FACULTY OF AGRICULTURE
COMMON REGULATIONS FOR ALL
M.Sc. (AGRICULTURE/HORTICULTURE) AND MBA (AGRI. BUSINESS MANAGEMENT) PROGRAMMES OFFERED BY
THE FACULTY OF AGRICULTURE
WITH EFFECT FROM 2022-2023

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) and MBA (Agri. Business Management) in the Faculty of Agriculture.
- They shall come into force with effect from the academic year 2022 – 2023.

Academic Year and Registration

- An academic year shall be normally from July to June of the following calendar year otherwise required under special situations. It shall be divided into two academic terms known as semesters. The Academic Calendar will be developed by the University from time to time and notified accordingly by the Registrar in advance.
- An orientation programme shall be organized by theDean, Faculty of Agriculture for the benefit of the newly admitted students immediately after commencement of the semester.
- On successful completion of a semester, the continuing students shall register for subsequent semester on the date specified in the Academic/ Semester Calendar or specifically notified separately. Every enrolled student shall be required to register at the beginning of each semester till the completion of his/ her degree programmes

Registration Cards

- A student shall register the courses offered in a semester by writing all the courses in registration card in quadruplicate.
- The Chairman, PG coordinator and Head of the Department are responsible to furnish the registration particulars of the students with their signature in the Registration card to the Dean.
- The Dean shall approve the registration cards.
- The approved registration cards shall be maintained by the Head of the Department, Chairman and the student concerned.
- The list of courses registered by the students in each semester shall be sent by the Dean to the Controller of Examinations/University for preparation of Report Cards

2. Definitions

- "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
- Entomology
- Agricultural Microbiology
- Genetics and Plant Breeding
- Seed Science and Technology
- Plant Molecular biology and 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
- M.B.A (Agri. Business Management)

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

Faculty of Agriculture, Annamalai university or Universities/colleges accredited with ICAR, New Delhi.

- **For M.Sc. (Ag.) Agronomy**

Eligibility: B.Sc. (Hons.) Agriculture / B.Sc. (Ag.) courses of four years duration.

- For M.Sc. (Ag.) Entomology, Genetics and Plant Breeding, Plant Pathology, Soil Science and Agricultural Chemistry, Seed Science and Technology, Plant Molecular biology and Biotechnology, Agricultural Microbiology, Agricultural Extension, Agricultural Economics and M.B.A (Agri. Business Management)
  Eligibility: B.Sc. (Hons.) Agriculture / B.Sc.(Hons.) Horticulture/B.Sc. (Ag.)/B.Sc.(Hort.) of four years duration.
- **For M.Sc. (Hort.)**
  Eligibility: B.Sc. (Hons.) Agriculture / B.Sc.(Hons.) Horticulture/ B.Sc.(Hort.)and B.Sc. (Ag.) courses of four years duration.

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 6.50 out of 10.00 and 7.00 out of 10.00 in the subject concerned is required. However, for SC/ST candidates OGPA of 6.75 out of 10.00 in the subject concerned is sufficient.

4.3. An entrance test will be held separately for each Degree programme. Selection of candidates shall be based on OGPA, Subject OGPA, Entrance Test and Interview

4.4. A student can apply to a maximum of two subjects only

5.1. Residential requirements

The duration for the M.Sc. (Agriculture/Horticulture) and MBA programme will be of two years with four semesters. A student registered for M.Sc. (Agriculture/Horticulture) programme should complete the course within five Academic year from the date of his/her admission.

In case a student fails to complete the degree programme within the maximum duration of residential requirement, his/ her admission shall stand cancelled. The requirement shall be treated as satisfactory in the cases in which a student submits his/ her thesis any time during the 4th semester of his/ her residentship at the University.

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 70 credits as detailed below.

I) Course work	
Major Courses	20
Minor Courses	08
Supporting Courses	06
Common Courses	0**5**
Seminar	01
ii) Thesis Research	30
Total credits	**70**

Major courses: From the Discipline in which a student takes admission. Among the listed courses, the core courses compulsorily to be taken will be given *mark

Minor courses: From the courses closely related to a student's major subjectchosen by the students in consultation with the Head of the department and the Chairman based on their research specialization.

Supporting courses: The subjects not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.

a. List of supporting courses for M.Sc. (Ag.) Agronomy, Agricultural Entomology, Genetics and Plant Breeding, Plant Pathology, Soil Science and Agricultural Chemistry, Seed Science and Technology, Plant Molecular biology and Biotechnology, Agricultural Microbiology and Horticulture are

STA 501	Statistical Methods for Applied Sciences	3(2+1)
COM 501	Information Technology in Agriculture	3(2+1)

b. List of supporting courses for M.Sc. (Ag.) Agricultural Extension, Agricultural Economics and M.B.A (Agri. Business Management)

STA 502	Statistical Methods for social Sciences	3(2+1)
COM 501	Information Technology in Agriculture	3 (2+1)

Common Courses: The following courses (one credit each) will be offered to all students undergoing Master's degree programme:

1. PGS 501 - Agricultural Research, Research Ethics and Rural Development Programmes (1+0)
2. PGS 502 - Technical Writing and Communications Skills (1+0)
3. PGS 503 - Basic Concepts in Laboratory Techniques (0+1)
4. PGS 504 - Library and Information Services (1+0)
5. PGS 505 - Intellectual Property and its management in Agriculture (1+0)

Some of these courses are already in the form of e-courses/ MOOCs. The students may be allowed to register these courses/ similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/ she may be permitted to register for other related courses with the prior approval of the Head of Department (HoD)/ Board of Studies (BoS).

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 which 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.

Advisor/ Co-guide/ Member, Advisory Committee from other collaborating University/ Institute/ Organization

• In order to promote quality Post-graduate research and training in cutting edge areas, the University will enter into Memorandum of Understanding (MOU) with other Universities/ Institutions for conducting research. While constituting an Advisory Committee of a student, if the Chairperson, Advisory Committee feels the requirement of involving of a faculty member/ scientist of such partnering university/ Institute/ Organization, he/ she may send a proposal to this effect to the Dean, Faculty of Agriculture along with the proposal for consideration of Student's Advisory Committee.

• The proposed faculty member from the partnering institution can be allowed to act as Chairperson/ Co-guide/ Member, SAC, by mutual consent, primarily on the basis of intellectual input and time devoted for carrying out the research work at the particular institution.

Allotment of students to the retiring persons

Normally, retiring faculty may not be allotted with M. Sc. Student if he/ she is left with less than 2 years of service.

Changes in the Advisory Committee:

i. Change of the Chairperson or any member of the Advisory Committee is not ordinarily permissible. However, in exceptional cases, the change may be effected with due approval of the Dean, faculty of Agriculture.

ii. Normally, staff members of the university on extra ordinary leave or on study leave or who leave the University service will cease to continue to serve as advisors of the Post-graduate students of the University. However, the Dean, faculty of Agriculture may permit them to continue to serve as advisor subject to the following conditions:
    a) The concerned staff member must be resident in India and if he/ she agrees to guide research and must be available for occasional consultations;
    b) An application is made by the student concerned duly supported by the Advisory Committee;
    c) The Head of the Department and the Dean, Faculty of Agriculture agree to the proposal;

iii. In case the Chairperson/ member of Advisory Committee retires, he/ she shall be allowed to continue provided that the student has completed his course work and minimum of 10 research credits and the retiring Chairperson/ member stays at the Headquarters of the College, till the thesis is submitted.

iv. The change shall be communicated to all concerned by the Head of Department.

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 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

Multiple levels of evaluation (First Test, Midterm and Final semester) will be conducted

9.1 First Test (FT) and Mid-semester examination (MSE)

9.1.1 Every teacher handling a subject shall conduct first Test (FT) as per the scheme drawn by the Head of the Department concerned /PG coordinator on the fourth week from the date of registration of the course, and evaluate. The evaluation process will be based on objective type questions and short concepts.

9.1.2 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, on the sixth week from the date of registration of the course and evaluate. The evaluation process will be of descriptive type.

9.1.3 The answer scripts of both FT and MSE 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.

9.1.4. Writing the first test and mid-semester examination is a pre-requisite for writing the final theory and practical examinations. If a student does not appear for FT/MSE, he/she is not eligible to appear for the final examinations. Such candidate has to reappear for the FT/MSE as and when the respective examinations are conducted only after getting permission from the Head of the Department concerned.

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

9.1.6 The FT and MSE marks will be furnished to the Head of the Department within 10 days after the conduct of Ft and 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.

9.1.7 The first test will be of 30 minutes duration and MSE of theory will be of one hour duration.

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

9.1.9 A student who fails to attend a first test and mid-semester examination due to unavoidable circumstances shall be permitted with prior approval of the head of the Department to take up missing examination of the particular course. Such tests should be completed ordinarily within 15 working days after the respective FT/MSE.

The distribution of marks will be as indicated below.

Test	**Subjects with Practical**	**Subjects without Practical**	**Subjects without Theory**
First test	10	20	20
Mid-Semester	20	30	30
Final theory	30	50	-
Final practical	40	-	50
Total	**100**	**100**	**100**

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

First Test (30 minutes duration) (Total Marks: 10)

1. Objective Type	10 out of 12	10 x 0.5 marks	5 Marks
2.Definitions/ Short Concepts	5 out of 7	5 x 1 marks	5 Marks

Mid-semester examination

For Subjects with practicals (One hour duration) (Total marks: 20)

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

For Subjects without practicals (One hour duration) (Total marks: 30)

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 two and a half hours duration each conducted separately by the University.

9.2.2. The final theory and practical examinations will be evaluated by respective course teacher)

9.2.3. 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 (2½ hour duration) (Total marks: 30)

1. Definitions	5 out of 7	5 x1 marks	5 marks
2. Short Notes	2 out of 3	2 x2½ marks	5 marks
3. Essay Type	Either or type (one question from each unit)	5 x 4 marks	20 marks

For subjects without practicals (2½ hour duration) (Total marks: 50)

1. Definitions	6 out of 8	6 x1 marks	6 marks
2. Short Notes	3 out of 5	3 x 3 marks	9 marks
3. Essay Type	Either or type (one question from each unit)	5 x 7 marks	35 marks

9.2.4**. Practical Examination**

Practical examinations will be conducted in the last practical class. 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.

9.2.5. Assignment

Each student will be assigned a topic by the concerned course teacher. Such topic should cover a wide range of topics within the subject limits. The topic should be different from that of the credit seminar. Assignments will be evaluated during practical examination.

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

S.No.	Particulars	Courses with theory and practical	Courses only with practical
1	Practical part	25	55
2	Assignment/specimen collection	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 Reappearence (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 a10 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 / Percentage ranking

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

OGPA	Percentage	**Class**
9.00 and above	90 and above	Distinction
8.00 to 8.99	80.00 to 89.99	I Class
7.00 to 7.99	70.00 to 79.99	II Class
6.50 to 6.99	65.00 to 69.99	Pass

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 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. Absence of advisory committee member during final viva-voce examination:

11.1 Conducting final viva voce examination in the absence of advisory committee members is not allowed.

11.2. Under extra-ordinary circumstances if the 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.

11.3. The co-opted member should be from the same department of the member who is not attending the examinations.

11.4. In the absence of the Chairman of advisory committee, respective Heads of Departments should act as Co-chairman with prior permission of Dean.

12. Research Work

12.1. 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.

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

I Semester	0+ 2
II Semester	0+ 6
III Semester	0+ 10
IV Semester	0+ 12*
Total	**0 + 30**

*** In the fourth semester out of 12 credits, 8 credits will be for evaluation of research and remaining 4 credits for evaluation of viva voce.**

13. Evaluation of Thesis Research

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 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.

13.3. 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.

13.4. 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'**.

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.

14. Submission of Thesis

14.1. 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.

14.2 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.

14.3 The thesis shall contain a certificate from the supervisor specifying that the thesis submitted is a record of research work done by the candidate during the period of study under him/her, and that the thesis has not

previously formed the basis for the award of any Degree, Diploma, Associateship, Fellowship or similar title. A statement from the supervisor indicating the extent to which the thesis represents independent work on the part of the candidate should also be made including free from plagiarism **above the specified level.**

14.4 The thesis shall also contain a declaration by the candidate that the work reported in the thesis has been carried out by the candidate himself/herself and that the material from other sources, if any, is duly acknowledged and no part of the thesis is plagiarized more than 25 %.

15. Grace period

15.1 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 forthcoming 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 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.

17. 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.

18. Evaluation of Thesis

18.1 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.

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 along with the external examiner. 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 thesis by the external examinerthe Head of the Department concerned and Advisory Committee refer the thesis for valuation by a second external examiner. If the second external examiner recommends the thesis for acceptance, Viva-Voce will be conducted.

18.4 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.

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 thesis

If an examiner recommends for revision of thesis 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 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.

19.3 A fine prescribed by the University to be collected from the students at the time of resubmission of thesis.

20. Failure to appear for final Viva-voce/ Non submission of thesis 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 fine prescribed by the University must be charged to the candidate.

20.3 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

21. Internship during Masters programme

Internship for Development of Entrepreneurship in Agriculture (IDEA)

Currently, a provision of 30 credits for dissertation work in M.Sc. programmes helps practically only those students who aspire to pursue their career in academic/ research. There is hardly any opportunity/ provision under this system to enhance the entrepreneurship skills of those students who could start their own enterprise or have adequate skills to join the industry.

Therefore, in order to overcome this gap, an optional internship/ in-plant training (called as IDEA) in lieu of thesis/ research work is recommended which will give the students an opportunity to have a real-time hands-on experience in the industry.

It is envisaged that the internship/ in-plant training would enhance the interactions between academic organizations and the relevant industry. It would not only enable the development of highly learned and skilled manpower to start their-own enterprises but also the industry would also be benefitted through this process. This pragmatic approach would definitely result in enhancedpartnerships between academia and industry.

The main objectives of the programme:

1. To promote the linkages between academia and industry
2. To establish newer University – Cooperative R&D together with industry for knowledge creation, research and commercialization
3. Collaboration between Universities and industries through pilot projects
4. To develop methods for knowledge transfer, innovation and networking potential
5. To enhance skill, career development and employability

Following criteria for IDEA will be taken into consideration:

- At any point of time there will not be more than 50% of students who can opt under IDEA
- Major Advisor will be from Academia and Co-advisor (or Advisory Committee member) from industry
- Total credits (30) will be divided into 20 for internship/ in-plant training and10 for writing the report followed by viva-voce similar to dissertation
- Work place will be industry; however, academic/ research support would be provided by the University or both. MoU may be developed accordingly
- The IPR, if any, would be as per the University policy

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 is a rank holder and secures at least 8.5 OGPA, clears all courses in first attempt and in the programme having a batch of at least three students.

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GPB M.Sc. (Ag.) Genetics and Plant Breeding

Courses with Credit Load

I) Course work

Major Courses	**20**
Minor Courses	**08**
Supporting Courses	**06**
Common Courses	**05**
Seminar	**01**
II) Thesis Research / IDEA	**30**
Total credits	**70**

Distribution Pattern of Courses and Credit (For Research Program)

Semester	Major Courses	Minor Courses	Supporting Courses	Common Courses	Seminar	Research	Credit Load
I	8	-	6	2	-	2	18
II	12	-	-	2	-	6	20
III	-	6	-	1	1	10	18
IV	-	2	-	-	-	12	14
Credit Load	**20**	**8**	**6**	**5**	**1**	**30**	**70**

Distribution Pattern of Courses and Credit (For IDEA Program)

Semester	Major Courses	Minor Courses	Supporting Courses	Common Courses	Seminar	IDEA	Credit Load
I	8	-	6	2	-	-	16
II	12	-	-	2	-	-	14
III	-	6	-	1	1	10	18
IV	-	2	-	-	-	10 +10	22
Credit Load	**20**	**8**	**6**	**5**	**1**	**30**	**70**

Distribution Pattern of Courses and Credit

S. No.	Course Code	Course Title	Credit Hours
		Compulsory Major Courses	
1	GPB 501*	Principles of Genetics	3 (2+1)
2	GPB 502*	Principles of Plant Breeding	3 (2+1)
3	GPB 503*	Fundamentals of Quantitative Genetics	3 (2+1)
4	GPB 506*	Molecular Breeding and Bioinformatics	3 (2+1)
		Optional Major Courses	
5	GPB 505	Principles of Cytogenetics	3 (2+1)
6	GPB 507	Breeding for Quality and Special Traits	3 (2+1)
7	GPB 508	Mutagenesis and Mutation Breeding	3 (2+1)
8	GPB 510	Seed Production and Certification	2 (1+1)
9	GPB 511	Crop Breeding-I *(Kharif* Crops)	3 (2+1)
10	GPB 512	Crop Breeding-II *(Rabi* Crops)	3 (2+1)
11	GPB 517	Germplasm Characterization and Evaluation	2 (1+1)
		Minor Courses	
12	GPB 504	Varietal Development and Maintenance Breeding	2 (1+1)
13	GPB 509	Hybrid Breeding	3 (2+1)
14	GPB 513	Breeding Vegetable Crops	3 (2+1)
15	GPB 514	Breeding Fruit Crops	3 (2+1)
16	GPB 515	Breeding Ornamental Crops	3 (2+1)
17	GPB 516	Breeding for Stress Resistance and Climate Change	3 (2+1)
18	GPB 518	Genetic enhancement for PGR Utilization	2 (1+1)
		Supporting Courses	
22	PGS 501	Library and Information Services	0+1
23	PGS 502	Technical Writing and Communications Skills	0+1
24	PGS 503	Intellectual Property and its Management in Agriculture	1+0
25	PGS 504	Basic Concepts in Laboratory Techniques	0+1
26	PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
27	AGR 591	**Master's Seminar**	1 (0+1)
28	AGR 599	**Research**	30

Programme Outcomes (POs)
1. The basics of classical to molecular plant breeding including biotechnological, quantitative, and genomic technique
2. Skill in self-designing, regional and crop specific plant breeding programs linking conventional and modern techniques; selection strategies for development of new varieties.
3. Competency in collection, investigation and analysis of data sets using statistical software; interpretation of the genetic results to arrive at meaningful conclusions.
4. Insight about various biotechnological tools, tissue culture techniques, principles behind transgenic crops and its ethical implications.
5. Understand the importance of quantitative genetic analysis, identifying the genes and QTL analysis.

PO and CO Mapping Matrix

AFFINITY LEVELS	
1	**Low**
2	**Moderate/ Medium**
3	**Substantial /High**

SEMESTER WISE DISTRIBUTION OF COURSES (RESEARCH)

Sl. No.	Course Title	Credit hours
	I Semester	
	Major Courses	8
	Supporting Courses	
	STA501 - Statistical Methods for Applied Sciences	3
	COM 501 - Information Technology in Agriculture	3
	Common Courses	
	PGS 501 - Agricultural research, research ethics and rural development programmes	1
	PGS 502 - Technical writing and communications skills	1
	AGR 599 Research	2
	Total	**18**
	II Semester	
	Major Courses	12
	Common Courses	
	PGS 503 - Basic Concepts In Laboratory Techniques	1
	PGS 504 - Library and information services	1
	AGR 599 Research	6
	Total	**20**
	III Semester	
	Minor courses	6
	Common course	
	PGS 505 - Intellectual property and its management in agriculture	1
	Disaster Management (1+ 0)	-
	Constitution of India (Contact hour 1+ 0)	-
	AGR 591 Master's Seminar	1
	AGR 599 Research	10
	Value Added Course (3+0) (https://annamalaiuniversity.ac.in/studport/value_added_crs.php)	-
		18
	IV Semester	
	Minor course	2
	AGR 599 Research	12 (8+4)
		14

SEMESTER WISE DISTRIBUTION OF COURSES (IDEA)

Sl. No.	Course Title	Credit hours
	I Semester	
	Major Courses	8
	Supporting Courses	
	STA501 - Statistical Methods for Applied Sciences	3
	COM 501 - Information Technology in Agriculture	3
	Common Courses	
	PGS 501 - Agricultural research, research ethics and rural development programmes	1
	PGS 502 - Technical writing and communications skills	1
	AGR 599 IDEA	
	Total	**16**
	II Semester	
	Major Courses	12
	Common Courses	
	PGS 503 - Basic Concepts in Laboratory Techniques	1
	PGS 504 - Library and information services	1
	AGR 599 IDEA	
	Total	**14**
	III Semester	
	Minor courses	6
	Common course	
	PGS 505 - Intellectual property and its management in agriculture	1
	Disaster Management (1+ 0)	-
	Constitution of India (Contact hour 1+ 0)	-
	AGR 591 Master's Seminar	1
	AGR 599 IDEA	10
	Value Added Course (3+0) (https://annamalaiuniversity.ac.in/studport/value_added_crs.php)	-
	Total	**18**
	IV Semester	
	Minor course	2
	AGR 599 IDEA	20 (10+10)
	Total	**22**

GPB 501 - PRINCIPLES OF GENETICS - (2+1)

Learning objective

- To inculcate knowledge on the fundamental concepts of inheritance and variation
- To make the students to understand the importance of gene mapping techniques and its utilization in novel plant breeding
- To explore Random mating population for linkage disequilibrium analysis
- To decipher the genetic code for the determination of protein product.
- To sort out the challenges ahead in Gene sequencing and gene editing technique

Theory

Unit I: Mendelian inheritance

Beginning of genetics**,** early concepts of inheritance, 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 traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.

Unit II: Population genetics

Mendelian population, Random mating population, Frequencies of genes and genotypes, Causes of change: Hardy-Weinberg equilibrium.

Unit III: Protein synthesis and gene expression

Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis, Genetic fine structure analysis, Allelic complementation, Split genes, overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters; Regulation of gene activity in prokaryotes and eukaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene eXpression, RNA editing.

Unit IV: DNA isolation and construction of DNA libraries

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).

Unit V: Functional genomics

Genomics and proteomics; metagenomics; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders.

Practicals

Laboratory eXercises in probability and chi-square; 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; EXtraction of proteins and isozymes; Use of *Agrobacterium* mediated method and Biolistic gun; Detection of transgenes in the eXposed plant material; Visit to transgenic glasshouse and learning the practical considerations.

Lesson plan

Theory lecture schedule

1. Beginning of genetics
2. Early concepts inheritance
3. Mendel's laws; Discussion on Mendel's paper
4. Chromosomal theory of inheritance
5. Multiple alleles
6. Geneinteractions
7. Sex determination, differentiation and sex-linkage
8. Sex-influenced andsex-limited traits
9. **First test**
10. Linkage-detection and estimation
11. Recombination and genetic mapping in eukaryotes
12. Somatic cell genetics, Extra chromosomal inheritance.
13. Mendelian population, Random mating population
14. Frequencies of genes and genotypes and causes of change
15. Hardy-Weinberg equilibrium.
16. Nature, structure and replication of the genetic material
17. **Mid-semester examination**
18. Organization of DNA in chromosomes and genetic code
19. Protein biosynthesis
20. Genetic fine structure analysis and allelic complementation
21. Split genes, overlapping genes, Pseudogenes
22. Oncogenes, Gene families and clusters
23. Regulation of gene activity in prokaryotes and eukaryotes
24. Molecular mechanisms of mutation, repair and suppression
25. Bacterial plasmids, insertion (IS) and transposable (Tn) elements
26. Molecular chaperones and gene expression and RNA editing.
27. Gene isolation, synthesis and cloning, genomic and cDNA libraries
28. PCR basedcloning and positional cloning
29. Nucleic acid hybridization and immunochemical detection
30. DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes, Micro-RNAs (miRNAs).
31. Genomics and proteomics, metagenomics
32. Transgenic bacteria and bioethics, Gene silencing
33. Genetics of mitochondria and chloroplasts.
34. Concepts of Eugenics, Epigenetics, Genetic disorders.

Practical schedule

1. Laboratory exercises in probability
2. Laboratory exercises in chi-square
3. Demonstration of genetic principles using laboratory organisms
4. Chromosome mapping using three-point test cross
5. Tetrad analysis
6. Induction of mutations through genetic tests
7. Detection of mutations through genetic tests
8. DNA extraction
9. PCR amplification
10. Electrophoresis
11. Basic principles and running of amplified DNA

12. EXtraction of proteins
13. Extraction of isozymes
14. Use of *Agrobacterium* mediated method and Biolistic gun
15. Detection of transgenes in the eXposed plant material
16. Visit to transgenic glasshouse and learning the practical considerations
17. **Final practical examination**

Course outcome

CO 1: Students will understand the molecular structure of DNA and the central dogma of life.

CO 2: Importance of studying Linkage and recombination mapping will be well understood by the students.

CO 3: Students will able to figure out the fine structure of gene and gene mapping techniques.

CO 4: The necessity of studying Gene regulation and function will be well elucidated

CO 5: To explore the students in understanding various Genetic disorders and have a better idea on consanguineous mating.

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	**2**	**-**	**-**	**3**	**2**
CO2	**-**	**-**	**-**	**-**	**-**
CO3	**-**	**-**	**-**	**-**	**2**
CO4	**-**	**-**	**-**	**-**	**-**
CO5	**-**	**-**	**-**	**-**	**-**

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GPB 502 - PRINCIPLES OF PLANT BREEDING - (2+1)

Learning objective

- To impart knowledge on application of various genetic principles in crop improvement.
- To impart knowledge on emasculation and pollination techniques of various crops.
- To impart knowledge on the development of varieties.
- To impart knowledge about plant variety protection.
- To get knowledge about different selection methods in breeding.

Theory

Unit I: Basics of plant breeding

Early Plant Breeding, Accomplishments through plant breeding, Objectives of plant breeding, Patterns of evolution in Crop plants – Centre of origin, Agro-biodiversity and its significance. Pre- breeding and plant introduction, Role of plant genetic resources in plant breeding. Self-incompatibility, Male sterility and apomixes in crop plants and their commercial exploitation.

Unit II: Selection methods

Genetic basis of breeding – self- and cross-pollinated crops including mating systems and response to selection, Nature of variability, Components of variation, Heritability and genetic advance, Genotype environment interaction, General and specific combining ability, Types of gene actions and implications in plant breeding. Pure line theory, Pure line and mass selection methods, Pedigree, Bulk, Backcross, Single seed descent and Multiline breeding, Population breeding in self – pollinated crops with special reference to diallel selective mating, Transgressive breeding.

Unit III: Recurrent selection

Breeding methods in cross pollinated crops, Population breeding : Mass selection and Ear-to-row methods, S_1 and S_2 progeny testing, Progeny selection schemes, Recurrent selection schemes for intra and inter – population improvement and development of synthetics and composites. Hybrid breeding: genetical and physiological basis of heterosis and inbreeding, Production of inbreeds, Breeding approaches for improvement of inbreeds, predicting hybrid performance, seed production of hybrid and their parent varieties/inbreds. Breeding methods in asexually/clonally propagated crops, Clonal selection.

Unit IV: Mutation breeding

Special breeding techniques: Mutation breeding, Breeding for abiotic and biotic stresses, Concept of plant ideotype and its role in crop improvement, Concept of MAS, Concept of polyploidy and wide hybridization, doubled haploidy.

Unit V: Maintenance breeding

Cultivar development: testing, release and notification, Maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Practicals

- 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; Prediction of performance of double cross hybrid.

Lesson plan

Theory lecture schedule

1. Early plant breeding, Objectives and role of plant breeding – historical perspective.
2. Activities in Plant Breeding
3. Centres of origin, Agrobiodiversity and its significance.
4. Pre-breeding and plant introduction.
5. Plant genetic resources – importance – roles in plant breeding.
6. Self incompatibility,
7. Male sterility, Apomixis in crop plants.
8. Genetic basis of plant breeding- self and cross pollinated crops.
9. **First test**
10. Mating systems and response to selection, Nature of variability-Components of variation – Heritability and genetic advance.
11. Genotype environment interaction, General and Specific combining ability.
12. Types of gene actions and implications in plant breeding.
13. Pure line theory, Pure line and mass selection methods, Pedigree method.
14. Bulk method, Single seed descent method.
15. Backcross method and Multiline breeding.
16. Population breeding in self pollinated crops – diallel selective mating, Transgressive breeding.
17. **Mid semester examination.**
18. Breeding methods in cross pollinated crops- Population breeding : Mass selection and Ear-to-row methods, S_1 and S_2 progeny testing.
19. Progeny selection schemes for intra and inter – population improvement,
20. Synthetics and Composites.
21. Hybrid breeding: genetical and physiological basis.
22. Production of inbreds, Breeding approaches for improvement of inbreds, predicting hybrid performance.
23. Seed production of hybrid and their parent varieties/ inbreds.
24. Breeding methods in asexually propagated crops - Clonal selection.
25. Special breeding techniques: Mutation breeding.
26. Breeding for abiotic and biotic stresses.
27. Concept of plant ideotype and its role in crop improvement.

28. Concept of MAS.
29. Concept of Polyploidy.
30. Concept of wide hybridization, doubled haploidy.
31. Cultivar development: testing, release and notification.
32. Maintenance breeding.
33. Participatory plant breeding, Plant breeder's rights.
34. Regulations for plant variety protection and Farmer's rights.

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.**

Course outcome:

CO 1: Students be well versed in practical emasculation and pollination methods of important crops.

CO 2: To understand the various components to structure a plant breeding programme.

CO 3: Know the requirements in breeding for biotic and abiotic stress tolerant varieties.

CO 4: Learn the impact of IPRs including PBR, PVP and PPVFRA.

CO 5: Students acquired independent ability to carry out statistical analysis of data and interpretation of results in breeding programs.

CO – PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1		**2**			
CO 2		**2**			
CO 3		**2**			
CO 4					
CO 5			**1**		

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GPB 503 - FUNDAMENTALS OF QUANTITATIVE GENETICS - (2+1)

Learning objective

- To differentiate the quantitative characters from qualitative characters.
- To provide the students with holistic knowledge about on Yield and yield contributing characters and genes involved.
- To impart theoretical knowledge and computation skills regarding component of variation and variances, scales, mating designs and gene effects.
- Basic understanding on the application aspects of quantitative characters in crop improvement.
- To provide statistical platform for robust selection of superior progenies.

Theory

Unit I: Continuous variation

Introduction and historical background of quantitative genetics, Multiple factor hypothesis, Qualitative and quantitative characters, Analysis of continuous variation mean, range, SD, CV ; Components of variation - Phenotypic, Genotypic, Nature of gene action - additive, dominance and epistatic, linkage effect. Principles of analysis of variance and linear model, Expected variance components, Random

and fixed effect model, Comparison of means and variances for significance.

Unit II: Analysis of variance

Designs for plant breeding experiments –principles and applications; Variability parameters, concept of selection, simultaneous selection modes and selection of parents, MANOVA.

Unit III: Plant breeding experiments

Association analysis – Genotypic and phenotypic correlation, Path analysis discriminate function and principal component analysis, Genetic divergence analysis – Metro glyph and D2, Generation mean analysis, Parent progeny regression analysis.

Unit IV: Gene action

Mating designs - classification, Diallel, partial diallel, L×T, NCDs, and TTC; Concept of combining ability and gene action, G × E interaction - Adaptability and stability; Methods and models for stability analysis; Basic models - principles and interpretation, Bi-plot analysis.

Unit V: G X E and QTL

QTL mapping, Strategies for QTL mapping – Desired population and statistical methods, QTL mapping in genetic analysis; Markers, Marker assisted selection and factors influencing the MAS, Simultaneous selection based on marker and phenotype.

Practicals

Analysis and interpretation of variability parameters; Analysis and interpretation of Index score and Metroglyph; Clustering and interpretation of D2 analysis; Genotypic and phenotypic correlation analysis and interpretation; Path coefficient analysis and interpretation, Estimation of different types of heterosis, inbreeding depression and interpretation; A,B and C Scaling test; L×T analysis and interpretation, QTL analysis; Use of computer packages; Diallel analysis; G×E interaction and stability analysis.

Lesson plan

Theory lecture 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. **First test**
10. Expected variance of components - random and fixed models, MANOVA - biplot analysis
11. Comparison of means and variances for significance.
12. Designs of plant breeding experiments - principles and applications
13. Genetic diversity analysis – metro glyph, 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,
19. selection differential and types of selection
20. Selection responses for additive and non-additive traits,
21. Heritability and genetic advance.
22. Heterosis and inbreeding depression
23. Mating designs – Diallel, partial diallel,
24. Line x tester analysis
25. NCDs and Triple Test Cross (TTC)
26. Generation mean analysis
27. Scaling techniques
28. Models for GxE analysis
29. Stability parameters
30. AMMI analysis – principles and interpretation
31. QTL mapping; Strategies for QTL mapping- 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- Path analysis
5. Parent progeny regression analysis
6. Diallel analysis - Griffing's methods I and II
7. Diallel analysis - Hayman's graphical approach
8. NCD and their interpretations
9. Line x tester analysis, Estimation of heterosis and inbreeding depression
10. Scaling test
11. Generation mean analysis Introducing, deriving data for various generations
12. G x E analysis : Stability parameters
13. Construction of saturated linkage maps and QTL mapping – strategies for QTL
14. Mapping ; statistical methods in QTL mapping
15. Phenotype and Marker linkage studies
16. Use of software's in statistical analysis
17. **Final practical examination**

Course outcome:

CO 1: Analyze and evaluate literature involving quantitative genetic experiments.
CO 2: Design and analyze quantitative genetic experiments.
CO 3: Statistically analyze the phenotypic data of plant traits collected taking into account G x E interaction.
CO 4: Manage breeding populations to maximize progress from selection for accomplishment of breeding objectives.
CO 5: Able to do statistical analysis

CO-PO Mapping matrix

	PO 1	PO2	PO3	PO4	PO5
CO 1	2				
CO2		2	3		
CO3			3		
CO4		3			
CO5					1

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GBP 504 - Varietal Development and Maintenance Breeding - (1+1)

Learning objective

- To study the techniques and procedures of varietal development.
- To provide knowledge on DUS testing.
- To know about various protocols of breeding techniques.
- To get idea about procedures of release variety and maintenance of variety.
- Study about production of nucleus and breeder seed of variety/hybrids.

Theory

Unit I: Variety development systems

Variety Development systems and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety,

farmers' variety, landraces, hybrid, and population; Variety testing, release and notification systems and norms in India and abroad.

Unit II: Dus testing

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding. Factors responsible for genetic deterioration of varieties - safeguards during seed production.

Unit III: Seed maintenance

Maintenance of varieties in self- and cross-pollinated crops, isolation distance; Principles of seed production; Methods of nucleus and breeder seed production; Generation system of seed multiplication -nucleus, breeders, foundation, certified.

Unit IV: Quality seed production

Quality seed production technology of self and cross-pollinated crop varieties, viz., cereals and millets (wheat, barley, paddy, pearl millet, sorghum, maize and ragi, etc.); Pulses (green gram, black gram, cowpea, pigeon pea, chickpea, field pea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton/ jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).

Unit V: Seed certification

Seed certification procedures; Seed laws and acts, plant variety protection regulations in India and international systems.

Practicals

Identification of suitable areas/ locations for seed production; Ear-to-row method and nucleus seed production; Main characteristics of released and notified varieties, hybrids and parental lines; PGMS and TGMS; Identification of important weeds/ objectionable weeds; Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops; Hybrid seed production technology of important crops; DUS testing and descriptors in major crops; Variety release proposal formats in different crops.

Lesson plan

Theory lecture schedule

1. Development of varieties, Maintenance of purity of varieties.
2. Variety, cultivar, extant variety, essentially derived variety.
3. Independently derived variety, reference variety, farmer's variety.
4. Land races and population, Hybrids.Varietal testing.
5. **First test**
6. Varietal release and notification system in India.
7. Varietal release and notification system in abroad.
8. Dus testing, Dus descriptors for major crops.
9. **Mid Semester**
10. Genetic purity, Maintenance breeding, Genetic deterioration of varieties.
11. Seed production safe guards, Maintenance of varieties in self-pollinated crops.
12. Maintenance of varieties in crops in cross pollinated crops, Principles of seed production.
13. Generation system of seed multiplication, Quality seed production in cereals.
14. Quality seed production in pulses, oil seeds.
15. Quality seed production in fibres, forages.
16. Seed certification procedures, Seed laws and acts.

17. Plant variety protection regulations in India and international systems

Practical schedule

1. Identification of suitable areas/ locations for seed production;
2. Ear-to-row method and nucleus seed production;
3. Main characteristics of released and notified varieties and parental lines;
4. Main characteristics of released and notified hybrids and parental lines
5. Cytoplasmic male sterility and hybrid production in asexually propagated plants
6. Genic male sterility and hybrid production in sexually propagated plants
7. Environmentally sensitive male sterility (PGMS and TGMS) and hybrid production
8. CGMS and hybrid production in mandate crops
9. Chemical hybridization, Seed production techniques in forage crops
10. Identification of important weeds/ objectionable weeds;
11. Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops;
12. Hybrid seed production technology of important crops;
13. DUS testing and descriptors in major crops;
14. Variety release proposal formats in different crops.
15. Harnessing the pollination mechanism in self pollinated crops
16. Harnessing the pollination mechanism in cross pollinated crops
17. **Final practical examination**

Course outcome

CO 1: Learning the techniques and procedures of varietal development.
CO 2: Understanding DUS testing.
CO 3: Students get an idea about various protocols of breeding techniques.
CO 4: Learning the procedures of release variety and maintenance of variety
CO 5: Gain knowledge about production of nucleus and breeder seed of variety/hybrids

CO-PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	-	2	-	1	1
CO 2	-	-	2	-	1
CO 3	3	3	2	1	3
CO 4	2	1	-	1	1
CO 5	1	-	-	-	1

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GPB 505 - PRINCIPLES OF CYTOGENETICS - (2+1)

Learning objective

- To acquaint the students with cell cycle and architecture of chromosome in prokaryotes and eukaryotes
- To acquaint the students with special types of chromosomes, techniques for karyotyping.
- To impart knowledge of variations in chromosomes numbers and their structures.
- To acquaint the students for the production and use of haploids.
- To acquaint the students for the production and use of apomictic populations and their role in genetics and breeding.

Theory

UNIT I: Introduction to cell biology

Cell cycle and 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. Variation in chromosome structure: Evolutionary significance; Introduction to techniques for karyotyping; Chromosome banding and painting –*In situ* hybridization and various applications**.**

UNIT II: Stuctural and numerical variations in chromosomes

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 lethal and chromosome complexes; Inter-varietal chromosome substitutions.

UNIT III: Polyploids and its significance

Fertilization barriers in crop plants at pre-and postfertilization levels; *In-vitro* techniques to overcome the fertilization barriers in crops; Polyploidy. Genetic consequences of polyploidization and role of polyploids in crop breeding; Evolutionary advantages of autopolyploid *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, evolutionary and genetic problems in crops with apomixes.

UNIT IV: Genome mapping in polyploids

Reversion of autopolyploid to diploids; Genome mapping in polyploids; Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, *Triticale, Brassica*, and cotton); 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 hybridisation

Chromosome manipulations in wide hybridization; case studies; Production and use of haploids, dihaploids and doubled haploids in genetics and breeding. Plant Sciences–Genetics and Plant Breeding

Practicals

Learning the cytogenetical laboratory techniques, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning, etc.; Microscopy: various types of microscopes; Preparing specimen for observation; Fixative preparation and fixing specimen for light microscopy studies in cereals; Studies on mitosis and meiosis in crop plants; Using micrometres and studying the pollen grain size in various crops. Pollen germination *in vivo* and *in-vitro*; Demonstration of polyploidy.

Lesson plan

Theory lecture schedule

1. Cell cycle and architecture of chromosome in prokaryotes and eukaryotes, Chromonemata, chromosome matrix, chromomeres, centromere, Secondary constriction and telomere
2. Artificial chromosome construction and its uses
3. Special types of chromosomes. Variation in chromosome structure: Evolutionary significance
4. Introduction to techniques for karyotyping;
5. Chromosome banding and painting -*Insitu* hybridization and various applications.
6. Structural and numerical variations of chromosomes and their implications
7. Symbols and terminologies for chromosome numbers, euploidy, haploids, diploids and polyploids
8. Utilization of aneuploids in gene location
9. **First test**
10. Variation in chromosome behaviour, somatic segregation and chimeras, Endomitosis and somatic reduction
11. Evolutionary significance of chromosomal aberrations, balanced lethal and chromosome complexes (Lecture 1)
12. Evolutionary significance of chromosomal aberrations, balanced lethal and chromosome complexes (Lecture 2)
13. Inter-varietal chromosome substitutions
14. Fertilization barriers in crop plants at pre-and postfertilization levels
15. *In-vitro* techniques to overcome the fertilization barriers in crops
16. Polyploidy, Genetic consequences of polyploidization and role of polyploids in crop breeding
17. **Mid semester**
18. Evolutionary advantages of autopolyploid *vs* allopolyploids
19. Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer (Lecture 1)

20. Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer (Lecture 2)
21. Alien addition and substitution lines, creation and utilization
22. Apomixis, evolutionary and genetic problems in crops with apomixes
23. Reversion of autopolyploid to diploids
24. Genome mapping in polyploids
25. Interspecific hybridization and allopolyploids
26. Synthesis of new crops wheat and *Triticale Brassica* and cotton
27. Hybrids between species with same chromosome number
28. Alien translocations
29. Hybrids between species with different chromosome number
30. Gene transfer using amphidiploids, bridge species.
31. Chromosome manipulations in wide hybridization
32. Chromosome manipulations in wide hybridization; case studies
33. Production and use of haploids
34. Dihaploids and doubled haploids in genetics and breeding

Practical schedule

1. Introduction to cytogenetical laboratory
2. Chemicals used fixation
3. Dehydation techniques and Embedding techniques
4. Stains and staining methods
5. Microscopy principles and Study of microscopes
6. Prepation of specimens
7. Fixative prepation and fixing
8. Fixing of rice
9. Fixing of sorghum
10. Fixing of pearl millet
11. Study of cell division in rice
12. Study of cell division in sorghum
13. Study of cell division in cumbu
14. Study of cell division in tomato
15. Study of pollen in crops
16. Pollen germination and Polyploidy
17. **Final practical examination**

Course outcome

CO 1: The course provides full knowledge to the student on the various procedures linked with cell development.

CO 2: The course provides full knowledge to the student on and chromosome structure and function.

CO 3: This course enables students how to tailor and utilize the variation in chromosome number

CO 4: The course provides full knowledge to the student on structures in the development

CO 5: The course provides full knowledge to the student on synthesis of new species and varieties.

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5

CO1	**1**	-	-	-	-
CO2	-	**2**	**3**	-	-
CO3	-	-	-	-	**2**
CO4	-	-	**2**	-	-
CO5	-	3	**-**	-	-

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GPB 506 - MOLECULAR BREEDING AND BIOINFORMATICS - (2+1)

Learning objective

- To provide deep knowledge to the students on genotyping and kinds of molecular markers including biochemical markers, mapping populations and allele mining.
- To provide holistic knowledge to the students on marker-assisted selection and gene pyramiding to evolve superior varieties.
- To impart theoretical knowledge and computation skills regarding transgenic plants.
- To impart knowledge and practical skills to use innovative approaches and Bioinformatics in Plant Breeding.
- Basic understanding on the bio-safety issues of GMOs and intellectual property rights in the molecular plant breeding.

Theory

UNIT I: Molecular markers

Genotyping; Biochemical and Molecular markers; Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs, etc.), Functional markers; Mapping populations (F_2s, backcrosses, RILs, NILs and DH); Molecular mapping and tagging of agronomically important traits; Statistical tools in marker analysis.

UNIT II: Marker-assisted selection

Allele mining; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants; Marker-assisted back cross breeding for rapid introgression; Genomics- assisted breeding; Generation of EDVs; Gene pyramiding.

UNIT III: Genome sequencing

Introduction to Comparative Genomics; Large scale genome sequencing strategies; Human genome project; Arabidopsis genome project; Rice genome project; Comparative genomics tools; Introduction to proteomics; 2D gel electrophoresis; chromatography and sequencing by Edman degradation and mass spectrometry; Endo-peptidases; Nanotechnology and its applications in crop improvement.

UNIT IV: Transgenic plants

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

UNIT V: Issues of GMOs and bioinformatics

Biotechnology applications in male sterility/ hybrid breeding, molecular farming; Application of Tissue culture in molecular breeding; GMOs and related issues (risk and regulations); GMO; International regulations, bio-safety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights; Introduction to bioinformatics: bioinformatics tools, biological data bases, implications in crop improvement.

Practicals

Requirements for plant tissue culture laboratory; Techniques in plant tissue culture; Media components and media preparation; Aseptic manipulation of various eXplants, observations on the contaminants occurring in media, interpretations; Inoculation of eXplants, callus induction and plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a green house and hardening procedures; Visit to commercial micro propagation unit; Transformation using Agro bacterium strains; GUS assay in transformed cells/tissues; DNA isolation, DNA purity and quantification tests; Gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship; Construction of genetic linkage maps using computer software; NCBI Genomic Resources, GBFF, Swiss Prot, Blastn/Blastp, Gene Prediction Tool, EXpasy Resources, PUBMED and PMC, OMIM and OMIA, ORF finder; Comparative Genomic Resources: Map Viewer (UCSC Browser and Ensembl); Primer designing-Primer3/Primer BLAST.

Lesson plan

Theory lecture schedule

1. Phenotyping, Genotyping and introduction to Markers
2. Morphological, biochemical and DNA-based markers
3. RFLP, RAPD, AFLP, SSR, SNPs, ESTs, etc
4. Functional markers
5. Mapping populations (F_2s, back crosses, RILs, NILs and DH)
6. Molecular mapping and tagging of agronomically important traits
7. Statistical tools in marker analysis

8. Allele mining
9. **First test**
10. Marker-assisted selection for qualitative and quantitative traits
11. QTLs analysis in crop plants
12. Marker-assisted back cross breeding for rapid introgression
13. Genomics- assisted breeding and Generation of EDVs
14. Gene pyramiding
15. Introduction to Comparative Genomics
16. Introduction to Comparative Genomics and Large scale genome sequencing strategies
17. **Mid- semester examination**
18. Human, Arabidopsis and Rice genome project
19. Comparative genomics tools
20. Introduction to proteomics and 2D gel electrophoresis
21. Chromatography and sequencing by Edman degradation and mass spectrometry
22. Endo- peptidases
23. Nanotechnology and its applications in crop improvement
24. Recombinant DNA technology and Transgenes
25. Method of transformation, selectable markers and clean transformation techniques
26. Vector-mediated gene transfer and physical methods of gene transfer
27. Production of transgenic plants in various fieldcrops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane, etc. and commercial releases
28. Biotechnology applications in male sterility/ hybrid breeding and molecular farming
29. Application of Tissue culture in molecular breeding
30. GMO related issues, International regulations, bio-safety issues of GMOs
31. Regulatory procedures in major countries including India, ethical, legal and social issues and Intellectual property rights
32. Introduction to bio-informatics
33. Bioinformatics tools, biological data bases and implications in crop improvement.
34. Orientation for final Examination

Practical schedule

1. Requirements for plant tissue culture laboratory;
2. Techniques in plant tissue culture;
3. Media components and media preparation;
4. Aseptic manipulation of various eXplants, observations on the contaminants occurring in media, interpretations;
5. Inoculation of eXplants, callus induction and plant regeneration; Standardizing the protocols for regeneration;
6. Hardening of regenerated plants; Establishing a green house and hardening procedures;
7. Visit to commercial micro propagation unit;
8. Transformation using Agro bacterium strains;
9. GUS assay in transformed cells/tissues;
10. DNA isolation, DNA purity and quantification tests;

11. PCR analysis and PCR-based DNA markers
12. Gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship;
13. Construction of genetic linkage maps using computer software;
14. NCBI Genomic Resources, GBFF, Swiss Prot, Blastn/Blastp, Gene Prediction Tool, EXpasy Resources, PUBMED and PMC, OMIM and OMIA, ORF finder;
15. Comparative Genomic Resources: Map Viewer (UCSC Browser and Ensembl);
16. Primer designing- Primer3/Primer BLAST.
17. **Final Practical Examination**

Course outcome:

CO 1: Handling of segregating population with early selection by MAS
CO 2: Assessment of gentic purity of hybrids and varieties
CO 3: Early release of crop varieties
CO 4: Knowledge on Transgeneics and Issues on GMO's
CO5: To design and execute gene manipulation research underlying social and environmental ventures.

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1					
CO2		1			
CO3		2			
CO4				2	
CO5					

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GPB 507 - BREEDING FOR QUALITY AND SPECIAL TRAITS - (2+1)

Learning objective

- This course helps the student to know the acquaints breeding for grain quality parameters in field crops.
- To get an idea about the quality breeding techniques for cereals, pulses, oilseed and fibre crops.
- To provide insight into recent advances in improvement of quality traits in cereals, millets, legumes, oilseeds, forage and industrial crops.
- To know about the genetic engineering protocols for quality improvement.
- To study about the Biofortification in crops and Nutritional genomics and Second generation transgenics.

Theory

Unit I: Nutritional and anti – nutritional properties

Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, amino acids and anti-nutritional factors; Nutritional improvement - A human perspective.

Unit II: Quality parameters in rice and wheat

Breeding for grain quality parameters in rice and its analysis; Golden rice and aromatic rice: Breeding strategies, achievements and application in Indian context; Molecular basis of quality traits and their manipulation in rice; Post harvest manipulation for quality improvement; Breeding for baking qualities in wheat, characters to be considered and breeding strategies, molecular and cytogeneticmanipulation for quality improvement in wheat.

Unit III: Breeding for quality in millets

Breeding for quality improvement in Sorghum, pearl millet, barley and oats; Quality protein maize, specialty corns, concept and breeding strategies; Breeding for quality improvement in important forage crops for stay green traits; Genetic resource management for sustaining nutritive quality in crops.

Unit IV: Quality breeding in pulses and oil seeds

Breeding for quality improvement in pulses – Chickpea, pigeonpea, green gram and black gram cooking quality; Breeding for quality in oilseeds - groundnut, mustard, soybean, sesame, sunflower and minor oilseeds; Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops; Genetic manipulation for quality improvement in cotton. Breeding for quality improvement in Sugarcane, potato.

Unit V: Application of genetic engineering

Genetic engineering protocols for quality improvement: Achievements made; Bio fortification in crops; Classification and importance, Nutritional genomics and Second generation transgenics.

Practicals

- Grain quality evaluation in rice; Correlating ageing and quality improvement in rice; Quality analysis in millets; Estimation of anti-nutritional factors like tannins in different varieties/ hybrids: A comparison; Quality parameters evaluation in wheat, pulses and oilseeds; Evaluation of quality parameters in cotton, sugarcane and potato; Value addition in crop plants; Post-harvest processing of major field crops; Quality improvement in crops through tissue culture techniques; Evaluating the available populations like RIL, NIL, etc. for quality improvement using MAS procedures; Successful example of application of MAS for quality trait in rice, mustard, maize,etc.

Lesson plan

Theory lecture schedule

1. biochemistry and genetics of carbohydrates
2. Developmental biochemistry and genetics of proteins
3. Developmental biochemistry and genetics of fats and vitamins
4. Developmental biochemistry and genetics of aminoacids and anti-nutritional factors - Nutritional improvement - A human perspective
5. Breeding for grain quality parameters in rice and its analysis
6. Golden rice and aromatic rice – Breeding strategies, achievements and application in Indian context
7. Molecular basis of quality traits and their manipulation in rice
8. Post-harvest manipulation for quality improvement
9. **First test**
10. Breeding for baking qualities in wheat;
11. Characters to be considered and breeding strategies - Molecular and cytogenetic manipulation for quality improvement in wheat.
12. Breeding for quality improvement in Sorghum
13. Breeding for quality improvement in pearl millet
14. Breeding for quality improvement in Quality protein maize
15. Concept and breeding strategies – Breeding for quality improvement in forage crops
16. Genetic resource management for sustaining nutritive quality in crops.
17. **Mid semester examination**
18. Breeding for quality in pulses Blackgram
19. Breeding for quality in pulses Green gram
20. Breeding for quality in pulses Pigeonpea
21. Breeding for quality in pulses Chickpea
22. Breeding for quality in pulses Cowpea
23. Breeding for quality in groundnut
24. Breeding for quality in sesame
25. Breeding for quality in sunflower
26. Breeding for quality in minor oilseeds
27. Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops
28. Breeding for quality improvement in Sugarcane, potato.
29. Genetic manipulation for quality improvement in cotton
30. Genetic engineering protocols for quality improvement– Achievements made
31. Value addition in crops

32. Bio fortification in crops
33. Classification and importance – Nutritional genomics
34. Second generation transgenics

Practical schedule

1. Genetics of rice – cytogenetic and genome relationship
2. Rice Breeding objectives- yield, quality characters,
3. Hybrid rice breeding- potential and outcome - Aerobic rice and its implications
4. Wheat Breeding objectives yield, quality characters
5. Sorghum- cytogenetic and genome relationship
6. Sorghum Breeding objectives- yield, quality characters
7. Pearl millet Breeding objectives- yield, quality characters.
8. Maize Breeding objectives: yield, quality characters
9. QPM and Bt maize – strategies and implications
10. Small millets: breeding objectives yield, quality characters
11. Cotton, Sugarcane breeding objectives- yield, quality characters.
12. Distinguishing features of popular released varieties in Rice and Sorghum , Wheat, Pearl millet, Maize and other millets, forage legumes
13. Application to DUS testing of popular released varieties
14. Quality improvement in crops through tissue culture techniques;
15. Evaluating the available populations like RIL, NIL, etc. for quality improvement using MAS procedures;
16. Successful example of application of MAS for quality trait in rice, mustard, maize,etc.
17. **Orientation for final practical examination**

Course outcome

CO 1: The students be able to know about the biochemistry, nutritional and anti-nutritional properties.

CO 2: To know about the grain quality parameters in rice and wheat.

CO 3: Students be able to know about the Breeding for quality improvement in important forage crops for stay green traits

CO 4: To know about the breeding quality improvement in pulses and oil seeds.

CO 5: Students get an idea about biofortification in genetically engineered crops

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	**-**	**-**	**-**	**3**	**2**
CO2	**2**	**-**	**-**	**1**	**2**
CO3	**3**	**-**	**-**	**-**	**3**
CO4	**2**	**-**	**-**	**3**	**-**
CO5	**1**	**-**	**-**	**-**	**2**

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GPB 508 - MUTAGENESIS AND MUTATION BREEDING - (2+1)

Learning objective

- To impart knowledge on general principles of mutagenesis.
- To help the students to learn about mutagens and various methods of inducing mutations.
- To expose the students to learn about efficiency and effectiveness of the mutagens.
- To impart knowledge on genomics, allele mining, TILLING etc.
- To impart knowledge on various tests / methods for detection of mutations.

Theory

Unit I: History, genetic basis of mutation and molecular basis of mutation

Mutation and its history, nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations; Detection of mutations. Para mutations in crop plants.

Unit II: Type of mutagens for crop improvement- physical mutagens

Mutagenic agents: physical – radiation types and sources: Ionizing and non-ionizing radiations. Radiobiology: mechanism of action of various radiations (photoelectric absorption, Compton scattering and pair production) and their biological effects – RBE and LET relationships; Effect of mutations on DNA – repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects; Dosimetry - Objects and methods of treatment; Factors influencing mutation: dose rate, acute vs chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects; Radiation sensitivity and modifying factors: External and internal sources – Oxygen, water content, temperature and nuclear volume.

Unit III: Type of mutagens for crop improvement- chemical mutagens

Chemical mutagens: Classification – base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action; Dose determination and factors influencing chemical mutagenesis; Treatment methods using physical and chemical mutagens, Combination treatments; other causes of mutation – direct and indirect action, comparative evaluation of physical and chemical mutagens.

Unit IV: Study of mutagenic effects

Observing mutagen effects in M_1 generation: plant injury, lethality, sterility, chimeras, etc.; Observing mutagen effects in M_2 generation; Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations; Mutations in traits with continuous variation; Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage, etc.; Individual plant based mutation analysis and working out effectiveness and efficiency in M_3 generation; Comparative evaluation of physical and chemical mutagens for creation of variability in the some species- Case studies.

Unit V: Use of mutagens in mutation breeding

Use of mutagens in creating oligogenic and polygenic variations – Case studies; *In-vitro* mutagenesis – Callus and pollen irradiation; Handling of segregating M_2 generations and selection procedures; Validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement, etc.) in different crops; Procedures for micro mutations breeding/ polygenic mutations; Achievements of mutation breeding- varieties released across the world, problems associated with mutation breeding. Use of mutagens in genomics, allele mining, TILLING.

Practicals

Characterization of male sterile lines using morphological descriptors; Restorer line identification and diversification of male sterile sources; Male sterile line creation in crop plants, problems in creation of CGMS system, ways of overcoming them; Diversification and restoration; Success stories of hybrid breeding in Maize, Rice, Pearl millet, Sorghum and Pigeon pea; Understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and aseXually propagated crops; Estimation from the various models for heterosis parameters; Hybrid seed production in field crops-an account on the released hybrids, their potential, problems and ways of overcoming it; Hybrid breeding at National and International level, opportunities ahead.

Lesson plan

Theory lecture schedule

1. Mutation and its history, nature and classification of mutations
2. Detection of mutations
3. Para mutations in crop plants
4. Mutagenic agents: physical - radiation types and sources
5. Radiobiology: mechanism of action of various radiations
6. Their biological effects - RBE and LET relationships
7. Effect of mutations on DNA - repair mechanisms operating at DNA
8. Chromosome cell and organism level to counteract the mutation effects
9. **First test**
10. Dosimetry - Objects and methods of treatment
11. Factors influencing mutation: dose rate, acute vs chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects
12. Radiation sensitivity and modifying factors
13. External and internal sources - Oxygen, water content, temperature and nuclear volume
14. Chemical mutagens: Classification - base analogues, antibiotics, alkylating agents, Acridine dyes and other mutagens
15. Dose determination and factors influencing chemical mutagenesis

16. Treatment methods using physical and chemical mutagens
17. **Mid semester examination**
18. Combination treatments; other causes of mutation - direct and indirect action
19. Comparative evaluation of physical and chemical mutagens.
20. Observing mutagen effects in M_1 generation: plant injury - lethality, sterility, chimeras, etc.
21. Observing mutagen effects in M_2 generation
22. Estimation of mutagenic efficiency and effectiveness
23. Spectrum of chlorophyll and viable mutations
24. Mutations in traits with continuous variation
25. Factors influencing the mutant spectrum
26. Individual plant-based mutation analysis and working out effectiveness and efficiency in M_3 generation
27. Comparative evaluation of physical and chemical mutagens for creation of variability in some species
28. Use of mutagens in creating oligogenic and polygenic variations
29. *In-vitro* mutagenesis - Callus and pollen irradiation
30. Handling of segregating M_2 generations and selection procedures; Validation of mutants
31. Mutation breeding for various traits in different crops
32. Procedures for micro mutations breeding/polygenic mutations; Achievements of mutation breeding - varieties released across the world
33. Problems associated with mutation breeding
34. Use of mutagens in genomics, allele mining, TILLING.

Practical schedule

1. Precautions on handling of mutagens
2. Dosimetry - Studies of different mutagenic agents: Physical mutagens and Chemical mutagens
3. Learning on Radioactivity - Production source and isotopes at BRIT, Trombay
4. Learning about gamma chamber
5. Radiation hazards: Monitoring - safety regulations and safe transportation of radioisotopes
6. Visit to radio isotope laboratory; learning on safe disposal of radioisotopes
7. Hazards due to chemical mutagens
8. Treating the plant propagules at different doses of physical and chemical mutagens;
9. Procedures in combined mutagenic treatments
10. Raising the crop for observation; Mutagenic effectiveness and efficiency, calculating the same from earlier literature
11. Study of M1 generation - Parameters
12. Study of M2 generation - Parameters
13. Mutation breeding in cereals and pulses-achievements made and an analysis
14. Mutation breeding in oilseeds and cotton- achievements and opportunities
15. Mutation breeding in forage crops and vegetatively propagated crops
16. Procedure for detection of mutations for polygenic traits in M2 and M3 generations
17. **Final practical examination**

Course outcome

CO 1: To obtain knowledge on genetic and molecular basis of mutation.

CO 2: To acquire knowledge about mutagens induced in agriculture.
CO 3: To learn about mutation breeding in different field crops.
CO 4: To acquire knowledge about factors influencing mutation treatment in crops.
CO 5: To know about hazards of mutagens.

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	**1**				**3**
CO2		**1**			
CO3		**1**			**2**
CO4		**1**			
CO5				**1**	

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GPB 509 - Hybrid Breeding - (2+1)

Learning objective

- To provide basic concepts of hybrid varieties and its genetic consequence.

- To provide knowledge about mechanisms of heterosis and its exploitation for yield improvement.
- To give an overview of various kinds of male sterility and their utilization in hybrid seed production
- To explain the various system of hybrid seed production.
- To import knowledge about various techniques for development of hybrids in important field crops.

Theory

Unit I. Genetic consequences of heterosis

Historical aspect of heterosis, nomenclature and definitions of heterosis; Heterosis in natural population and inbred population; Evolutionary aspects – Genetic consequences of selfing, sibbing and crossing in self-and cross-pollinated and asexually propagated crops; Pre-Mendelian and Post-Mendelian ideas – Evolutionary concepts of heterosis; Genetic theories of heterosis – Physiological, Biochemical and molecular factors underlining heterosis; theories and their estimation; Biometrical basis of heterosis.

Unit II. Heterosis breeding

Prediction of heterosis from various crosses, inbreeding depression, coefficient of inbreeding and its estimation, residual heterosis in F2 and segregating populations, importance of inbreeding in exploitation of heterosis – case studies.; Relationship between genetic distance and expression of heterosis – case studies; Divergence and genetic distance analyses, morphological and molecular genetic distance in predicting heterosis; Development of heterotic pools in germplasm/ genetic stocks and inbreeds, their improvement for increasing heterosis.

Unit III. Male sterile systems

Male sterility and use in heterosis breeding; Male sterile line creation and diversification in self-pollinated, cross pollinated and asexually propagated crops; Creation of male sterility through genetic engineering and its exploitation in heterosis; Maintenance, transfer and restoration of different types of male sterility; Use of self-incompatibility in development of hybrids.

Unit IV. System of hybrid seed production

Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreeds and parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis, maintenance breeding of parental lines in hybrids; Fixation of heterosis in self, cross and often cross pollinated crops, asexually/ clonally propagated crops, problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid; Organellar heterosis and complementation.

Unit V. Hybrid breeding in various crops

Hybrid breeding in wheat, rice, cotton, maize, pearl millet, sorghum and rapeseed-mustard, sunflower, safflower and castor oilseed crops and pigeon pea.

Practicals

Description of male sterile lines – 3-line and 2-line breeding, Diversification and restoration of male sterile sources, Learning techniques in hybrid seed production using male sterility in various crops – Rice, Maize, Pearlmillet, Sorghum, Pigeonpea, Roll of apomixis in crop improvement, Estimation of heterosis, Strategies of hybrid breeding.

Lesson plan

Theory lecture schedule

1. Historical aspect and nomenclature of heterosis
2. Expression of heterosis in natural and inbred populations
3. Genetic consequences of selfing, sibbing and crossing in sexually and asexually propagated crops
4. Evolutionary concepts of heterosis by Pre and Post Mendelian ideas
5. Physiological, Biochemical and Molecular theories of heterosis
6. Biometrical basis of heterosis
7. Prediction of heterosis, inbreeding depression and coefficient of inbreeding depression
8. Residual heterosis in F_2 and segregating populations
9. **First test**
10. Importance of inbreeding in exploitation of heterosis
11. Relationship between genetic distance and expression of heterosis
12. Predicting heterosis by morphological and molecular genetic distance
13. Development of heterotic pools in germplasm/genetic stocks and inbreeds
14. Male sterility - CMS, GMS, CGMS
15. Male sterility - TGMS, PGMS, Gametocides
16. Creation and diversification of male sterile line in self-pollinated crops
17. **Mid-semester examination**
18. Creation and diversification of male sterile line in cross - pollinated crops
19. Creation and diversification of male sterile line in asexually propagated crops
20. Creation of male sterility through genetic engineering (Transgenic male sterility) and its exploitation in heterosis
21. Maintenance, transfer and restoration of different types of male sterility
22. Classification and application of self-incompatibility in developing hybrids
23. Development of inbreeds and parental lines for hybrid seed production
24. Hybrid seed production system by 3-line breeding method
25. Hybrid seed production system 2-line and 1-line breeding methods
26. Commercial exploitation of heterosis and maintenance breeding
27. Problems and prospects for fixation of heterosis in self, cross and often cross- pollinated crops
28. Problems and prospects for fixation of heterosis in asexually/clonally propagated crops
29. Apomixis in fixing heterosis-concept of single line hybrid
30. Organellar heterosis and complementation
31. Hybrid breeding in wheat and rice
32. Hybrid breeding in cotton and maize
33. Hybrid breeding in pearl millet, sorghum and pigeon pea
34. Hybrid breeding in rapeseed-mustard, sunflower, safflower and castor

Practical schedule

1. Characterization of male sterile lines using morphological descriptors
2. Restorer line identification
3. Diversification and restoration of male sterile sources
4. Problems in creation of male sterile line in CGMS system (3-line breeding) and overcoming them
5. Problems in creation of male sterile line in TGMS system (2-line breeding) and overcoming them

6. Hybrid breeding techniques in Rice
7. Hybrid breeding techniques in Maize
8. Hybrid breeding techniques in Pearl millet
9. Hybrid breeding techniques in Sorghum
10. Hybrid breeding techniques in Pigeonpea
11. Understanding the difficulties in breeding apomicts
12. Estimation of heterotic parameters in self, cross and asexually propagated crops
13. Estimation from the various models for heterosis parameters
14. Hybrid seed production—an account on the released hybrids
15. The potential and problems associated with hybrid seed production and ways of overcoming it
16. Hybrid breeding at National and International level and opportunities ahead
17. **Final practical examination**

Course outcome

CO 1: Gain knowledge about the importance of heterosis
CO 2: Cultivate skills on conventional approaches for developing hybrids
CO 3: Gain expertise about biotechnological approaches for developing hybrids
CO 4: Learn to use of male sterility in hybrid seed production of important field crops
CO 5: Independently able to produce hybrid seeds in various crops

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1		2	1		2
CO2		3			
CO3				2	
CO4		2			
CO5		3	2		

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GPB 510 – SEED PRODUCTION AND CERTIFICATION - (1+1)

Learning objective

- To enable the students to learn about Seed and its multiplication
- Classes of seed and principles of seed production in crop plants
- Floral biology and seed production techniques in cereals, millets and pulses
- Floral biology and seed production techniques in oilseeds, fibre crops and hybrid seed production in vegetative propagated crops
- Seed Certification, phases of seed certifications and its standards

Theory

Unit I: Introduction

Importance of seed as basic input in agriculture, seed quality concept and importance; Generation system of seed multiplication – Varietal replacement rate, seed multiplication ratios, seed replacement rate, seed renewal period and seed demand and supply; various factors influencing seed production – physical and genetic purity in seed production; factors responsible for varietal and genetic deterioration.

Unit II: Seed production techniques

Nucleus seed production and its maintenance – maintenance of parental lines of hybrids, production of breeder, foundation and certified seed and their quality maintenance; principles of seed production in self- and cross-pollinated crops – hybrid seed production – system and techniques involved in seed village concept; organic seed production and certification

Unit III: Seed production of field crops

Principles of seed production in field crops; floral structure; pollination mechanism and seed production techniques in self- and cross-pollinated cereals, millets, major pulses and oilseed crops; varietal and hybrid seed production techniques in pigeon pea, mustard, castor and sunflower.

Unit IV: Seed production of fibers and vegetatively propagated crops

Floral structure, pollination mechanism and methods and techniques of seed production in major commercial fibres - Hybrid – seed production techniques in major vegetatively propagated crops.

Unit V: Seed certification

Seed certification – history, concept, objectives; central seed certification board, seed certification agency/organization and staff requirement; legal status- phases of seed certification, formulation, revision and publication of seed certification standards;

minimum seed certification standards (MSCS) for different crops- General and specific crop standards, 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.

Practicals

Planting design for variety – hybrid seed production techniques, planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony - Identification of rogues and pollen shedders, supplementary pollination, detasseling, hand emasculation and pollination - Pollen collection and storage methods, pollen viability and stigma receptivity - Pre-harvest sanitation, maturity symptoms, harvesting techniques - Visit to seed production plots – visit to seed industries; Planning for seed production: cost benefit ratio, seed multiplication ratio and seed replacement rate - 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, harvesting/threshing, processing and after processing for seed law enforcement - Specifications for tags and labels to be used for certification purpose

Lesson plan

Theory lecture schedule

1. Importance of seed as basic input in agriculture, seed quality concept and importance.
2. Generation system of seed multiplication – Varietal replacement rate, seed multiplication ratios, seed replacement rate, seed renewal period and seed demand and supply; various factors influencing seed production.
3. Physical and genetic purity in seed production; factors responsible for varietal and genetic deterioration.
4. Nucleus seed production and its maintenance – maintenance of parental lines of hybrids
5. **First test**
6. Production of breeder, foundation and certified seed and their quality maintenance.
7. Principles of seed production in self and cross pollinated crops – hybrid seed production – system and techniques involved in seed village concept; organic seed production and certification.
8. Principles of seed production in field crops; floral structure; pollination mechanism and seed production techniques in self and cross pollinated cereals, millets
9. **Mid-semester examination**
10. Principles of seed production in field crops; floral structure; pollination mechanism and seed production techniques in self and cross pollinated major pulses and oilseed crops
11. varietal and hybrid seed production techniques in pigeon pea and mustard
12. Varietal and hybrid seed production techniques in castor and sunflower
13. Floral structure, pollination mechanism and methods and techniques of seed production in major commercial fibres
14. Hybrid seed production techniques in major vegetatively propagated crops.
15. Seed certification – history, concept, objectives; central seed certification board, seed certification agency/organization and staff requirement; legal status

16. phases of seed certification, formulation, revision and publication of seed certification standards;
17. Minimum seed certification standards (MSCS) for different crops-General and specific crop standards, 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.

Practical schedule

1. Planting design for variety
2. Hybrid seed production techniques
3. Identification of rogues and pollen shedders
4. supplementary pollination
5. Detasseling, hand emasculation and pollination
6. Pollen collection and storage methods
7. Pollen viability and stigma receptivity
8. Pre-harvest sanitation, maturity symptoms, harvesting techniques
9. Visit to seed production plots
10. Visit to seed industries
11. Planning for seed production: cost benefit ratio, seed multiplication ratio and seed replacement rate
12. General procedure of seed certification
13. Identification of weed and other crop seeds as per specific crops
14. Field inspection at different stages of a crop
15. Harvesting, threshing and processing
16. Specifications for tags and labels
17. **Final practical examination**

Course outcome:

CO 1: Understand seed multiplication techniques

CO 2: Gain knowledge on classes of seeds and their quality maintenance

CO 3: Gain knowledge on floral biology, pollination mechanism and seed production techniques of field crops

CO 4: Gain expertise on hybrid seed production techniques in major crops

CO 5: Expose on seed certification procedures and various standards

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1		2	1		2
CO2		3			
CO3				2	
CO4		2			
CO5		3	2		

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GPB 511 - CROP BREEDING I (*KHARIF* CROPS) - (2+1)

Learning objective

- Origin, evolution, mode of reproduction, chromosome number of each crop to known
- Cytogenetics and genome relationship
- Specific breeding objectives for developing new cultivars/lines/hybrids
- Specific breeding procedure for breeding objective
- MAS for improvement in varieties

Theory

Unit I: Crop breeding of cereals and millets

Rice: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, eXamples of MAS used for improvement, Aerobic rice, its implications and drought resistance breeding.

Maize: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, eXamples of MAS used for improvement- QPM and Bt maize – strategies and implications.

Small millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - breeding objectives yield, qualitycharacters, biotic and abiotic stress resistance, etc.

Unit II Crop breeding of pulses

Pigeon pea: evolution, mode of reproduction, chromosome number; Genetics –

cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at National and International institutes.

Groundnut: Origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement.

Other pulses: Urdbean, mungbean, cowpea: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

Unit III Crop breeding of oilseed crops

Soybean: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. **Castor and Sesame**: Origin, evolution mode of reproduction, chromosome number; Genetics –cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement; Hybrid breeding in castor – opportunities, constraints and achievements.

Unit IV Crop breeding of commercial crops - i

Cotton: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Development and maintenance of male sterile lines – Hybrid development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton.

Jute: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement.

Unit V Crop breeding of sugarcane, forage and seed crops.

Sugarcane: Evolution and distribution of species and forms, wild relatives and germplasm; Cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, etc.

Forage crops: Evolution and distribution of species and forms – Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality

characters and palatability studies; Biotic and abiotic stress resistance, etc. **Seed spices**: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and biotic stress resistance, heterosis breeding and MAS.

Practicals

Floral biology, emasculation, pollination techniques in rice, maize, pigeon pea, soybean, sesame, cotton; Study of range of variation for yield and yield components; Study of segregating populations in cereal, pulses and oilseed crops; Learning on the crosses between different species; attempting crosses between black gram and green gram; Evaluating the germplasm of cotton for yield, quality and resistance parameters, learning the procedures on development of Bt cotton; Visit to Cotton Technology Laboratory and Spinning Mills; Learning on the Standard Evaluation System (SES) and descriptors; Use of software for database management and retrieval; Practical learning on the cultivation of fodder crop species on sewage water, analysing them for yield components and palatability; Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes; Visit to animal feed producing factories; Learning the practice of value addition; Visiting the animal husbandry unit and learning the animal eXperiments related with palatability and digestibility of fodder

Lesson plan

Theory lecture schedule

1. Rice
2. Rice
3. Maize
4. Finger millet
5. Little millet
6. Kodo millet
7. Foxtail miilet
8. Barnyard millet
9. **First Test**
10. Proso millet
11. Pigeon pea
12. Pigeon pea
13. Groundnut
14. Groundnut
15. Urdbean
16. Mungbean
17. **Mid semester examination**
18. Cowpea
19. Soyabean
20. Soyabean
21. Castor
22. Castor
23. Sesame
24. Sesame

25. Cotton
26. Cotton
27. Jute
28. Sugarcane
29. Sugarcane
30. Forage crops
31. Forage crops
32. Forage crops
33. Seed species
34. Seed species

Practical schedule

1. Floral biology, emasculation, pollination techniques in rice and maize.
2. Floral biology, emasculation, pollination techniques in pigeon pea, and soybean.
3. Floral biology, emasculation, pollination techniques in sesame and cotton;
4. Study of range of variation for yield and yield components;
5. Study of segregating populations in cereal.
6. Study of segregating populations in pulses.
7. Study of segregating populations in oilseed crops.
8. Learning on the crosses between different species; attempting crosses between black gram and green gram;
9. Evaluating the germplasm of cotton for yield, quality and resistance parameters,
10. learning the procedures on development of Bt cotton;
11. Learning on the Standard Evaluation System (SES) and descriptors;
12. Use of software for database management and retrieval;
13. Practical learning on the cultivation of fodder crop species on sewage water, analysing them for yield components and palatability;
14. Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes;
15. Visit to animal feed producing factories;
16. Learning the practice of value addition; Visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.
17. **Final practical examination.**

Course outcome

CO 1: Acquire knowledge on floral biology and selection of proper breeding method.
CO 2: To understand the various components to structure a plant breeding programme.
CO 3: Know the requirements in breeding for biotic and abiotic stress tolerant varieties.
CO 4: Gain expertise on hybrid seed production techniques.
CO 5: Learn to use the descriptors in various crops for selection of superior genotypes.

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	**1**	**2**			**3**
CO2		**2**			
CO3		**1**			**2**
CO4		**2**			

CO5		**2**			

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GPB 512 – CROP BREEDING – II (Rabi Crops) - (2+1)

Learning objective

- To impart knowledge about the origin, evolution and modes of reproduction for different Rabi Crops.
- To impart knowledge about the floral biology, crossing techniques, objectives of breeding and wild species as donors for resistant traits
- To impart knowledge about the Genetics and Genomic relationship of Yield and Quality characters for different Rabi Crops.
- To impart knowledge about the Biotic and Abiotic stress resistance breeding for different Rabi Crops.
- To provide insight into recent advances in improvement of cereals, pulses, fibres and oil seeds using conventional and modern biotechnological approaches.

Theory

UNIT I: Crop improvement for cereals

Wheat: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression

ofaliengene(s) heterosis breeding, released varieties, examples of MAS used for improvement.

Oats: Origin, evolution, mode of reproduction, chromosome number; Genetics cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of aliengene(s), released varieties, examples of MAS used for improvement.

Barley: Origin, evolution, center of origin, mode of reproduction, chromosome number; Genetics cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of aliengene(s), released varieties, eXamples of MAS used for improvement.

UNIT II: Crop improvement for pulses

Chickpea: Origin, evolution mode of reproduction, chromosome number; Genetics Cyto-genetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of aliengene(s), released varieties, eXamples of MAS used for improvement.

Other pulses: Lentil, field pea, Rajma, Horse gram : Origin, evolution, mode of reproduction, chromosome number; Genetics. cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of aliengene(s) (ifrequired), heterosis breeding, released varieties, eXamples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

UNIT III: Crop improvement for oil seeds

Rapeseed and Mustard: Origin, evolution, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship; Breeding objectives; yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of aliengene(s), heterosis breeding, released varieties, eXamples of MAS used for improvement, Oilquality, Improvement for oil quality.

Sunflower, Safflower: Origin, mode of reproduction, chromosome number; Genetics, cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of aliengene(s), heterosis breeding, released varieties, eXamples of MAS used for improvement.

UNIT IV: Crop improvement for fibres and forages

Mesta and minorfibre crops: Origin, mode of reproduction, chromosome number;
Genetics–cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of aliengene(s) (ifrequired), biotic and abiotic stress resistance, released varieties, eXamples of MAS used for improvement.

Forage crops: Origin, evolution mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of aliengene(s) (if required), biotic and abiotic stress resistance.

UNIT V: Crop improvement for seed spices

Seed spices: Origin, evolution, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of aliengene(s) (if required), biotic and abiotic stress resistance, scope of heterosis breeding,

released varieties, eXamples of MAS used for crop improvement.

Practicals

- Floral biology, emasculation and pollination techniques in wheat, oats, barley, chickpea, rajma, rapeseed mustard, sunflower; Study of range of variation for yield and yield components; Study of segregating populations in cereal, pulses and oilseed crops; Use of descriptors for cataloguing; Learning on the crosses between different speci es; Trait based screening for stress resistance; Learning on the Standard Evaluation System (SES) and descriptors; Use of software for data base management and retrieval.

Lesson plan

Theory lecture schedule

1. Introduction
2. Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship for wheat
3. Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, breeding approaches, introgression of aliengene (s) for wheat
4. Heterosis breeding, released varieties, examples of MAS used for improvement for wheat
5. Origin, evolution, mode of reproduction, chromosome number; Genetics– cytogenetics and genome relationship, Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, for Oats
6. Breeding approaches, introgression of aliengene(s), released varieties, examples of MAS used for improvement for Oats
7. Origin, evolution, center of origin, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance for Barley
8. Breeding approaches, introgression of aliengene(s), released varieties, examples of MAS used for improvement for Barley
9. **First test**
10. Origin, evolution mode of reproduction, chromosome number, Genetics cytogenetics and genome relationship, Breeding objectives: yield, quality characters, biotic and abiotic stress resistance for chickpea
11. Breeding approaches, introgression of aliengene(s), released varieties, examples of MAS used for improvement for chickpea
12. Origin, evolution, mode of reproduction, chromosome number; Genetics. cytogenetics and genome relationship for Lentil, Field pea, Rajma and Horse gram
13. Breeding objectives: yield, quality characters, biotic and abiotic stress resistance for Lentil, Field pea, Rajma and Horse gram
14. Breeding approaches, introgression of aliengene(s), heterosis breeding, released varieties, examples of MAS used for improvement.
15. Interspecific crosses and its implications, reasons for failure, ways of overcoming them Lentil, Field pea, Rajma and Horse gram
16. Origin, evolution, mode of reproduction, chromosome number; Genetics– cytogenetics and genome relationship for Rapeseed and Mustard
17. **Mid semester examination**
18. Breeding objectives; yield, quality characters, biotic and abiotic stress resistance,

19. Breeding approaches, introgression of aliengene(s) for Rapeseed and Mustard
20. Heterosis breeding, released varieties, examples of MAS used for improvement, Oilquality, Improvement for oil quality for Rapeseed and Mustard
21. Origin, mode of reproduction, chromosome number; Genetics, cytogenetics and genome relationship for Sunflower and Safflower
22. Breeding objectives: yield, quality characters, biotic and abiotic stress resistance.
23. Breeding approaches, introgression of alien gene(s) for Sunflower and Safflower
24. Heterosis breeding, released varieties, examples of MAS used for improvement for Sunflower and Safflower
25. Origin, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship for Mesta and minor fibre crops
26. Breeding objectives: yield, quality characters, biotic and abiotic stress resistance for Mesta and minor fibre crops
27. Breeding approaches, introgression of alien gene(s), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement for Mesta and minor fibre crops
28. Origin, evolution mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship for Forage crops
29. Breeding objectives: yield, quality characters, biotic and abiotic stress resistance for Forage crops
30. Breeding approaches, introgression of alien gene(s) Forage crops
31. Biotic and abiotic stress resistance for Forage crops
32. Origin, evolution, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship for Seed Spices
33. Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, for Seed Spices
34. scope of heterosis breeding, released varieties, eXamples of MAS used for crop improvement for Seed Spices

Practical schedule

1. Emasculation and crossing techniques in Wheat
2. Emasculation and crossing techniques in Oat
3. Emasculation and crossing techniques inBarley
4. Emasculation and crossing techniques in Chickpea
5. Emasculation and crossing techniques in Rajma
6. Emasculation and crossing techniques inRapeseed
7. Emasculation and crossing techniques inMustard
8. Emasculation and crossing techniques in Sunflower
9. Emasculation and crossing techniques in Mesta and Minor Fibres
10. Range of variation for yield and yield components
11. Study of Segregating populations in Cereals,
12. Study of Segregating populations in Pulses and Oilseeds
13. Study of descriptors for cataloguing and standard Evaluation System (SES) for Cereals,
14. Study of descriptors for cataloguing and standard Evaluation System (SES) for Pulses and Oilseeds
15. Study of trait based screening for stress resistance

16. Study of software for database management
17. **Final practical examination**

Course outcomes

CO1: Acquire knowledge on floral biology and selection of proper breeding method for major Rabi Field Crops

CO2: Cultivate skill in emasculation and pollination methods for major Rabi Field Crops

CO3: Gain expertise on hybrid seed production techniques for major Rabi Field Crops

CO4: Learn to use the descriptors in various crops for selection of superior genotypes for major Rabi Field Crops.

CO 5: To get an overview about the breeding aspects about Rabi Crops

CO-PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2				
CO 2		2	3		
CO 3			3		
CO 4		3			
CO 5			3		

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GPB 513 - BREEDING VEGETABLE CROPS - (2+1)

Learning Objective

- This course enables the students to learn about breeding objectives and methodologies in vegetable crops
- To learn about the importance of vegetable crops
- To understand the genetics involved for the improvement of major vegetable crops
- To impart knowledge on hybrid seed production and screening techniques in vegetable crops
- To know about the identification of useful traits in vegetable crops through molecular and special breeding techniques

Theory

Place of origin – wild species – related species - breeding objectives - breeding methods - varieties and hybrids – quantity – quality – stress – conventional – innovative - heterosis breeding – important varieties and hybrids in the following crops

Unit I - Breeding for Leafy vegetables

Breeding for Leafy vegetables: Amaranth, chenopods and lettuce.

Unit II - Breeding for Cucurbits

Breeding for Cucurbits: Gourds, melons, pumpkins and squashes.

Unit III - Breeding for Solanaceae

Breeding for Solanaceae: Potato and tomato, eggplant, hot pepper, sweet pepper

Unit IV - Breeding for Cole crops and root vegetables

Breeding for Cole crops: Cabbage, cauliflower, broccoli and knolkhol. Breeding for Root vegetables: Carrot, beetroot, radish, sweet potato and tapioca.

Unit V - Breeding for other vegetable crops

Breeding for other vegetable crops: Peas, beans, onion, garlic and okra.

Practicals

Selection of desirable plants from breeding population - observations and analysis of various qualitative and quantitative traits in germplasm - Hybridization and handling segregating generations - Induction of flowering - palanological studies - selfing and crossing techniques in vegetable crops - Hybrid seed production of vegetable crops in bulk - Screening techniques for insect-pests - disease and environmental stress resistance in vegetable crops - Demonstration of sib-mating and mixed population - Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques - Visit to breeding blocks - MAS for incorporating traits governed by major and polygenes.

Lesson plan

Theory lecture schedule

1. Breeding for Leafy vegetables - Amaranth
2. Breeding for Leafy vegetables - Chenopods
3. Breeding for Leafy vegetables - Lettuce
4. Breeding for Cucurbits - Gourds
5. Breeding for Cucurbits - Melons
6. Breeding for Cucurbits - Pumpkins

7. Breeding for Cucurbits - Squashes
8. Breeding for Solanaceae – Potato
9. **First Test**
10. Breeding for Solanaceae - Tomato
11. Breeding for Solanaceae - Eggplant
12. Breeding for Solanaceae - Hot pepper
13. Breeding for Solanaceae - Sweet pepper
14. Breeding for Cole crops - Cabbage
15. Breeding for Cole crops - Cauliflower
16. Breeding for Cole crops – Broccoli
17. **Mid-semester examination**
18. Breeding for Cole crops - knolkhol
19. Breeding for Root vegetables - Carrot
20. Breeding for Root vegetables - Beetroot
21. Breeding for Root vegetables – Radish
22. Breeding for Root vegetables - Sweet potato
23. Breeding for Root vegetables - Tapioca.
24. Breeding for other vegetable crops - Peas
25. Breeding for other vegetable crops - Beans
26. Breeding for other vegetable crops - Onion
27. Breeding for other vegetable crops - Garlic
28. Breeding for other vegetable crops - Okra.

29-31. Biotic stress breeding in vegetables.

32-34. Abiotic stress breeding in vegetables.

Practical schedule

1. Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm
2. Hybridization and handling segregating generations
3. Induction of flowering, palynological studies in vegetable crops
4. Selfing and crossing techniques in vegetable crops
5. Field visit
6. Hybrid seed production of vegetable crops in bulk
7. Screening techniques for insect-pests and disease stress resistance in vegetable crops
8. Screening techniques for environmental stress resistance in vegetable crops
9. Demonstration of sib-mating and mixed population
10. Molecular marker techniques to identify useful traits in the vegetable crops
11. Special breeding techniques
12. Visit to breeding blocks, MAS for incorporating traits governed by major and polygenes
13. Breeding techniques in Leafy vegetable – Amaranth
14. Breeding techniques in Cucurbit – Gourds
15. Breeding techniques in Solanaceae – Eggplant
16. Breeding techniques for other vegetable crops - Okra
17. **Final practical examination**

Course outcome

CO 1: After completion of this course the students be able to know about the different breeding methods of major vegetable crops

CO 2: Learn about the biotic and abiotic stress resistance in vegetable crops
CO 3: The students be able to learn about principles and practices involved in crop improvement
CO 4: This course be useful for the students to understand about hybridization
CO 5: Success completion of the course helps in useful traits identification

CO- PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	**1**	**3**	**-**	**2**	**-**
CO2	**-**	**2**	**-**	**-**	**-**
CO3	**1**	**2**	**-**	**1**	**-**
CO4	**2**	**3**	**-**	**1**	**-**
CO5	**-**	**-**	**-**	**-**	**-**

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GPB - 514 BREEDING FRUIT CROPS - (2+1)

Learning objective

- To learn about the importance and origin of fruit crops
- To learn about the problems in fruit crop breeding
- To overcome the problems occurs in apomixes
- To understand the breeding strategies and avenues in fruit crops
- To impart knowledge on crop improvement in rosaceous and region specific fruit crops.

Theory

Unit I – History, importance and origin

Fruit crop breeding: History, importance of fruit breeding, centers of diversity, distribution, domestication and adaptation of commercially important fruits.

Unit II – Issues in fruit crop breeding

Issues in fruit crop breeding – heterozygosity, polyploidy, polyembryony, parthenocarpy and seedlessness, Mutation – types – mutagens – breeding procedure – applications - incompatibility and sterility systems.

Unit III - Apomixis

Apomixis - merits and demerits, types, variability for economic traits, role of genetic engineering and biotechnology in improvement of fruit crops.

Unit IV – Crop improvement in fruit crops

Crop improvement in Mango, Banana, Citrus, Grapes, Papaya, Sapota, Pomegranate, Pineapple and Guava

Unit V – Crop improvement in rosaceous fruits and region specific fruits

Apple and other Rosaceous crops and region specific fruit crops.

Practicals

Germplasm documentation - Floral biology of mango, guava, citrus, grape, pomegranate, pollen viability in major fruit crops - Pollen germination to study time of anthesis and stigma receptivity - Hybridization technique in important fruit crops, hybrid seed collection and raising - Colchicine treatment for induction of polyploidy - EXposure to resistance breeding and screening techniques - Mutation breeding practices raising and evaluation of segregating populations - Use of mutagens to induce mutations and polyploidy - Visit to Biotechnology Lab and study of *in-vitro* breeding techniques.

Lesson plan

Theory lecture schedule

1. Fruit crop breeding: History of fruit crop breeding
2. Importance of fruit breeding
3. Centers of diversity and distribution of important fruit crops
4. Domestication and adaptation of commercially important fruits
5. Issues in fruit crop breeding
6. Heterozygosity
7. polyploidy
8. Polyembryony
9. **First test**
10. Parthenocarpy and seedlessness
11. Mutation – types – mutagens – breeding procedure – applications
12. Incompatibility and sterility systems
13. Apomixis – Definition and Mechanism
14. Types of apomixis
15. Apomixis - merits and demerits
16. Variability for economic traits in fruit crops
17. **Mid-semester examination**
18. Role of genetic engineering
19. Biotechnology in improvement of fruit crops
20. Crop improvement in Mango

21. Banana
22. Citrus
23. Grapes
24. Papaya
25. Sapota
26. Pomegranate
27. Pineapple
28. Guava
29. Crop improvement in Apple
30. Other Rosaceous crops
31. Other Rosaceous crops
32. Other Rosaceous crops
33. Region specific fruit crops
34. Region specific fruit crops

Practical schedule

1. Germplasm documentation
2. Floral biology of mango
3. Floral biology of guava and citrus
4. Floral biology of grape
5. Floral biology of pomegranate
6. Pollen viability in major fruit crops
7. Pollen germination to study time of anthesis and stigma receptivity
8. Hybridization technique in important fruit crops
9. Hybrid seed collection and raising
10. Colchicine treatment for induction of polyploidy
11. Exposure to resistance breeding
12. Screening techniques for biotic and abiotic resistance
13. Mutation breeding practices raising and evaluation of segregating populations
14. Use of mutagens to induce mutations and polyploidy
15. Study of *in-vitro* breeding techniques
16. Visit to Biotechnology Lab
17. **Final practical examination**

Course outcome

CO 1: This course will be helpful for the students to know about the history and origin of fruit crops

CO 2: Successful completion of this course by the students will be useful to acquire technical skill on breeding of fruit crops

CO 3: It will help the students to overcome the difficulties in fruit crop breeding

CO 4: This course will be useful for the students to overcome through biotechnological methods

CO 5: Learn about the breeding programmes and avenues in fruit crops

CO- PO Mapping matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	3	1	-	-
CO2	-	3	1	-	-

CO3	-	3	1	1	-
CO4	2	1	-	3	-
CO5	-	2	-	-	-

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GPB 515 - BREEDING ORNAMENTAL CROPS - (2+1)

Learning objective

- To study the basics of ornamental plant breeding
- To know about different techniques for improvement of ornamental crops
- To study about the development of better cultivars and production of F1 hybrids in ornamental and flower crops
- To know about the genetics of different flower crops
- To know about the harvesting, storage of seeds and process of seed certification

Theory

UNIT I: Basics of ornamental plant breeding

History of improvement of ornamental plants; Centre of origin of ornamental crop; Objectives and techniques in ornamental plant breeding.

UNIT II: Improvement of ornamental and flower crops

Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops, viz., Rose, Jasmine, *Chrysanthemum*, Tuberose, *Gerbera*, *Gladiolus*, *Dahlia*, *Lilium*, *Gaillardia.*

UNIT III: Improvement of ornamental and flower crops

Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops, viz., *Petunia*, *Bougainvillea*, Pansy, Marigold, *Geranium*, *Antirrhinum*, China aster, Orchids, *Carnation*, *Hibiscus.*

UNIT IV: Breeding and development

Development of promising cultivars of important ornamental and flower crops; Role of Heterosis and its eXploitation, production of F_1 hybrids and utilization of male sterility.

UNIT V: Seed storage and certification

Production of open pollinated seeds, harvesting, processing and storage of seeds; Seed certification.

Practicals

Study of floral biology and pollination in important species and cultivars of ornamental crops; Techniques of inducing polyploidy and mutation; Production of pure and hybrid seed; Methods of breeding suited to seed propagated plants; Polyploidy and mutations to evolve new varieties; Breeding methods for biotic and abiotic stresses; Visit to research institutes involved in ornamental crop breeding.

Lesson plan

Theory lecture schedule

1. History of improvement of ornamental plants
2. Centers of origin of different ornamental crops
3. Objectives and techniques in ornamental plant breeding.
4. Introduction, Selection techniques for development of ornamental crops
5. Hybridization techniques for development of ornamental crops
6. Mutation: Definition and different types of mutations
7. Different biotechnological techniques for improvement of ornamental and flower crops
8. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Rose
9. **First test**
10. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Jasmine
11. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Chrysanthemum
12. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Tuberose
13. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Gerbera
14. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Gladiolus
15. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Dahlia and Lilium,
16. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Gaillardia.

17. **Mid semester examination**
18. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Marigold
19. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Petunia
20. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Bougainvillea
21. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Pansy
22. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: China aster
23. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Geranium
24. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Orchids
25. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Antirrhinum
26. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Carnation
27. Introduction, selection, hybridization, mutation and biotechnological techniques for improvement of ornamental and flower crops: Hibiscus.
28. Development of promising cultivars of important ornamental and flower crops: Role of Heterosis and its eXploitation and production of F1 hybrids
29. Male sterility and its types
30. Utilization of male sterility in F1 hybrids production
31. Production and harvesting of open pollinated seeds
32. Seed treatment and processing techniques
33. Seed storage methods with examples
34. Seed certification procedure

Practical schedule

1. Study of floral biology and pollination in important species and cultivars of ornamental crops: Rose, Jasmine, Chrysanthemum
2. Study of floral biology and pollination in important species and cultivars of ornamental crops: Tuberose, Gerbera, Gladiolus
3. Study of floral biology and pollination in important species and cultivars of ornamental crops: Dahlia, Gaillardia
4. Study of floral biology and pollination in important species and cultivars of ornamental crops: Marigold, Pansy
5. Study of floral biology and pollination in important species and cultivars of ornamental crops: Bougainvillea, China aster
6. Study of floral biology and pollination in important species and cultivars of ornamental crops: Orchids, Antirrhinum
7. Study of floral biology and pollination in important species and cultivars of ornamental crops: Carnation, Hibiscus
8. Study of floral biology and pollination in important species and cultivars of ornamental crops: Lilium, Petunia
9. Techniques of inducing polyploidy and mutation;

10. Production of pure seed in ornamental crops
11. Production of hybrid seed in flower crops
12. Methods of breeding suited to seed propagated plants
13. Polyploidy and mutations to evolve new varieties
14. Breeding methods for biotic stresses
15. Breeding methods for abiotic stresses
16. Visit to research institutes involved in ornamental crop breeding.
17. **Final practical examination**

Course outcomes:

CO 1: The students know about the production and botany of ornamental and flower crops

CO 2: Students be able to do the breeding of ornamental crops by conventional breeding

CO 3: Students be able to know different biotechnological methods for improvementof flower crops

CO 4: Students understand about the genetics of major ornamental crops

CO 5: Students educated about the commercial production of flowers by various industries and its market

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	-	-
CO2	2	2	-	-	-
CO3	3	-	-	3	-
CO4	2	-	-	-	3
CO5	-	-	-	-	-

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GPB 516 - BREEDING FOR STRESS RESISTANCE AND CLIMATE CHANGE (2+1)

Learning objective

- To study the basic concept and impact of climate change
- To apprise about various abiotic and biotic stresses influencing crop yield
- To study about the mechanisms and genetics of resistance.
- To formulate methods to breed stress tolerant varieties.
- To utilize wild relatives and use biotechnology tools in evolving stress tolerance.

Theory

UNIT I: Concept and classification of biotic stress

Concept and impact of climatic change; Importance of plant breeding with special reference to biotic and abiotic stress resistance; Classification of biotic stresses – major pests and diseases of economically important crops.

UNIT II: Insect and pathogen resistance and host defence mechanism

Concepts of resistance to insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and eXceptions; Concept of signal transduction and other host-defence mechanisms against viruses and bacteria

UNIT III: Genetic mechanism in biotic stress and classification of abiotic stress

Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants; Quantitative resistance/ adult plant resistance and slow rusting resistance; Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies; Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications.

Classification of abiotic stresses - Stress inducing factors, moisture stress/ droughtand water logging and submergence; Acidity, salinity/ alkalinity/ sodicity; High/ low temperature, wind, etc.; Stress due to soil factors and mineral toXicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

UNIT IV: Genetics of abiotic stress and breeding methods

Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging and submergence, high and low/ freezing temperatures; Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton, etc.; Breeding for resistance to stresses caused by toXicity, deficiency and pollutants/ contaminants in soil, water and environment.

UNIT V: Utilizing wild relatives and Application of Biotechnology

Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops; Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitinases and Bt for diseases and insect pest management.

Practicals

Understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them for diseases caused by fungi and bacteria; Symptoms and data recording; use of MAS procedures; Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level; Phenotypic screening techniques for nematodes and borers; Ways of combating them; Evaluating the available populations like RIL, NIL, etc. for pest resistance; Use of standard MAS procedures. Breeding strategies - Weeds – ecological, environmental impacts on the crops; Breeding for herbicide resistance; Screening crops for drought and flood resistance; factors to be considered and breeding strategies; Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies; Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation.

Lesson plan

Theory lecture schedule

1. Concept and impact of climatic change
2. Importance of plant breeding with special reference to biotic and abiotic stress resistance
3. Classification of biotic stresses
4. Major pests and diseases of economically important crops
5. Concepts of resistance to insect and pathogen resistance.
6. Analysis and inheritance of resistance variation
7. Host defence responses to pathogen invasions
8. Biochemical and molecular mechanisms
9. **First Test**
10. Host-pathogen interaction, gene-for-gene hypothesis,
11. Molecular evidence for Host- Pathogen , operation and exceptions
12. Concept of signal transduction and other host-defence mechanisms against viruses and bacteria.
13. Types and genetic mechanisms of resistance to biotic stresses
14. Horizontal and vertical resistance in crop plants
15. Quantitative resistance/ adult plant resistance and slow rusting resistance
16. Classical and molecular breeding methods - Measuring plant resistance using plant fitness
17. **Mid Semester Examinations**
18. Behavioural, physiological and insect gain studies
19. Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data
20. Gene pyramiding methods and their implications.
21. Classification of abiotic stresses
22. Stress inducing factors, moisture stress/ drought and water logging and

submergence

23. Stress due to soil factors and mineral toxicity
24. Acidity, salinity/alkalinity/ sodicity/ drought and water logging and submergence.
25. Stress due to soil factors and mineral toxicity
26. Physiological and Phenological responses
27. Genetics of abiotic stress resistance
28. Genes and genomics in breeding cultivars suitable to low water regimes and water logging and submergence, high and low/ freezing temperatures
29. Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton, etc
30. Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/ contaminants in soil, water and environment.
31. Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops
32. Transgenics in management of biotic and abiotic stresses
33. Use of toxins, protease inhibitors, lectins, chitinases.
34. Bt for diseases and insect pest management.

Practical schedule

1. Understanding the climatological parameters and its impacts;
2. Predisposal of biotic and abiotic stress factors -Ways of combating diseases caused by fungi and bacteria;
3. Host defense response and mechanism;
4. Symptoms and data recording; Use of MAS procedures;
5. Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level;
6. Phenotypic screening techniques for nematodes and borers; Ways of combating them; Genetic resistance for vertical and horizontal resistance;
7. Evaluating the available populations like RIL, NIL, etc. for pest resistance;
8. Use of standard MAS procedures for identification of resistant types;
9. Breeding strategies - Weeds – ecological,environmental impacts on the crops;
10. Breeding for herbicide resistance;
11. Screening crops for drought and flood resistance; factors to be considered and breeding strategies;
12. Breeding cultivars for high and chilling/freezing temperatures;
13. Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies;
14. Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation;
15. Source of resistance for various biotic and abiotic stresses;
16. Use of transgenic breeding approach to mitigate the biotic and abiotic stresses;
17. **Final practical examination**

Course outcome:

CO 1. The students will be able to know about all the stress factors that reduce the plant growth and yield.

CO 2. Thorough knowledge on the Bio chemical and molecular mechanisms involved in the stress and defence mechanisms.

CO 3. The genetic level studies will help the students to formulate new methods to overcome the stress.
CO 4. Ability of students to utilize the MAS for identifying crops resistant to various stress.
CO 5. Utilization of Transgenics and wild relatives to transgress novel genes into cultivars.

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	-	3	-	3	2
CO2	2	3	-	1	2
CO3	3	1	-	2	3
CO4	2	2	-	3	-
CO5	1	2	-	-	2

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GPB 517 - GERMPLASM CHARACTERIZATION AND EVALUATION - (1+1)

Learning objective

- To impart knowledge on morphological and quality agronomic traits of accessions.
- Need to study about biotic and abiotic stresses for conserved accessions.
- To insist the importance of the germplasm.
- To gain knowledge on web-based tool for systematic description for efficient use of germplasm.

- To assess the evaluation of nutritional and resistance traits using biochemical and molecular markers.

Theory

UNIT I : Germplasm characterization

Introduction - germplasm characterization; objectives - levels of characterization; Understanding genetic diversity in crop plants; Types of descriptors. Crop descriptors, descriptor states; germplasm characterization

UNIT II : Collection and management of data

Principles and methods for formulating core and mini core collections and their validation, Web based tools for management of data – IUCN - Red data book.

UNIT III : Germplasm evaluation and their uses in pgr

Evaluation procedures; evaluation of germplasm for specific traits; Measuring diversity using agro-morphological data, statistical procedures to measure population genetic variation, markers and their use in PGR.

UNIT IV : Germplasm regeneration and maintenance

Principles and practices of germplasm regeneration and maintenance: breeding systems and mode of reproduction; maintaining sufficiently large populations for effective conservation of farmer landraces, evaluation and maintenance of wild relatives of crop plants. Genetic enhancement, Use of CWRs genetic resources for crop improvement.

UNIT V : Germplasm characterization using markers

High throughput phenotyping systems- imaging and image processing concepts for automated germplasm characterization (phenotyping) – evaluation for nutritional traits, resistance traits -Genetic (NEP), Biochemical and molecular markers (MAGE) for characterization.

Practicals

Field layout and experimental designs - Recording field data on germplasm evaluation in different agri-horticultural crops - post harvest handling - Evaluating quality traits, biochemical and phyto-chemical evaluation of crop germplasm, data processing - Documentation, analysis of diversity and cataloguing, data analysis, variability - equations, sampling strategies, data documentation, cataloguing, biochemical - analyses of samples – genetic – biochemical – molecular markers.

Lesson plan:

Theory lecture schedule

1. Germplasm characterization- introduction- objectives-levels of characterization.
2. Understanding genetic diversity in crop plants – types of descriptors - Germplasm characterization.
3. Core and mini core collections –management of data.
4. IUCN – Red bank data.
5. Evaluation of germplasm – genetic variability of collected accessions – augmented design
6. Genetic diversity – molecular markers – uses in PGR.
7. Statistical data for evaluation of germplasm.
8. Germplasm regeneration - principles and practices.
9. **Mid – semester Examination**
10. Germplasm maintenance – pre breeding systems – mode of reproduction.

11. Evaluation and maintenance of farmer landraces –wild relatives of crop plants.
12. Genetic enhancement
13. Use of CWRs genetic resources for crop improvement.
14. High throughput phenotyping systems – imaging and image processing concepts.
15. Evaluation for nutritional traits – genetic – biochemical – molecular markers.
16. Evaluation for biotic resistance traits – genetic – biochemical – molecular markers.
17. Evaluation for biotic resistance traits – genetic – biochemical – molecular markers.

Practical schedule

1. Field layout and experimental designs
2. Recording field data for germplasm evaluation in agricultural and horticultural crops.
3. Postharvest handling techniques.
4. Germplasm evaluation for quality traits
5. Germplasm evaluation for biotic stress.
6. Germplasm evaluation for abiotic stresses.
7. Documentation of germplasm collection.
8. Genetic diversity analysis in crop plants.
9. Augmented design
10. Phenotyping in germplasm evaluation.
11. Red bank data
12. Data cataloguing
13. Germplasm characterization using genetic markers.
14. Germplasm characterization using biochemical assay.
15. Germplasm characterization using MAGE.
16. Gene bank / Field visit.
17. **Final Practical examination**.

Course outcome

CO 1: To educate students about science of managing genetic resources including principles involved in maintaining genetic integrity.

CO 2: Students acquired knowledge on data collection and documentation for germplasm evaluation using software.

CO 3: Proficiency in assessing genetic diversity, biotic and abiotic stresses in crop plants using statistical software.

CO 4: Students know about germplasm characterization using biochemical and molecular markers.

CO 5: Ability in germplasm characterization using innovative technology (high throughput phenotyping system).

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	1	3	3	1	
CO2	1	3	3	2	
CO3	3	1	3	1	3
CO4	3		3	3	3

CO5	3	3	2		

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GPB 518 - GENETIC ENHANCEMENT FOR PGR UTILIZATION - (1+1)

Learning objectives

- To teach theoretical and practical knowledge on genetic improvement using plant genetic resources.
- To know about CWRs reproductive behavior, acclimatization and adaptation for utilization in prebreeding programmes using advanced tools.
- To impart knowledge on screening of biotic and abiotic resources
- To provide knowledge on selection of genotypes for prebreeding.
- To provide information about cytogenetical approaching studies.

Theory

Unit I Basic concepts of pre-breeding programme

Concepts of gene pools; Introduction, potential of pre-breeding. Role of crop wild relatives, semi exotics, creating and managing variation, basic concepts to set up a successful pre-breeding programme.

UNIT II Crop wild resources

Understanding crop adaptation, handling and maintenance of CWRs, synchronization of flowering, overcoming impediments to flowering through photoperiodic adjustments, role of other barriers to flowering, role of amphidiploids, semi exotics and other unadapted germplasm, identifying desirable traits in natural population.,

UNIT III Screening for biotic and abiotic stress resistance traits

Screening for biotic and abiotic stress resistance traits; Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants; Quantitative resistance/ adult plant resistance and slow rusting resistance; Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging and submergence, high and low/ freezing temperatures; screening of nutritionally important traits, genetic analysis to understand the inheritance of novel traits.

Unit IV Parental selection for pre-breeding

Parental selection for pre-breeding, search for superior genotypes, breeding methods for trait transfer; moving the genes - unadapted to adapted, wide hybridization, Incongruity and its management, modern tools for incongruity management.

UNIT V Cytogenetical approaching studies

Cytogenetical approaches for gene transfer such as alien addition and substitution, segregating populations and their management in wide crosses, purging the undesirable traits, testing and improving the adaptability of wide cross derivatives, cytological studies, florescence microscopy, embryo rescue methods, pollen physiology and storage, pollen storage methods to facilitate wide hybridization, pre- and post- zygotic barriers.

Practical

Characterization of CWRs by visiting the fields-Screening methods for biotic resistance-Screening methods for abiotic resistance-Screening methods for Water logging condition-Screening methods for Submergence tolerance-Screening for nutritional traits-Crossability studies in CWRs of cereals and legumes- Crossability studies in CWRs of oilseeds and vegetables-Wide hybridization-Modern tools for incongruity management-cytogenetical approaches for gene transfer-Assessment of pre and post-zygotic barriers in wide hybridization crosses-Requirements for growing CWRs, inducing flowering by manipulating day length, temperature, chemical spraying, etc-Florescence microscopy and its applications in cytological studies-Embryo rescue methods-Pollen physiology and storage studies-Orientation for practical examination.

Lesson plan

Theory lecture schedule

1. Concepts of gene pools; Introduction, potential of pre-breeding,Role of crop wild relatives, semi exotics, creating and managing variation.
2. Basic concepts to set up a successful pre-breeding programme.
3. Understanding crop adaptation, handling and maintenance of CWRs,.
4. Synchronization of flowering, overcoming impediments to flowering through photoperiodic adjustments, role of other barriers to flowering.
5. **First test**
6. Role of amphidiploids, semi exotics and other unadapted germplasm, identifying desirable traits in natural population.
7. Screening for biotic and abiotic stress resistance traits; Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants;

8. Quantitative resistance/ adult plant resistance and slow rusting resistance; Genetics of abiotic stress resistance;
9. **Mid semester examination**
10. Genes and genomics in breeding cultivars suitable to low water regimes and water logging and submergence, high and low/ freezing temperatures;
11. Screening of nutritionally important traits, genetic analysis to understand the inheritance of novel traits.
12. Parental selection for pre-breeding, search for superior genotypes.
13. Breeding methods for trait transfer; moving the genes - unadapted to adapted, wide hybridization.
14. Incongruity and its management, modern tools for incongruity management.
15. Cytogenetical approaches for gene transfer such as alien addition and substitution, Segregating populations and their management in wide crosses.
16. Purging the undesirable traits, testing and improving the adaptability of wide cross derivatives.
17. Cytological studies, florescence microscopy, embryo rescue methods, pollen physiology and storage, pollen storage methods to facilitate wide hybridization, pre- and post- zygotic barriers.

Practical schedule

1. Characterization of CWRs by visiting the fields;
2. Screening methods forbiotic resistance
3. Screening methods for abiotic resistance;
4. Screening methods for Water logging condition.
5. Screening methods for Submergence tolerance.
6. Screening for nutritional traits;
7. Crossability studies in CWRs of cereals and legumes,
8. Crossability studies in CWRs of oilseeds and vegetables.
9. Wide hybridization.
10. Modern tools for incongruity management.
11. cytogenetical approaches for gene transfer.
12. Assessment of pre and post-zygotic barriers in wide hybridization crosses.
13. Requirements for growing CWRs, inducing flowering by manipulating day length, temperature, chemical spraying, etc.
14. Florescence microscopy and its applications in cytological studies.
15. Embryo rescue methods
16. Pollen physiology and storage studies
17. **Final practical examination.**

Course outcome

CO 1: Students would be conversant with handling and analysis of data for un adapted germplasm.

CO 2: To help to understand the screening methods for special traits-biotic and abiotic resistance, nutritional traits,

CO 3: To acquire knowledge on Characterization of CWR, pre-breeding

CO 4: To proficiency in assessing Cytogenetical approaching studies.

CO 5: Students know about selection of genotypes for pre breeding.

CO-PO Mapping matrix

	PO1	PO2	PO3	PO4	PO5
CO1	1	3	3	-	2
CO2	3	-	3	-	2
CO3	-	2	3	-	2
CO4	3	3	3	-	2
CO5	3	3	2	1	3

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3. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/plant-genetic-resources
4. http://www.genopomii.unina.it/genopom/files/uso%20delle%20risorse%20geneti che%20nel%20mg.pdf
5. https://agritech.tnau.ac.in/crop_improvement/crop_imprv_plantgeni.html

Common Courses

STA 501 Statistical Methods for Applied Sciences (2+1)

Learning objectives

To acquaint the students about the basics of statistics and design of experiments

Theory

Unit – I

Box – Plot, Descriptive Statistics, Exploratory data analysis, Theory of Probability, Random variable and Mathematical Expectations. Concept of Discrete and Continuous Probability Distributions: Binomial, Poisson, Normal Distributions and their applications.

Unit – II

Concept of Sampling distribution; Chi – Square, t and F distributions. Tests of Significance based on Normal, Chi – Square, t and F distributions.

Unit – III

Simple, Multiple and Partial Correlation Coefficient; Rank Correlation, Simple and Multiple Linear Regression, Test of Significance of Correlation of Coefficient and Regression Coefficient and Coefficient of Determination

Unit – IV

Need for Design of Experiments, Characteristics of a good design, Basic Principles of Design of Experiments, Completely Randomized Design, Randomized Block Design and Latin Square Design Layout and their analysis.

Unit – V

Concepts of Factorial experiments 2^n, 3^2 factorial experiments; Concepts of Confounding in factorial experiments – Confounding in 2^3 factorial experiments; partial and total confounding; Split – plot design and Strip – plot design.

Lesson plan

Theory lecture schedule

1. Meaning of Box-Plot
2. Descriptive Statistics – Concepts
3. Exploratory data analysis
4. Theory of Probability
5. Random variable and Mathematical Expectation
6. Discrete probability distributions – binomial and poison distribution
7. Continuous probability distributions – normal distribution and their application
8. Concept of sampling distribution – Standard Error
9. **First test**
10. t distribution , F and Chi square distribution
11. Tests of significance based on t, z, (mean and equality of means only). X^2 test for goodness of fit.
12. Definition of correlation, significance and types
13. Properties of correlation coefficient
14. Definition of regression – measuring and uses of regression analysis properties.
15. Differences between correlation and regression.
16. Regression co – efficient - simple, linear.
17. **Mid- semester examination**
18. Multiple linear regression co - efficient – standard error of estimate
19. Test of significance of observed regression co -efficient and co - efficient of determination.
20. Characteristics of agricultural experiments: concepts – field studies.
21. Characteristics of agricultural experiments -pot-culture – quantitative and qualitative variables.
22. Sources of errors and estimate of errors
23. Design of Experiments– Basic principles
24. Completely Randomized Design

25. Randomized Block Design
26. Latin Square Design
27. Comparison of treatments – least significant difference method
28. Duncan's Multiple Range Test (DMRT)
29. Concept of factorial experiments
30. 2^n, 3^2 Factorial experiments
31. Principle of confounding in factorial experiments
32. Confounding in 2^3 Factorial experiments
33. Split-pot design
34. strip – plot design

Practical schedule

1. Estimation of samples statistic viz., means, SD, SE and CV.
2. Fitting of distributions – binomial and poison
3. Z-test, t-test and paired t-test
4. Comparison of two variances using F-test
5. Bartlett's test for homogeneity of variances
6. Chi-square test for test of goodness of fit and homogeneity of ratio test for independence of attributes
7. Computation of correlation co-efficient and it's significance
8. Fitting of simple linear regression and testing the significance of regression coefficient
9. Multiple linear regressions fitting and testing
10. Determination of optimum plot size using uniformity trial.
11. Analysis of CRD and RBD
12. Analysis of LSD and DMRT
13. 2^2 Factorial Experiment
14. 2^3Factorial Experiment
15. Complete confounding in 2^3 Factorial Experiment
16. Analysis of Split-plot and Strip-plot design
17. Final practical Examination

Reference

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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.

COM 501 - Information Technology in Agriculture - (2+1)

Learning objectives

1. Introduction to Networking and Internet Applications that aims at exposing the students to understand analogy of computer, basic knowledge of MS Office.
2. Give students an in-depth understanding of why computers are essential

components in business, education and society.

3. Provide hands-on use of Microsoft Office applications Word, Excel, Access and PowerPoint. Completion of the assignments will result in MS Office applications knowledge and skills.
4. To get familiar with basics of the Internet Programming and different IT tools in Agriculture.

Theory

Unit I

Introduction to Computers, Anatomy of computer, Operating Systems, definition and types, Applications of MS Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions.

Unit II

Database, concepts and types, uses of DBMS in Agriculture, World Wide Web Statistical Sciences: Computer Application.

(WWW): Concepts and components, Introduction to computer programming languages, concepts and standard input/output operations. e-Agriculture, concepts and applications,

Unit III

Programming fundamentals with C – Constants and Variables – Data Types – Arithmetic expressions – assignment statements - Logical expressions – Control flow – Arrays and Structures.

Unit IV

Hyper Text Markup Language (HTML), DHTML, web based application development. Static websites, dynamic websites. Client Side processing – scripting languages.

Unit V

Use of ICT in Agriculture, Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc.,

Lesson plan

Theory lecture schedule

1. Introduction to Computers, Anatomy of Computers.
2. Memory concepts.
3. Booting sequence of operating system.
4. Operating systems.
5. DOS, Windows, Unix
6. Types of VIRUS.
7. MS Office word, Creating, Editing, Formatting a document and saving a document.
8. MS Excel Data Presentation, Data graph creation.
9. MS Power Point Presentation.
10. MS Access Concepts of Database, Creating Database.
11. Statistical analysis and mathematical expressions.
12. Database Concepts.
13. Database in Agriculture.
14. Internet - World Wide Web (WWW)

15. Programming Languages, Computer programming languages.
16. e-Agriculture concepts and applications.
17. Programming Fundamentals with C.
18. **Mid semester examination**
19. Constant and Variable.
20. Data Types.
21. Operators.
22. Arrays and Structures.
23. HTML-DHTML.
24. Web based applications development.
25. Client side processing.
26. Scripting Languages
27. ICT in Agriculture.
28. IT application.
29. Computer Control devices.
30. Agri input management.
31. Smartphone Apps in Agriculture.
32. Agriculture for farm advises.
33. Agri-input management.
34. Postharvest management.

Practical schedule

1. MSWORD- Creating, Editing and Presenting a Scientific Document
2. MS POWER POINT- creating, editing and presenting a scientific Document
3. MSEXCEL- Creating a spreadsheet, writing expressions, Entering formula expression through the formula tool bar and use of inbuilt statistical, mathematical functions
4. MSEXCEL- Creating graphs, analysis of scientific data- Data analysis t-test, Regression, ANOVA
5. MSACCESS: Creating Database, preparing queries and reports
6. MSACCESS: Demonstration of Agri-information system
7. C program to find addition and subtraction of two numbers
8. C Program to find whether the given input is palindrome or not
9. C program to find the given number is Armstrong or not
10. C program for finding Fibonacci series
11. C Program to find Factorial of a given number
12. C Program for calculating student grade using if-else and switch statement
13. Introduction to World Wide Web (WWW) and its components
14. HTML: Creation of website
15. HTML: Creation of Scientific Calculator
16. Internet: Presentation and management agricultural information through web
17. **Practical Exam**

Course outcomes

At the end of the course students will be able to

CO 1: Describe the usage of computers and why computers in society.
CO2: E-Agriculture concepts and applications
CO 3: Learn categories of programs.
CO 4: Web based application development

CO 5: Information Technology applications and systems.

CO-PO Mapping matrix

	PO 1	PO2	PO3	PO4
CO1	3	3	3	3
CO2	0	1	3	1
CO3	0	3	2	3
CO4	3	0	0	0
CO 5	0	3	2	0

References

1. Satish Jain, M Geetha, Kratika,(2012) Computer Course Windows 7 With Ms Office 2010, Bpb Publications.
2. Anupama Jain and AvneetMehra(2012), Computer Fundamental MS Office: Including Internet & Web Technology 2010.
3. Programming in Ansi C Paperback – 8 May 2012, by E Balagurusamy (Author).
4. Cox V, Wermers L and Reding E.E. 2006. *HTML Illustrated Complete*. 3rd Ed. Course Technology.
5. Meera SN 2008 ICTs in agricultural extension: Tactical to practical.

COMPULSARY COMMON COURSES

PGS 501 - AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES - (1+0)

Learning objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Unit I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

Unit II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

Unit III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Unit IV

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- Computer software in tabulation, presentation - Thesis writing – writing of research articles- projects and report writing – Formulation and preparation of research / scheme proposal – Impact factor and citation index - citation and references- Guidelines for oral / poster presentations – Internet in scientific research.

Unit V

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

Lesson plan

Theory lecture schedule

1. History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment
2. National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR); International Agricultural Research Centres (IARC)
3. Partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.
4. Research ethics: research integrity, research safety in laboratories
5. **First test**
6. Welfare of animals used in research, computer ethics, standards and problems in research ethics.
7. Concept and connotations of rural development, rural development policies and strategies.
8. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations.
9. **Mid semester examination**
10. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.
11. Research prioritization and selection of research problem – Research planning - review of literature – setting of objectives and hypothesis – research design and techniques
12. Data collection -– analysis – formulation of tables – interpretation of results- Computer software in tabulation and presentation
13. Thesis writing – writing of research articles- projects and report writing – Formulation and preparation of research / scheme proposal
14. Impact factor and citation index - citation and references- Guidelines for oral / poster presentations – Internet in scientific research.

15. 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
16. Responsibility of society and self – Public interest in research, relevance to society and motivation - Conflict of interest, moral commitment
17. Social trends on research ethics, adequate codes of conduct to regulate research activity

Reference

1. Bhalla GS and Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
2. Punia MS. *Manual on International Research and Research Ethics.* CCS Haryana Agricultural University, Hisar.
3. Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
4. Singh K. 1998. *Rural Development - Principles, Policies and Management*. Sage Publ.

PGS 502 - TECHNICAL WRITING AND COMMUNICATION SKILLS - (0+1)

Learning objective

To equip the students with skills *Viz.,* writing of dissertations, research papers, etc. and to communicate and articulate in English

Practicals

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. **First test**
6. Accentual pattern: Weak forms in connected speech
7. Participation in group discussion, Facing an interview; presentation of scientific papers.
8. Technical Writing- Various forms of scientific writings- theses, technical papers
9. **Mid -semester examination**
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, Writing of a review article.
17. Final practical examination

References

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 503 - BASIC CONCEPTS IN LABORATORY TECHNIQUES - (0 + 1)

Learning objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practicals

Unit-I-Safety measures and common laboratory equipment's

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; Neutralization of acid and bases ;preparation of buffers of different strengths and ph values.

Unit-III-Use and handling of laboratory equipment's

Use and handling of vacuum pumps, viscometer, thermometer, magnetic stirrer, 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 equipment's. Calibration and cleanliness of volumetric glass wares.

3. Methods of expressing strength of solutions.
4. Preparation of primary standard solutions and buffer solutions.
5. **First test**
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. Handling of instruments-vacuum pumps, thermometers, and magnetic stirrer.
9. **Mid semester examination**
10. Handling of instruments-ovens, sand bath and water bath.
11. Handling and uses of microscopes and laminar flow.
12. Sterilization by physical methods and Sterilization by chemical methods.
13. Preparation of different media for culturing the micro-organisms.
14. Description of flowering plants-seed viability test and pollen fertility test.
15. Aseptic manipulations and media.
16. In vitro culture of different explants.
17. Final practical examination

References

1. Furr, A.K.2000.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, McGraw Hill, USA.
4. Gupta, P.K. 1997.Elements of Biotechnology, Rastogi Publications. Meerut.
5. Singh, B.D. 2005.Biotechnology, Expanding Horizons, Kalyani Publications, New Delhi.

e-resources

1. Analytical chemistry vol.1 (pdf) www.freebookcentre.net.
2. Micheal ZehfusAnalytical chemistry www.freebook centre.net.
3. Introduction to Instrumental Analytical Chemistry Roger Terril www.freebook centre.net.
4. Analytical Chemistry lecture notes sadhu malyadri centre.net.
5. Manfred Sietz and Andreas Sonnenberg. Short introduction into analytical chemistry www.freebookcentre.net.

PGS 504 - LIBRARY AND INFORMATION SERVICES - 0+1

Learning 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.

Practicals

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, Secondary Sources and Tertiary Sources
5. **First test**
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
15. e-resources access methods.
16. **Final practical examination**

PGS 505 - INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE - (1+0) (e-course)

Learning objective

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.

Lesson plan

Theory lecture 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. **First test**
6. Discovery versus invention patentability of biological inventions
7. Procedure for patent protection, 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, Biodiversity protection,
14. Procedures for commercialization of technology - valuation, costs and pricing of technology
15. Licensing and implementation of intellectual properties - procedures for commercialization
16. Exclusive and non exclusive marketing rights - research exemption and benefit sharing
17. **Final practical examination**

Reference

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.

Non gradial compulsory courses

NGC 001* DISASTER MANAGEMENT - (1+ 0)

(e-Course)

Learning 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. Resilent farming concepts – reclamation and revival of the agriculture system after natural disaster (Bio-shield). Preparedness – Emergency Operations Centres (EOCS).

Lesson plan

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. **First test**
5. Manmade disaster - Nuclear disasters, chemical disasters, biological disasters.
6. Building fire, coal fire, forest fire. oil fire.
7. Air pollution, water pollution, deforestation, industrial wastewater pollution.
8. Disaster management- efforts to mitigate natural disasters. 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
2. https://searchworks.stanford.edu/
3. http://guodes.litrary.illinois.edu>c.php
4. http:// libguides. auu.edu.au>c.php
5. www.wcpt.org

NGC 512* CONSTITUTION OF INDIA - (1+0)

Learning objectives

1. To Understand the basic feature of Indian constitution
2. To gain knowledge about basic rights and duties of Indian citizens
3. To ponder over the form of Indian Political system
4. To have broad understanding about the pivotal provision related with liberty, quality and fraternity

Theory

Unit I: **Constitution of India** and **Basic features and Fundamental Principles**

Meaning of the Constitution and Constitutionalism - Origin & Development of the Constitution of India - salient features of the Constitution of India.

Unit II: Fundamental Rights and Duties

Fundamental Rights - Fundamental Duties - The Directive Principles of state policy

Unit III- Union Government

Executive: President, Prime Minister and Council of Ministers. –Legislature, Parliament- Judiciary: Supreme Court

Unit IV: State Government and Local Government

Executive: Governor, Chief Minister and Council of Ministers -Legislature- High Courts - Local Governments

Unit V: Constitutional Commissions

Election Commission -UPSC- Finance Commission

Lesson plan

Lecture schedule

1. Constitution of India – Definition, Basic features
2. Fundamental principles
3. Difference between constitution and constitutionalism
4. **First test**
5. Origin and development of constitution
6. Salient features of constitution of India
7. Fundamental rights and Fundamental duties
8. Direct principles of state policy
9. **Mid Semester Examination**
10. Union government -President, Prime Minister and Council of Ministers
11. Legislature, Parliament
12. Judiciary: Supreme Court
13. Executive: Governor
14. Chief Minister and Council of Ministers and Legislature
15. High Courts and Local Governments
16. Election Commission and UPSC
17. Finance Commission

References

1. The Constitution of India **2017** Kindle Edition- Government of India
2. Bahkshi P. M. 2015 The Constitution of India. Universal Law Publishing Co Ltd
3. Pylle M.V. 2018 An Introduction to The Constitution of India. Vikas Publishing
4. Bhansali S.R.2015. Textbook on The Constitution of India. Universal LexisNexis

ANNEXURE-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		

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).

ANNEXURE-II
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

ANNEXURE-III

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

ANNEXURE-IV

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		
Intra		
Inter		

Professor and Head

ANNEXURE-V

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		Chairperson	Intra Member	Inter Member	Aver age
Signature					

Grade point:

Head of the Department

ANNEXURE-VI

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. Intra		
2. Inter		

Professor and Head

Approval may be accorded within 10 days of registration

ANNEXURE-VII

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		
1.Intra		
2.Inter		

Professor and Head

ANNEXURE- VIII
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 FOR REPORT OF THE FINAL VIVA VOCE EXAMINATION

The meeting of the Examining Committee for Mr./Ms. ----------M.Sc.(Ag.) Student Reg.No. ---------- Majoring in ----------was held at ---------- a.m/p.m on ----------

The following members were present:

1. ---------- : Chairperson
2. ---------- : Member
3. ---------- : Member
4. _____ : External examiner

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 and external examiner. The candidate has secured satisfactory/unsatisfactory

The Committee recommends/ does not recommend unanimously the award of Degree of M.Sc.(Ag.).to Mr./Ms.----------

1. Chairman
2. Member
3. Member
4. External examiner:

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

Date:

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.

Chairman

1. Chairman :
2. Member :
3. Member :
4. External examiner :