Sultan Chand and Sons, New Delhi.
3. Priestly, M.B., 1981. *Spectral Analysis and Time Series*, Academic Press, New Delhi.

4. Rangasamy, R., 1990. *A Text Book on Agricultural Statistics*, New Age India Ltd, Chennai.
5. Senthamarai Kannan, K. and D. Venkatesan, 2005. *Introduction to Statistical Methods*, Scitech Publications (India) Private Ltd., Chennai.

COM 611 – COMPUTER APPLICATIONS FOR AGRICULTURAL RESEARCH

(1 + 1)

Objectives

- To understand the basics of Computer and to gain abundant knowledge in information technology.
- To know how to use office automation tools to increase personal and academic productivity.
- To get exposed to aspects of internet usage and to propagate the awareness of research facilities using browsing and searching.

Unit – I Introduction to Computer

Overview of Computers - Devices of a Computer and their functions - Classification of Computers - Hardware – Software – Classification of Software - Operating System – Dos – Windows – Unix - VIRUS – Current trends in Hardware and Software.

Unit –II Word Processor & Spread Sheet Applications

MS-Word – Word Processing and Components of Word Ribbon - Creating, Editing and Printing of a document – Features of word like Page setting, Font, Paragraph, Table, Clip arts, Text box, Spell check, Grammar check - Mail Merge concepts. MS-Excel – Ribbon Components - Spread sheet - Creating a simple formula and Aggregate function - Preparation of charts – Applying Conditional formula - Use of Data Analysis tools.

Unit – III Database & Presentation

MS-Access – Creation of database, storing and retrieval - Table form – Adding records – SQL Query – using GUI to design printing layout - Report generation. MS-PowerPoint – Slide preparation – Components of PowerPoint Ribbon – Adding slides with different layouts – Design, Custom Animation and Transition effects.

Unit – IV Internet, Webpage Design & Networks

Introduction to Internet – Service providers - Web browser – Search engines – Internet applications – Cyber Security – Types of Web Pages – HTML webpage design – Usage of script language – Introduction to Computer Networks- Topologies – Network device - Current trends in Networks & Internet.

Unit – V Agricultural Statistical Software

SAS, MSTAT, IRRISTAT, AGRES, AGRISTAT, STATISTICA, MANOVA, MANCOVA AND SPSS.

Theory Schedule

1. Introduction to Computers, Anatomy of Computers.
2. Input and Output devices, Units of memory, Hardware, Software and Classification of Computers.
3. Software, Categories of software, Operating System, Types of operating system.
4. Booting sequence of operating system, DOS, Windows, Unix, VIRUS.
5. Word Processor and their components of ribbon.

6. Creating, Editing and printing a document, Features of word Table creation, Insert menu option.
7. Creation of spread sheet and their ribbon components.
8. Creating different types of graphs and working procedure of Aggregate function and data analysis.
9. Concepts of Database, Creating Database.
10. Mid semester Examination
11. Creation, Storing and retrieval of data from database and report generation.
12. PowerPoint preparation, Different layouts, Design Custom Animation and Transition effects.
13. Introduction to Internet and its applications
14. Types of WebPages, Service providers, Web browser and Search engines
15. HTML and usage of script language.
16. Introduction to Networks Concepts.
17. SAS, MSTAT, IRRISTAT and AGRISTAT.
18. MANOVA, MANCOVA and SPSS.

Practical schedule

1. Introduction to Hardware, Software and Operating System.
2. Study of Dos and Unix Commands.
3. MS-Word – Create, Edit and Print a document and Ribbon features.
4. MS-Word – Formatting, Inserting, Table creation and Alignment.
5. MS-Word – Creating a Mail Merge.
6. MS-Excel – Inbuilt Functions, Chart preparations.
7. MS-Excel – Prepare Student mark sheet with Aggregate and draw chart.
8. MS-Excel – Prepare Employee payroll with Income tax and draw chart.
9. MS-Excel – Statistical Function and Data analysis tools.
10. MS-Access – Database Creation.
11. MS-Access – Insert, Update and Delete data from the database.
12. MS-Access – Query Execution and Report generation.
13. Webpage creation using basic HTML tags.
14. Webpage creation with Hyperlink and Images.
15. Email – Compose, Attaching, Browsing a webpage .
16. IRRISTAT, AGRESS
17. SPSS – Median, Mode Standard Deviation and Correlation.
18. SPSS – Regression for Linear and Non linear.
19. Model Practical Examination.

Reference

1. Mathew Leon and Alexis Leon, 2008. Introduction to Computers, Vikas Publishing House.
2. Katherine Murray, Suzanne Weixel, and Faithe Wempen, 2011. Learning Microsoft Office 2010 Advanced Skills, Pearson Education/Prentice Hall
3. Mathew Leon and Alexis Leon, 2012. Internet for Everyone, Vikas Publishing House.
4. Behrouz A FoRouzen, 2003. Data communication and Networking, Tata McGraw Hill Publishing Company Limited, New Delhi.
5. Thomas Powell, 2010. HTML and CSS: the Complete Reference, Fifth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi.

NONCREDIT COMPULSARY COURSES

PGS 611 - RESEARCH ETHICS AND METHODOLOGY (0 + 1)

Objective

To enlighten the students about the agricultural research systems at National and International levels, Research ethics and Research methodologies adopted to carry out agricultural research.

Practical

Agricultural research system - need, scope, opportunities, role in food security, poverty reduction and environmental protection. Research ethics - research integrity, research safety in laboratories, Lab equipments, welfare of animals used in research, computer ethics, standards and problems in research ethics-Good Laboratory Practices – Plagiarism and Copy right rules.

Research – Fundamental vs. applied research – research prioritization and selection of research problem – Research planning - review of literature – setting of objectives and hypothesis – research design and techniques – data collection – analysis – formulation of tables – interpretation of results and thesis writing – writing of research articles - Type and choice of experiment - Designing research programme for experimentation – Formulation and preparation of research / scheme proposal – Impact factor and citation index – different forms of writing in text - citation and references.

Layout of field experiment - Designing - sampling techniques - Use of experimental tools and equipments for recording observation and analysis – recording biometric observations - data analysis - Computer software - Tabulation and presentation - Guidelines for thesis and technical paper writing – Appraisal of published research articles - Collection of details on research periodicals - Guidelines for oral / poster presentations – Internet in scientific research.

Practical schedule

1. Agricultural research system – needs, scope, opportunities in the role of food security and poverty reduction.
2. Research ethics: research integrity, computer ethics, standards and problems in research ethics, plagiarism and copy right rules.
3. Research safety in laboratories, good laboratory practices and welfare of animals used in research and learning the use of various lab equipments required for agronomical research.
4. Research prioritization and selection of research problem, basic principles and objectives of the problem.
5. Designing and planning of research programme for field experimentation.
6. Selection of experimental sites and laying out field experiments for various experimental designs.
7. Recording growth parameters and its analysis.
8. Mid-semester examination
9. Writing review of literature using various sources of information.
10. Practice on writing materials and methods and ethics involved in the use of biological materials in the research.
11. Writing bibliography and references.

12. Practice in the use of various instruments for field research observations.
13. Recording of yield parameters and yield - tabulation, analysis of results and its Interpretation.
14. Model technical paper writing, guidelines for oral / poster presentation.
15. Practice on discussion of results.
16. Evaluation of research articles on National and International journals with impact factor and citation index.
17. Preparation of research projects/schemes proposal.

References

1. Bhalla, GS and Singh, G. 2001. *Indian agriculture - Four decades of development*. Sage Publication.
2. Gomez, K.A. and Gomez, A.A. 1984. *Statistical procedures for agricultural research*. John Willey and Sons, New York
3. Panse, U.G. and Sukhatme, P.V. 1995. *Statistical methods for agricultural workers*. ICAR, New Delhi.
4. Punia, MS. 2016. *Manual on international research and research ethics*. CCS, Haryana Agricultural University, Hisar.
5. Rangaswamy, R. 1995. *A text book of agricultural statistics*. Willey Eastern Limited, New age International Limited Publishers, New Delhi.
6. Sekar, K. 2004. *Research methodology for agricultural sciences*, Velan Pathipagam, Chidambaram.

e-Resources

1. www.onlineethics.org
2. <http://ethics.ucsd.edu>
3. <http://naarm.org.in>

PGS 611 - RESEARCH ETHICS (0+1)

OBJECTIVES

- To provide researcher with an overview of current and emerging ethical issues with special emphasis on cross – disciplinary issues involving research integrity, ethics and social accountability.
- To help students understand the purpose and process of technical and research writing and documentation.

PRACTICAL

Research ethics – Research integrity, research safety in laboratories - Authorship and copy right – Plagiarism – Scientific misconduct – Falsification of research results, data fabrication – Peer review, informed consent attribution of authorship and adequacy of peer review publication process -Responsibility of society and self – Public interest in research, relevance to society and motivation - Conflict of interest, moral commitment – Social trends on research ethics, adequate codes of conduct to regulate research activity – Technical writing – Characteristics of legal writing, purpose of technical writing – Challenges to legal writing, use of appropriate formats for resumes, letters, memos, reports, proposals etc., Basic approaches for

developing advanced critical writings -Projects and report writing - Research papers
- Thesis writing - Use of computer in report writing.

PRACTICAL SCHEDULE

1. To study the research ethics and research integrity
2. Research safety in laboratories
3. Authorship and copy right
4. Plagiarism
5. Data Falsification and falsification of research results
6. Peer review and adequacy of peer review in publication process
7. Responsibility of society and researcher in research.
8. Conflict of interest and moral commitment in research
9. Mid Semester Examination
10. To study the code of regulate research activity
11. Characteristics of legal writing
12. Challenges to legal writing
13. Formulation of appropriate formats for resumes, letters, memos, reports, proposals
14. Essential consideration in thesis writing a research report and research papers
15. Essential consideration in thesis writing
16. Report writing for the publication in the research journal
17. Use of computer in report writing.

REFERENCES

1. National Academy of Sciences. 2009. On Being a Scientist – Third Edition, Washington. DC: The National Academics Press. Available at: <http://W.W.W.nap.edu/catalog.php?>
2. Hand book of Agriculture, 2011. ICAR, Publications.
3. Kothari, C.R. 2009. Research Methodology – Methods and Techniques. New Age International Publishers, New Delhi.
4. Mangal, S.K.2015. Research Methodology in Behavioural Sciences. Published by PHI Learning Private Limited, New Delhi.
5. S.K. Varma and M. Afzal Wani (ed) 2006. Legal Research and Methodology, ILI publication, New Delhi.
6. www.naasindia.org
7. www.cgiar.org
8. www.uasd.edu
9. cathy.corr@umontana.edu
10. <http://www.nap.edu/catalog.php?>

PGS 611 RESEARCH DATA ANALYSIS (0+1)

Objective

This course provides the usage of various statistical packages like MS Excel, SYSTAT and IRRI STAT for the analysis of agricultural research data. It would provide the students hands on experience in the analysis of research data.

Practical

Statistical data analysis using MS Excel – creation and usage of excel spread sheet. Descriptive statistics - cross tabulation - one way, two way and multi-way tables - chi square test for socio economic conditions - comparison of means - student's t test - comparing a single mean - comparison of two means - paired and independent t tests - one way ANOVA. F test for testing the equality of variances - correlation coefficient - simple linear regression analysis - multiple linear regression analysis. Mann Whitney U-test - Wilcoxon matched pairs signed rank test - Kruskal Wallis one -way analysis - Friedman two-way analysis – Spearman's rank correlation - Kendall's rank correlation - time series analysis - moving average - exponential smoothing.

Reference books

1. Darren George and Paul Mallery, 2007. *SPSS for Windows Step by Step - A simple guide and reference*, Pearson Education, New Delhi.
2. Leland Wilkinson, Grant Blank and Christian Gruber, 1996. *Desktop Data Analysis with Systat*, Prentice Hall, New Jersey.
3. Ramesh Babu and Samyuktha, 2003. *Computer Practice - I*, V.R.B. Publications, New Delhi.
4. Saxena, 2003. *A first course in Computers*, Vikas Publishing House (P) Ltd., New Delhi.
5. Sharma, K.V.S., 2010. *Statistics Made Simple: Do it yourself on PC*, Prentice Hall of India, New Delhi.

PGS 612 - TECHNICAL WRITING AND COMMUNICATION SKILLS (0+1)

Objective

- To equip the students with skills Viz., writing of dissertations, research papers, etc. and to communicate and articulate in English

Practical

Grammar - Tenses, parts of speech, clauses, punctuation marks; Error analysis - Common errors; Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers. Proof reading. Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Structure of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Practical schedule

1. Grammar (Tenses, parts of speech)
2. Grammar (clauses, punctuation marks)
3. Error analysis (Common errors); Concord; Collocation;
4. Phonetic symbols and transcription;
5. Accentual pattern: Weak forms in connected speech
6. Participation in group discussion
7. Facing an interview; presentation of scientific papers.
8. Technical Writing- Various forms of scientific writings- theses, technical papers
9. Mid -semester

10. Technical Writing- reviews, manuals
11. Structure of thesis and research communications
12. Writing of abstracts, summaries, précis, citations etc
13. Commonly used abbreviations in the theses and research communications
14. Illustrations, photographs and drawings with suitable captions
15. Pagination, numbering of tables and illustration, numbers and dates in scientific write-ups
16. Editing and proof-reading
17. Writing of a review article.

Suggested Readings

1. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
2. Mohan K. 2005. Speaking English Effectively. MacMillan India.
3. Richard WS. 1969. Technical Writing. Barnes & Noble.
4. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek.
5. Wren PC & Martin H. 2006. High School English Grammar and Composition. S.Chand & Co.

PGS 623- BASIC CONCEPTS IN LABORATORY TECHNIQUES (0 + 1)

Objective

- To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Unit-I-Safety measures and common laboratory equipments

Safety measures while in labs; Handling of chemical substances ; use of burettes ,pipettes, measuring cylinders, flasks, separator funnel, condensers and micropipettes. Washing ,drying and sterilization of glassware; drying of solvents/ chemicals.

Unit-II - Preparation of standard solutions

Weighing and preparation of solutions of different strengths and their dilution ;Handling techniques of solutions; preparations of different agro-chemical doses in field and pot applications; preparation of solutions of acids; Neutralisation of acid and bases ;preparation of buffers of different strengths and ph values.

Unit-III-Use and handling of laboratory equipments

Use and handling of vacuum pumps, viscometer, thermometer, magneticstirrer, micro-ovens,incubators, sand bath and water bath.

Unit-IV - Microscopy and media preparation

Use and handling of microscope and laminar flow-preparation of media- differential ,selective and enriched media. Methods of sterilization –physical methods-dry and moist heat ,cold ,filtration and radiation, chemical methods and disinfectants.

Unit-V - In-vitro culture techniques

Description of flowering plants in botanical terms in relation to taxonomy- seed viability test-pollen fertility test-tissue culture media-composition of media-media preparation –instant media-aseptic manipulation-procedure for in vitro culture of explants-leaf bit-stem bit-anthers-pollen –microspores-ovule and embryo.

Practical schedule

1. Safety measures in labs and handling of chemical substances.
2. Common laboratory equipments.
3. Calibration and cleanliness of volumetric glass wares.

4. Methods of expressing strength of solutions.
5. Preparation of primary standard solutions and buffer solutions.
6. Preparation of standard solutions for nutrient analysis of soil, plant and water.
7. Preparation of different agro-chemical doses for field experiments, Preparation of buffer solutions,
8. Mid semester
9. Handling of instruments-vacuum pumps, thermometers, magnetic stirrer.
10. Handling of instruments-ovens, sand bath and water bath.
11. Handling and uses of microscopes and laminar flow.
12. Sterilization by physical methods.
13. Sterilization by chemical methods.
14. Preparation of different media for culturing the micro organisms.
15. Description of flowering plants-seed viability test and pollen fertility test.
16. Aseptic manipulations and media.
17. In vitro culture of different explants.

Reference Books

1. Furr, A.K. 2000. CRC Handbook of laboratory safety. CRC press.
2. Jackson, M.L. 1997. Soil Chemical Analysis. Prentice Hall of India pvt.Ltd., New Delhi.
3. Prescott.L.M., Harley, P and Klein, A. 2003. Microbiology, 5th Edition, MC.Graw Hill, USA.
4. Gupta, P.K. 1997. Elements of Biotechnology, Rastogi Publications. Meerut.
5. Singh, B.D. 2005. Bio technology, Expanding Horizons, Kalyani Publications, New Delhi.

e-courses

1. Analytical chemistry vol.1(pdf) www.freebookcentre.net.
2. Analytical chemistry Dr.michaelzehfus www.freebookcentre.net.
3. Introduction to Instrumental Analytical Chemistry Roger Terrell www.freebookcentre.net.
4. Analytical Chemistry lecture notes sadhu malyadri www.freebookcentre.net.
5. Short introduction into analytical chemistry Dr.manfredsietz and Dr. Andreassonnenberg www.freebookcentre.net.

PGS 623 BASIC ANALYTICAL TECHNIQUES (0+1)

Objective

This course provides the use of the statistical package SPSS for different statistical analyses of agricultural research data.

Practical

Use of SPSS / equivalent for frequency distribution, summarization and tabulation of data, F test, correlation, pearson correlation, spaeerman correlation, ANOVA, ANCOVA. For regression: simple, multiple linear regression, estimation of regression by OLS and MLE method, logit, probit, stepwise regression, coefficient of determination. For Kolmogorov - Smirnov test, Wilcoxon signed rank test, Mann-Whitney U, Kruskal-Wallis, McNemar's test. For discriminant analysis - fitting of discriminant functions, identification of important variables, factor analysis, principal component analysis - obtaining principal component. For analysis of time series data - AR, MA, ARIMA models.

Practical schedule

1. Use of SPSS / equivalent for frequency distribution
2. Summarization and tabulation of data
3. F test
4. Correlation, pearson correlation, spearman correlation
5. ANOVA, ANCOVA
6. Regression - simple, multiple linear regression, estimation of regression by OLS and MLE method
7. Logit, probit, stepwise regression
8. Coefficient of determination
9. Kolmogorov - Smirnov test
10. Wilcoxon signed rank test, Mann - Whitney U test
11. Kruskal - Wallis, McNemar's test
12. Discriminant analysis
13. Fitting of discriminant functions
14. Identification of important variables
15. Factor analysis. Principal component analysis
16. Obtaining principal component
17. Time series data AR, MA, ARIMA models

Reference books

1. SPSS User's guide and User's manual.
2. Wetherill, G.B., 1982. Elementary Statistical Methods. Chapman & Hall.
3. Wetherill, G.B., 1986. Regression Analysis with Applications. Chapman & Hall.
4. Learning statistics: <http://freestatistics.altervista.org/en/learning.php>.
5. Free statistical software's: <http://freestatistics.altervista.org/en/stat.php>.
6. Statistics glossary http://www.cas.lancs.ac.uk/glossary_v1.1/main.html

PGS 623 LABORATORY TECHNIQUES FOR AUDIO AND
VIDEO PRODUCTION (0+1)

OBJECTIVES

- To learn about the commonly used techniques in audio visual laboratory
- To gain knowledge and skills in audio and video production technologies
- To prepare students to undertake audio and video production.

PRACTICAL

Designing an audio-visual lab, Familiarising audio-visual equipments and aids, Audio production – Produce programmes in different formats - Talk , compering, announcement, anchoring, interviews - Create an audio story book with BGM - create a signature tune, a PSA, a radio ad, a jingle - Video production –Script, Story board, Camera movements, Shots, Angles, Basic lighting techniques and tilting, Capturing, Editing techniques – Produce programmes in different formats - Anchoring, Short film, Interview, News production, Talk show and Compering - Students will work individually and in groups to write, record, shoot, and edit their own projects. Selected audios and videos are played during class throughout the semester to enhance the critique process.

PRACTICAL SCHEDULE

1. Designing an audio-visual lab
2. Familiarising audio-visual equipments and aids
3. Audio production - Talk, compering, announcement, anchoring, interviews
4. Create an audio story book with BGM

5. Create a signature tune, a PSA, a radio ad, a jingle
6. Visit to radio station
7. Project (audio) presentation and analysis
8. Video production –Script, Story board, Camera movements, Shots, Angles
9. Mid semester Examination
10. Basic lighting techniques and titling
11. Capturing and Editing techniques
12. Production of programmes in different formats - Anchoring
13. Short film production
14. Interview show
15. News production
16. Talk show and Programme compeering
17. Visit to digital studio
18. Project (video) presentation and analysis

REFERENCES

1. Mills, Jenni. Broadcast Voice. Oxford: Focal Press, 2004
2. Audio- Visual Education: Teaching Innovative Techniques – Janardan Prasad, Kanishka Publishing House, 2014
3. Video Production - Vasuki Belavadi, 2nd Edition, Oxford University Press, 2013
4. Basics of Video Production - Des Lyver, Graham Swainson, Focal Press, Oxford, United Kingdom, 2016
5. Making Short Films: The Complete Guide from Script to Screen - Clifford Thurlow, bloomsbury publishing, 2012
6. <https://www.maximes.net>
7. <https://eyeconvideo.com>
8. <http://www.videomaker.com>
9. <http://motionsource.com>
10. <http://vidblaster.com>

PGS 624 - LIBRARY AND INFORMATION SERVICES 0+1

Objective

- To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary -Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services - (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing - information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized - library services; Use of Internet including search engines and its resources; e-resources access methods.

Practical Schedule

1. Introduction to library and its services
2. Role of libraries in education, research and technology transfer;
3. Classification systems and organization of library
4. Sources of information- Primary –Sources

5. Sources of information -Secondary Sources and Tertiary Sources
6. Intricacies of abstracting and indexing services
7. Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);
8. Tracing - information from reference sources; Literature survey
9. Mid- Semester
10. Citation techniques/Preparation of bibliography;
11. Use of CD-ROM Databases,
12. Online Public Access Catalogue and other computerized - library services
13. Online Public Access Catalogue and other computerized - library services
14. Use of Internet including search engines and its resources
15. Use of Internet including search engines and its resources
16. e-resources access methods.
17. e-resources access methods.

PGS 715 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN
AGRICULTURE (1+0) (e-course)

Objectives

The objective of the course is to create awareness about intellectual property rights in agriculture. The course deals with management of patents, trademark, geographical indications, copy rights, designs, plant variety protection and biodiversity protection. The students will be taught on the marketing and commercialization of intellectual properties.

Theory

Unit - I- World trade organization - introduction

World Trade Organization - Agreement on Agriculture (AoA) and Intellectual Property Rights (IPR) - importance of intellectual property management - IPR and economic growth - IPR and bio diversity - major areas of concern in intellectual property management - technology transfer and commercialization - forms of different intellectual properties generated by agricultural research.

Unit - II- Patent document

Discovery *versus* invention - patentability of biological inventions - procedure for patent protection - preparatory work - record keeping, writing a patent document, filing the patent document - types of patent application - patent application under the Patent Cooperation Treaty (PCT).

Unit - III- Plant genetic resources

Plant genetic resources - importance and conservation - sui generic system - plant varieties protection and farmers' rights act - registration of extinct varieties - registration and protection of new varieties / hybrids / essentially derived varieties - dispute prevention and settlement - farmers' rights.

Unit - IV- Trademark

Trademark - geographical indications of goods and commodities - copy rights- designs - biodiversity protection.

Unit - V- Benefit sharing

Procedures for commercialization of technology - valuation, costs and pricing of technology - licensing and implementation of intellectual properties - procedures for

commercialization - exclusive and non exclusive marketing rights - research exemption and benefit sharing.

Theory schedule

1. World Trade Organization - Agreement on Agriculture (AoA) and Intellectual Property Rights (IPR)
2. Importance of intellectual property management - IPR and economic growth - IPR and bio diversity
3. Major areas of concern in Intellectual property management - technology transfer and commercialization
4. Forms of different intellectual properties generated by agricultural research
5. Discovery versus invention patentability of biological inventions
6. Procedure for patent protection
7. Preparatory work - record keeping, writing a patent document, filing the patent document
8. Types of patent application - patent application under the Patent Cooperation Treaty (PCT)
9. Mid semester examination
10. Plant genetic resources - importance and conservation
11. Sui generic system - plant varieties protection and farmers' rights act - registration of extant varieties
12. Registration and protection of new varieties / hybrids / essentially derived varieties - dispute prevention and settlement - farmers' rights
13. Trade mark - geographical indications of goods and commodities - copy rights - designs
14. Biodiversity protection
15. Procedures for commercialization of technology - valuation, costs and pricing of technology
16. Licensing and implementation of intellectual properties - procedures for commercialization
17. Exclusive and non exclusive marketing rights - research exemption and benefit sharing

Reference books

1. Arun Goyal and Moor Mohamed, 2001. *WTO in the New Millennium*, Academy of Business Studies, New Delhi.
2. Bilek Debroy, 2004. *Intellectual Property Rights*, BR World of books, New Delhi.
3. Ganguli, P., 2001. *Intellectual Property Rights - Unleashing the Knowledge Economy*. Tata McGraw Hill, New Delhi.
4. Narayanan, R., 2006. *Patent Law*, Eastern Law House, New Delhi.
5. Ramappa, T., 2000. *Intellectual Property Rights under WTO - Tasks before India*, Wheeler Publishing, New Delhi.

PGS 716 ** DISASTER MANAGEMENT (1+ 0)
(e-Course)

Objectives

To introduce students to the key concepts and practices of mitigation for natural disasters and calamities and to equip them for disaster preparedness to conduct thorough assessment of hazards, risks vulnerability and capacity building strategies.

Theory

Unit I – Natural disaster

Natural Disasters - meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves.

Unit II – Climate change

Climatic change - Global warming, sea level rise, ozone depletion, Manmade disasters - Nuclear disasters, chemical disasters, biological disasters.

Unit III – Man – made disaster

Building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, disaster management- efforts to mitigate natural disasters at national and global levels – India's key hazards, vulnerabilities and disaster response mechanisms in India.

Unit IV – Disaster warning, response and preparedness

Concept of disaster management, national disaster management framework; financial arrangements, role of NGOs, community-based organizations, and media - central, state, district and local administration. Dissemination of disaster warning, response to natural disasters, national, state, district level, relief – food and nutrition – water – health – mental health services.

Unit V – Rehabilitation

Rehabilitation – food - clothing - utensils - fuel – shelter – relief camp – sanitation and hygiene. Resilient farming concepts – reclamation and revival of the agriculture system after natural disaster (Bio-shield). Preparedness – Emergency Operations Centres (EOCS).

Theory lecture schedule

1. Natural Disaster - meaning and nature of natural disasters, their types and effects.
2. Flood, drought, cyclone, earthquakes landslides, avalanches, volcanic eruptions, Heat and cold waves.
3. Climatic change- Global warming, sea level rise, ozone depletion
4. Manmade disaster - Nuclear disasters, chemical disasters, biological disasters.
5. Building fire, coal fire, forest fire. oil fire.
6. Air pollution, water pollution, deforestation, industrial wastewater pollution.
7. Disaster management- efforts to mitigate natural disasters at national and global levels.

8. India's key hazards, vulnerabilities and disaster response mechanism in India.
9. Mid-Semester examination
10. Concept of disaster management, national disaster management framework.
11. Financial arrangements, role of NGOs, community-based organizations and media.
12. Central, state, district and local administration.
13. Dissemination of disaster warning - response to natural disasters, national, state, district level.
14. Relief – food and nutrition – water – health – mental health services.
15. Rehabilitation – tolerant and resistant crops- resilient farming concepts – bioshields - livelihood options – insurance and compensation.
16. Disaster preparedness - clothing and utensils and fuel – shelter – relief camp – sanitation and hygiene.
17. Preparedness – Emergency Operations Centers (EOCS).

References

1. Gautam, D R. 2009. *Community based disaster risk reduction*. Mercy Corps, Lalitpur, Nepal.
2. Gupta, HK. 2003. *Disaster management*. Indian National Science Academy. Orient Blackswan.
3. Hodgkinson, PE and Stewart, M. 1991. *Coping with Catastrophe: A handbook of disaster management*. Routledge.
4. Ministry of Home Affairs. 2010. *Standard operating procedure for responding to natural disasters*, Ministry of Home Affairs – Disaster management Division, New Delhi.
5. Sharma, VK. 2001. *Disaster management*. National Centre for Disaster Management, India.
6. Das, H.P. 2016. *Climate change and agriculture implications for global food security*. BS Publications, Hyderabad.
7. Kelkar, R.R. 2010. *Climate change -A Holistic view*. BS Publications, Hyderabad.

e resources

1. [http:// research.un.org/en/disaste](http://research.un.org/en/disaste)
2. <https://searchworks.stanford.edu/>
3. <http://guodes.litrary.illinois.edu>c.php>
4. [http:// libguides. auu.edu.au>c.php](http://libguides.aau.edu.au>c.php)
5. www.wcpt.org

Proforma-1**PROFORMA FOR FORMATION OF RESEARCH ADVISORY COMMITTEE**

(To be sent before the end of I Semester)

1. Name of the student :
2. Enrolment number: Reg. No. :
3. Degree :
4. Subject :
5. Advisory Committee :

S.No.	Advisory Committee	Name, Designation and Department	Signature
1.	Chairperson		
2.	Members		
	Additional Member		
	Reasons for additional Member		

Signature of Professor and Head

Additional members may be included only in the allied faculty related to thesis research with full justification at the time of sending proposals (Program of research).

Proforma-1a.

PROFORMA FOR CHANGE IN THE RESEARCH ADVISORY COMMITTEE

1. Name of the student :
2. Enrolment number: Reg. No.
3. Subject :
4. Degree :
5. Proposed Change :

Advisory Committee	Name and designation	Signature
a. Existing member		
b. Proposed member		

6. Reasons for change

Chairperson

Signature of Professor and Head

Proforma-2**PROFORMA FOR OUTLINE OF RESEARCH WORK (ORW)**

(To be sent before the end of I Semester)

1. Name :
2. Enrolment number: Reg. No.
3. Degree :
4. Subject :
5. Date of Joining :
6. Title of the research project :
7. Objectives :
8. Duration :
9. Review of work done :
10. Broad outline of work/methodology :
11. Semester wise break up of work :

Signature of student

Approval of the advisory committee

Advisory committee	Name	Signature
Chairperson		
Members		
1.		
2.		

Professor and Head

Proforma-2a

PROFORMA FOR CHANGE IN OUTLINE OF RESEARCH WORK (ORW)

1. Name :
2. Enrolment number: Reg. No
- 3 Degree :
- 4 Subject
- 5 Reasons for change :
- 6 Proposed change in the approved Program of research :
- 7 Number of credits completed so far Under the approved program :
- 8 a. Whether already earned credits are to be retained or to be deleted :
- b. if retained, justification :

Signature of the

student

Approval of the Advisory Committee

Advisory committee	Name	Signature
Chairperson		
Members		

Professor and Head

DEPARTMENT OF -----
PROFORMA FOR EVALUATION OF SEMINAR

1. Name of the candidate :
2. Register Number :
3. Degree programme :
4. Semester :
5. Topic of the seminar
and credit :
- 6 . Distribution of marks

Distribution of marks	Max Marks					
i. Literature coverage	40					
ii. Presentation	30					
iii. Use of audio – visual aid	10					
iv. Interactive skills	20					
Total	100					
Name						
Designation		H.O.D	Chairperson	Member 1	Member 2	Average
Signature						

Grade point

Head of the Department

Proforma-4**PROFORMA FOR REGISTRATION OF RESEARCH CREDITS**

(To be given during first week of semester)

PART A: PROGRAM

Semester:

Year:

Date of registration:

1. Name of the student and
2. Enrolment number : Reg. No .:
3. Total research credits completed so far:
4. Research credits registered during the semester:
5. Program of work for this semester (list out the
Items of research work to be undertaken during
the semester) :

Approval of advisory committee

Advisory committee	Name	Signature
Chairperson		
Members		
1		
2		

Professor and Head

Approval may be accorded within 10 days of registration

PROFORMA FOR EVALUATION OF RESEARCH CREDITS

PART B EVALUATION

(Evaluation to be done before the closure of Semester)

Date of Commencement semester : Date of closure of semester:

Date of evaluation :

1.Name of the student

2.Enrolment number : Reg. No .:

3.Total research credits completed so far:

4.Research credits registered during the semester:

5.Whether the research work has
been carried out as per the approved :
program

6.If there is deviation specify the reasons :

7.Performance of the candidate : SATISFACTORY /NOT SATISFACTORY

Approval of the advisory committee

Advisory committee	Name	Signature
Chairperson		
Members		

Professor and Head

Proforma-6

PROFORMA FOR THE PROPOSAL OF QUALIFYING EXAMINATION

1. Name of the student:
2. Enrolment number : Reg. No .:
3. Degree:
4. Subject:
5. Whether all major courses have been completed:
6. No. of credits completed:
7. Whether he/she has an overall GPA of above 6.5:
8. Title of thesis:
9. Panel of external examiners:
10. Remarks:

Signature of Chairman with
Name and designation

Professor and Head

Proforma-7

**PROFORMA FOR COMMUNICATION OF RESULTS OF QUALIFYING
EXAMINATION**

1. Name of the student:
2. Enrolment number : Reg. No .:
3. Degree:
4. Subject:
5. Department :
6. Date of examination:
7. Result (Successful / not Successful*):
8. Remarks:

(*) to be written by the external examiner

Examination committee	Name	Signature
Chairperson		
Members		
External Examiner		

Professor and Head

Note if this is the re-exam the date of previous examination may be indicated

ANNAMALAI UNIVERSITY
FACULTY OF AGRICULTURE
DEPARTMENT OF _____
PROFORMA FOR EVALUATION OF THESIS

1. Name of the examiner:
2. Postal Address:
3. Telephone/Mobile:
4. E-Mail:
5. Name of the candidate :
6. Title of the thesis:
7. Date of receipt of the thesis copy:
8. Date of dispatch of the detailed report and thesis by the examiner to the Controller of Examinations:
9. Examiner's recommendations choosing one of the following based on quality of thesis

Please give your specific recommendation (select any one decision from the list

below) with your signature and enclose your detailed report in separate sheet(s).

- a. I recommend that the thesis entitled -----

-----submitted by ----- be accepted for award of the Degree of MASTER OF SCIENCE (AGRICULTURE / HORTICULTURE / AGRI BUSINESS MANAGEMENT) of Annamalai University, Annamalainagar.

(OR)

- b. I do not recommend the acceptance of the thesis entitled.

----- submitted by -----for
award of the Degree of MASTER OF SCIENCE (AGRICULTURE / HORTICULTURE / AGRI BUSINESS MANAGEMENT)of Annamalai University, Annamalainagar. (Please specify reasons)

Date :

Signature with Office Seal:

Note- Please enclose a detailed report in duplicate duly signed by you giving the merits and demerits of the thesis on the choice of problem, review of literature, methods followed, results and discussion, etc.

Proforma- 9**PROFORMA FOR REPORT OF THE FINAL VIVA VOCE EXAMINATION**

The meeting of the Examining Committee for Mr./Ms. -----

M.Sc.(Ag.)/(Hort.)/Agri Business Management Student Reg. .No. ----- majoring

in -----was held at -----a.m/p.m on -----

The following members were present:

1. ----- : Chairperson

2. ----- : Members

3. -----

The committee took note of the report of the external examiner Dr. ----- recommending the thesis for acceptance.

The final viva voce examination for the candidate was conducted by the members of the Advisory Committee. The performance of the candidates was Satisfactory/ not Satisfactory.

The Committee recommends/ does not recommend unanimously the award of Degree of M.Sc.(Ag.)/(Hort.)/Agri Business Management to Mr./Ms.-----

1. Chairperson

2. Member

3. Member

The original report from the External Examiner is attached herewith

Chairperson of the Advisory Committee

Professor and Head

**CERTIFICATE FOR HAVING CARRIED OUT THE SUGGESTIONS OF THE
EXTERNAL EXAMINER AND ADVISORY COMMITTEE**

Certified that Mr./ Ms. ----- Reg. No. -----
-has carried out all the corrections and suggestions as pointed out by the External
examiner and the Advisory Committee. He/She has submitted **TWO** copies of his/
M.Sc.(Ag.)/(Hort.)/Agri Business Management thesis in hard bound cover and two soft
copies in CD format, two copies each of the abstract of thesis and summary of the
findings both in Tamil and English in CD format.

Chairperson

Professor and Head

ANNAMALAI  **UNIVERSITY**
DEPARTMENT OF
FACULTY OF AGRICULTURE

CERTIFICATE

This is to certify that the thesis entitled “-----” submitted in partial fulfillment of the requirements for the award of the degree of ----- to Annamalai University, Annamalainagar is a record of bonafide research work carried out by -----, under my guidance and supervision and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prizes and that the work has been published / not been published in part or full in any scientific or popular journals or magazines.

Chairperson

1. Member

2. Member