

FLA-624: TURFING AND TURF MANAGEMENT (2+1)



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1. HISTORY, SCOPE AND IMPORTANCE OF LAWN / TURF

HISTORY

Reference to “grass and gardens” is found in biblical literature. lawns were an integral part of the Persian pleasure garden carpets and later of the Arabian gardens. Low growing, flowering plants were the basic constituents of these early gardens.

In pre-medieval times, lawns were of important survival value, since a low growing ground cover (mainly of grass) would allow the view of the far horizon, so villagers and protectors of the guard could have clear view of approaching friends or foes. Thus the early turfs had a strategic value for local communities.

The culture of mowed lawn is a relatively recent development in this history of man. References to “lawn gardens” are found in English literature of medieval times. Lawns of this period were composed of low growing grasses, along with low growing meadow flowers. Some gardens of the thirteenth century had turfs composed of grass mono-stands. Turfs seats were a feature of this period.

- The word “lawn” itself originated from the word “launde” in old French, meaning wooded district or heath.
- By the 1700s, the word had entered English and acquired the meaning of mowed, grassy area.
- Lawns for commonsers got a huge boost on Aug 31, 1830. on that day, machinist Edwin Beard Budding in Gloucestershire, England, was granted patent 5990 for his invention : the first lawn mower
- The first lawn mower using budding’s design was manufactured in 1832.

- Formal gardens, including grassy areas, have been cultivated for centuries in Europe , Japan and china.
- Europeans in the 12th and 13th centuries began to cultivate turf grass as playground areas.
- One bowling green in England ,the Southampton old bowling green has been in continuous use since 1299.
- The lawn, as we know it seems to have European origins. Some of the earliest lawns were the grassland around Medieval castles in France and Britain.
- Lawns were an integral part of the Persian pleasure garden carpets and later of the Arabian gardens. Low growing ,flowering plants were the basic constituents of these early gardens.
- The culture of mowed lawns is a relatively recent development in the history of man.
- Some gardens of the 13th century had turfs composed of grass mono-stands. Turf seats were a feature of this period.
- The 13th centuries literature also contains references to the sport of lawn bowling that utilized turf Cricket, known then as the elementary form of “club ball” used grass turfs.
- This sports was played on turfs during the latter portion of the 13th century.
- 16th century –the renaissance of the 16th century saw lawns being deliberately cultivated by the rich in France and England.
- 17th century –the first closely and meticulously manicured lawns appear.
- It was still a luxury only the rich could afford, because teams had to be hired to use scythes,and weed the grass .
- Having a manicured lawn in these days was a status symbol and a mark of wealth.

- 1800's – the lawn didn't become widely popular in north American until the industrial revolution .it was seen as an unnecessary expenses up until then.
 - 1828 –the term “landscape architecture” was coined by a Scottish man, Glibert Laing Meason ,in his book ,*n the landscape architecture of the great painters of Italy*.
 - 1830 – Englishman Edwin beard budding was granted the patent for the first mechanical lawn mower, known as the real lawn mower .
 - 1915 - The U.S department of agriculture and the U.S. golf association collaboration to find the right types of grass to suite all climate types. Some of the grasses in contension ,are now household names.
1. Bermuda from Africa
 2. Blue grass from Europe
 3. Fescue are all tested for American soil.
- 1940 the rotary push mower is invented.

inventions like the lawn mower make lawn care more realistic to the average homeowner.

- 1963 the riding lawn mower

Today the average homeowner spends about 4hr a week and 5 to 9 days out of the years on their lawns.

SCOPE AND IMPORTANCE OF TURF GRASS

- Turf grass transforms carbon dioxide into oxygen .
- Lawns helps to reduce the heat island effect commonly found in urban environments.
- Lawn reduce energy consumption through its cooling effects.
- Lawn help reduce soil erosion through deep roots that hold the soil in place during heavy flooding.
- Lawn also help reduce noise in urban areas.

Importance

- Soil erosion control and dust stabilization
- Ground water recharge and ground water quality
- Organic chemical decomposition
- Soil improvement and restoration
- Heat dissipation-temperature moderation
- Noise abatement and glare reduction
- Decreases noxious pests, allergy-related pollens, and human disease exposure
- Safety in vehicle operation and longevity
- Security for vital installations and lower fire hazard
- Wild life habitat
- Turf grass recreational benefits
- Turf grass aesthetic benefits

Soil erosion control and dust stabilization

- Turf grasses are relatively inexpensive , durable ground covers that protect our valuable ,non renewable soil resource from water and wind erosion.
- The erosion control effectiveness of turf grass is combined result of a high shoot density and root mass for surface soil stabilization , plus a high biomass matrix that provides resistance to lateral surface water flow thus slowing otherwise potentially erosive water velocities.
- Perennial turf grasses offer one of the efficient methods to control water and wind erosion of soil
- Such control is very important in eliminating dust and mud problems around homes , factories, school and business

Ground water recharge and surface water quality

- A mowed turf grass possess a leaf and stem biomass ranging from 1,000 to 30,000 kg/ha depending on the grass species , season and cultural regime.
- The turf grass eco-system can support abundant populations of earth warms of from 20 to 300m².
- Earth warm activities increases the amount of macrospore space with the soil,that results in higher soil water infiltration rates and water retention capacity

Organic chemical decomposition

- The runoff water and sediment that occurs from impervious surfaces in urban areas carries many pollutant , including metals such as Pb , Cd, Cu and Sz, hydrocarbon compounds as from oil, grease and fuels; and household and industrial hazardous wastes such as waste oils, paint thinners, organic preservations, and solvents.
- Turf grass areas can be designed for the catchments and filtration of these polluted runoff waters .
- It is significant that the large soil-turf grass ecosystem. Micro flora constitutes the largest proportion of the decomposer biomass of most soils.
- The bacterial biomass component ranges from 30 to 300 g m⁻², and fungi from 50 to 500 g m⁻², with actinomycetes probably in a similar ranges from 30 to 300 g m⁻².

Soil improvement and restoration

- An extremely important function of turf grass is soil improvement through organic matter addictions derived from turnover of roots and other plant tissues that are synthesized in part from atmospheric co₂ via photosynthesis.

- The root depth potential ranges from 0.5-3m, depending on the turf grass species, extent of defoliation and soil environmental conditions.
- Generally, C4 warm season turf grasses produce a deeper, more extensive root system than the C3 cool season species.
- Accelerated soil restoration of environmentally damaged areas by planting perennial grasses is employed effectively on highly eroded rural landscapes, burned –over lands, garbage dumps, mining operations and steep timber harvest areas.

Heat dissipation –temperature moderation

- The overall temperature of urban areas may be as much as 5 to 7°C warmer than that of nearby rural areas.
- Turf grass dissipates high levels of radical heat in urban areas.
- Maximum daily canopy temperatures of a green, growing *Cyanodon dactylon* turf was found to be 21°C cooler than a brown dormant turf and 39°C cooler than a synthetic turf.
- Energy inputs for maintenance could be reduced by proper selection of resource efficient, sustainable species and cultivars of turf grasses, trees and shrubs.

Decreased noxious pests, allergy-related pollens and human disease exposure

- Closely mowed residential lawns reduced the numbers of nuisance pests such as snakes, rodents, mosquitoes, ticks and chiggers.
- Allergy related pollen can cause human discomfort and potentially serious health concerns to susceptible individuals.
- Most turf grasses that are mowed regularly at a low height tend to remain vegetative with minimal floral development, and thus have reduced pollen production.

Noise abatement and glare reduction

- The surface characteristics of turf grasses function in noise abatement as well as in multi-directional light reflection that reduces glare.
- The turf grass absorb harsh sound significantly better than hard surfaces such as pavements, gravel or bare ground.
- These benefits are maximized by an integrated landscape of turf grasses, trees and shrubs.

Safety in vehicle operation –equipment longevity

- Roadside turf grasses aid in highway safety, as well as erosion control, by serving as a stabilized zone for emergency stoppage of vehicles.
- Mowed roadside turfs enhance line-of-sight visibility and views of signs and animal hazards, which are vital factors for operators of fast mowing vehicles.
- Turf grasses are used for soil and dust stabilization around airport runways and taxiways to prolong the operating life of airplane engines.

Security for vital installation and lower fire hazards

- Expanses of green, low growing turfs in the landscape provide a high visibility zone that is a viable security measure, especially around sensitive military and police installation.
- The low fuel value of green, prostrate-growing turfs serves a valuable function as a firebreak that significantly lowers the fire hazards if properly positioned.

Wild life habitat

- The ever increasing human population of the world results in a continuous increase in land area devoted to urban development.
- The impact on the wild life species normally found in such areas is of concern. Certainly, proper planning of appropriate landscapes around

homes, businesses, industrial complexes and public buildings can enhance the potential to support a representative wildlife community that residents may enjoy.

- Properly designed urban landscape green areas such as golf courses and parks can maintain and even promote plant and animal diversity, natural habitats and wetlands when compared to intensive agriculture and urban residential usage.

Turf grass recreational benefits

- Turf provides a low cost, safe recreational surface. Many outdoor sports and recreational activities utilize turf grasses, including archery, badminton, baseball, cricket, croquet, field hockey, football, horse racing, lawn tennis, volleyball.
- Both the enjoyments and benefits of improved physical and mental health derived from recreation and leisure activities on turfs are vital to contemporary society, especially in densely populated urban areas.
- Turf grass provide unique, low-cost cushioning effects that reduce injuries to the participants when compared with poorly or non turfed soils, particularly more active contacts sports like football.

Turf grass aesthetic benefits

- Turf grass provides beauty and attractiveness that enhance the quality of life for human activities.
- Their aesthetic benefits are magnified when combined with an integrated landscape of trees, shrubs and flowers
- Two important mental therapeutic benefits
 1. Improves mental health via a positive therapeutic impact
 2. Contribute to the social harmony and improved productivity.

2.SITE ANALYSIS FOR TURF ESTABLISHMENT

Accurate site specifications are indispensable for planning with relation to management practices, materials applications, and renovation or reconstruction. Problem areas that impact turf health directly affect the potential loss of turf quality and function and increase the likelihood of pest infestations.

Points to consider in a thorough site assessment include:

- Map or photo record of property - square footage of turf area(s) being managed.
- Drainage patterns - as-built drawings/maps of drainage and irrigation systems.
- Determination of functional condition and adequacy of drainage and irrigation systems
- The age, condition, and species composition of the turf (including cultivars if known) –
- The physical condition, texture, and variation of soils on the site.
- A current soil pH and nutrient analysis.
- The fertility history and a summary of the current fertility program
- A pest history and current or potential problems.

IDENTIFY AND RECORD PERMANENT FEATURES OF EACH SITE IN RELATION TO MANAGEMENT OF THE TURF:

Permanent features on or in close proximity to the site should be assessed from two perspectives:

1. How turf function and quality might be impacted by these features.
2. How these features might be impacted by turf management practices.

The following are important items and structures that might be included:

- Trees, shrubs, gardens and fencing.

- Buildings.
- Temporary structures.
- Monuments or grave markers.
- Playgrounds and/or daycare facilities.
- Decorative ponds.
- Significant abutters that have potential for impact other landscape plantings.
- Driveways and walkways.
- Parking lots and roadways.

II Changes to this record should be made as they occur.

Devote particular attention to the identification of areas of environmental sensitivity.

Similar to above, areas of environmental sensitivity on or in close proximity to the site should be assessed from two perspectives:

1. How turf function and quality might be impacted by these areas.
2. How these areas might be impacted by turf management practices.

The following are key areas that should be included:

- Wetland protection resource areas
- Wells on property
- Wells in proximity to property
- Zone I & II areas
- Surface water features
- High water table areas
- Catch basins
- Exposed bedrock

OTHER ENVIRONMENTALLY SENSITIVE AREAS DETERMINE AND RECORD AGRONOMIC PROBLEMS IN KEY LOCATIONS AND CONSIDER POTENTIAL SOLUTIONS:

The recognition of agronomic problems is the first step in developing a solution.

Problems to note include but are not limited to the following:

- Inappropriate turfgrass species or cultivars
- Poor fertility - undesirable soil types

- Excessive thatch
- Excessive traffic stress
- Compaction
- Pet damage
- Poor drainage
- Shade
- Localized dry spots
- Poor air circulation
- Southwest facing slopes
- Tree root influence
- Shallow soil or bedrock
- Areas prone to damage from snow removal or salt application

CHECKLIST FOR LAWN PREPARATION:

This operations provide a simplified version, for quick and easy reference, of the month-by-month guide to lawn maintenance in warm regions, given in further exercises. As stated previously, the exact timing of various operations depends very much on the weather conditions, the state of the soil and the nature of lawn.

In the table, heavy shading indicates that the particular operation or treatment will be necessary, or almost always so, during the period concerned. Where the shading is lighter, it indicates that the operation is optional or in the case of of treatment, that might sometimes be necessary. For example, moss is very likely to occur in the autumn, but it may also be present in the spring.

Site analysis checklist (Based on the Cliental preference)

Site analysis checklist for lawn

Clients name: _____

Clients address: _____

Date taken _____

Taken by

<i>Site characteristics</i>	<i>Physical importance</i>	<i>Visual importance</i>	<i>+ ve</i>	<i>- ve</i>	<i>Neutral</i>
<u><i>Natural factors</i></u>					
<i>Existing factors</i>	<i>Trees</i>	<i>Good</i>			
<i>Weeds</i>	<i>None</i>	<i>None</i>	√		
<i>Wind / breezes</i>	<i>Leeward</i>			√	
<i>Surface water quality</i>	<i>Moderate</i>		√		
<i>Groundwater</i>	<i>High</i>				√
<i>Soil conditions</i>	<i>Good</i>	<i>None</i>		√	
<i>Shade</i>	<i>None</i>		√		
<i>Turf plastering</i>	<i>Suitable</i>				√
<i>Direct sunlight</i>	<i>All day</i>				
<i>Others</i>			√		
<i>Soil pH</i>	<i>6 -7</i>				
<i>Soil texture</i>	<i>Sandy loam</i>				
<i>Water EC</i>					
<u><i>Man- made factors</i></u>					
<i>Buildings</i>					
<i>Existing hardscape</i>	<i>None</i>	<i>-</i>			
<i>Off site features</i>	<i>None</i>	<i>-</i>	√		
<i>Pools</i>	<i>None</i>	<i>-</i>		√	
<i>Others</i>	<i>-</i>	<i>-</i>	√		
<u><i>Cultural factors</i></u>					
<i>Power line</i>					
<i>Telephone lines</i>	<i>Yes</i>				√
<i>Water lines</i>	<i>Yes</i>				
<i>Historical features</i>	<i>No</i>			√	
<i>Nearby roadways</i>	<i>No</i>		√		
<i>Off- site nuisances</i>	<i>-</i>			√	
<i>Off – site benefits</i>	<i>-</i>		√		
<i>Others</i>	<i>-</i>				√

MOTHLY LAWN CARE FOR WARM SEASON GRASSES:

April

Clean up debris from winter

Cultivation (aerifying, spiking, slicing) - lawn should be actively growing

Vertical mowing or dethatching (lawn should be actively growing)

Overseeding, establishment (late in month; late summer is better)

Preemergence annual weed (i.e. crabgrass) control (or early May)

May

Cultivation (aerifying, spiking, slicing) - lawn should be actively growing.

Preemergence annual weed (i.e. crabgrass) control (or late April) if needed

Fertilization (1 pound of nitrogen/1,000 square feet)

Postemergence broadleaf weed (i.e.dandelions) control to actively growing weeds

Overseeding, establishment (early in month; late summer is better)

June

Postemergence broadleaf weed control (avoid hot weather) Late summer or early fall is better

Light fertilization (with irrigation); controlled-release nitrogen suggested

July

Irrigation (as needed or allow lawn to go dormant)

Monitoring for pests/problems (sod webworm)

August

Monitor for pests (annual white grubs mid-Aug. thru Sept.) (sod webworm)

Irrigation (as needed)

Prepare for seeding, overseeding (optimum time)

Seeding - latter half of month (optimum time)

September

Overseeding & establishment (optimum time) - first week

Fertilization (key time) - first 2 weeks

Cultivation (aerifying, spiking, slicing) - lawn should be actively growing

Postemergence broadleaf weed control to actively growing weeds (optimum time)

October

Postemergence broadleaf weed control (early in month) if weeds actively growing

Cultivation (aerifying, spiking, slicing) - lawn should be actively growing

November

Mowing until dormant

Late season fertilization within 1 week of final mowing of year

* Not all of these practices are suggested for one lawn in one season; this schedule is intended to be a guide when planning lawn care. Practices should be based on needs and problems of a specific lawn.

* Calendar can be adapted to the warm grasses.

* Some practices cannot be done in conjunction with another; such as reseeding and applying most herbicides, or fertilizing new seedings at rates for established lawns.

MONTHLY SCHEDULE FOR COOL SEASON GRASSES:

JANUARY:

Remove any accumulation of dead leaves.

Check drains if water is standing on the surface for any length of time after rain, and drain persistently wet sites.

FEBRUARY:

From the February check regularly for signs of worm activity or unhealthy turf following mild spells.

Disperse worm casts regularly. Complete all major turfing work by the end of the month. Apply a mosskiller in late February if the weather is settled, if still cold leaves until march.

Top dress if necessary. Towards the end of the month, being preparation for spring sowing if soil conditions and weather are suitable.

MARCH:

Scatter worm casts and lightly rake to remove debris; then mow with the blade set high.

Roll the turf grasses. Treat against worms if they become very troublesome.

Realing ragged lawn edges. In southern region feed in late march if the weather is mild and settled.

APRIL:

Increase the frequency of mowing according to the weather and grass growth continue checking at intervals for signs of unhealthy turf.

Apply a spring feed in early to mid-April, a few days after feeding apply a weed killer if necessary. Remove patches of coarse grass and re-seed. Seed in sparsely grassed areas and top-dress lightly if necessary to improve levels to fill joins.

MAY:

In early may adjust the mower to the summer cutting height. Continue weedkilling if very mossy apply a mosskiller. From may be needed in drier periods.

During mid- to late may apply a light dressing of nitrogenous fertilizer.

JUNE:

Mow frequently, if patches of creeping weeds are troublesome lightly scarify before mowing. Continue weedkilling and irrigation as necessary.

Spike, lightly top-dress and irrigate areas that are subjected to heavy wear.

JULY

Mow regularly, scarify patches of creeping weeds and surface running grasses before mowing. Feed lightly early in July. Apply weedkillers and irrigate as necessary.

AUGUST:

Mow regularly, give a final summer feed in mid to late august, followed by a final application of weed killer. In colder areas sow grass seed during late August.

SEPTEMBER:

Modify the cutting height of the mower towards end of the month, since the rate of the growth is now slowing.

Examine the condition of the turf and carry out the autumn renovation, scarify to remove matted growth or thatch, spike and top-dress, and seed in sparse patches.

Apply a lawn sand to control moss. Do not use mosskillers containing sulphate of ammonia at this time of year. With the onset of cooler, moister conditioning check regularly signs of unhealthy turf and worm activity. In milder area seed in new lawn sites.

OCTOBER:

Set the mower to its winter height and mow as the growth dictates during dry periods. Switch or brush to remove early morning dew and encourage rapid drying if the weather is fine.

Spike and top-dress if unable to do so in September. Prevent accumulation of fallen leaves because this can create conditions in which diseases may establish. Treat against worms and leatherjackets if they become very troublesome.

Lay turf lawn from this month onwards. i.e. Second seeding.

NOVEMBER:

A final mow may be necessary, but do not attempt mowing in frosty conditions, nor when the soil is heavy after a recent fall of rain.

Continue clearing up fallen leaves. Continue turfing when conditions are suitable.

DECEMBER:

Apply lime this month if it is needed. Continue with turfing and leaf clearance where necessary.

DETERMINE CUSTOMER OR CLIENT EXPECTATIONS TO INFORM MANAGEMENT OBJECTIVES:

In general, the higher the level of quality desired, and the more intense the use of the turf, the higher the level of management needed to maintain a quality surface.

Set realistic expectations based on communication between turf practitioner and customer or client.

Expectations considerations include, but may not be limited to:

- Use and appearance of lawn
- Acceptable level of pest infestation
- Acceptable level of abiotic stress
- Use of water and other resources
- Use of synthetic, organic-based or organic management materials
- Budget and other financial resources
- Other site specific details

STRATEGIES FOR THE UPCOMING YEAR WITH AN ANNUAL MANAGEMENT PLAN:

Formulate a yearly management plan based on site assessment information, client expectations and pest action levels as determined for the site.

The following information at a minimum should be included:

- management objectives and practices

- regulations that impact the particular site, and compliance factors for those regulations
- identification of agronomic problems, with a plan for addressing causes:
 - Irrigation
 - Drainage
 - Excess Wear And Traffic
 - Landscaping (Trees And Shrubs)
- Soil Problems - Cultural Practices:
 - Construction, Renovation, Repair If Needed
 - Seeding/Overseeding
 - Irrigation
 - Fertility Management
 - Mowing
 - Aeration And Topdressing
- Other Practices Specific To The Site - Scouting Timetable And Procedures
 - Identification Of Key Pests In Key Locations At Key Times
 - Training And Assignment Of Scouting Personnel - Pest Management Strategies
 - Determination Of Pest Action Levels
 - Scouting/Monitoring Plan
 - Cultural Management
 - Biological Management
 - Pesticide Management

Monitor or scout for pests, potential pest problems and environmental stresses.

- Managed sites should be checked on a routine basis for pest presence, pest population density, and pest damage.
- Other potential problems (i.e. heat stress, excessive thatch accumulation, etc) should also be noted and recorded.
- Consult the appropriate pest sections of this manual for information useful in monitoring disease, insect, and weed pests as well as problems caused by abiotic factors.
- Refer to the Turf Pest Damage Monitoring Chart on page 116 for approximations of when damage is most likely to occur.

Keep a written record of monitoring findings with an intended course of action.

- List or map locations where particular or key pests or problems first occurred during critical periods.

- List or map locations where particular environmental or other abiotic stresses first occurred during critical periods.
- Record action needed, and also action taken.

BMPs FOR LAWN & LANDSCAPE TURF

Record management activities.

- Keep a detailed record of yearly growing conditions and management activities.

Suggested record items:

- Temperature
- Precipitation
- Humidity
- Pest Problems
- Pest 'Hot Spots'
- Pesticide Applications And Results
- Timing, Frequency And Effectiveness Of Cultural Practices
- Fertilizer And Other Materials Applications
- Soil And Tissue Test Results
- Soil Ph - Uncommon Occurrences Such As Flood, Prolonged Ice Cover, Etc.

Note management activities that differ from those outlined in the yearly management plan. Determine if measures taken to manage a pest or alleviate a problem were truly effective in protecting and maintaining the quality and viability of the turf. These evaluations should be maintained as a key aspect of the written record. Keep pesticide application records as required by law. If applicable, customer program, invoicing and associated records should be kept on file. Staff are should be trained in Right to Know and other pertinent laws, and documentation should be retained in personnel files. Training records for staff using or handling materials and doing field work should be retained.

Encourage and maintain communication between supervisors, crew and other staff.

Effective communication will promote success of management decisions and results. Train staff and crew in proper procedures.

Share management plans with appropriate staff, clients, and/or end-users. Discuss as needed.

- Clients, and/or end-users who utilize turf subject to pesticide applications should receive notification and documentation as required by law.
- If requested by clients and/or end-users, provide advance notice of site visits and applications.
- Provide an information sheet, post-treatment instructions and documentation to clients and/or end-users as appropriate.

BMPs FOR LAWN & LANDSCAPE TURF

Evaluate the management plan as implemented.

- All aspects of the management plan including pest management strategies should be evaluated each year and a written summary kept.
- Management strategies that need to be adjusted or implemented during the coming year can be identified in the course of the annual evaluation.

3.SITE PREPARATION FOR TURFING

INTRODUCTION:

The quality of a new lawn is directly related to the success of establishment. Turf establishment begins with careful planning, knowledge of soil conditions, and an understanding of the environmental and cultural requirements of turfgrasses. This publication provides a stepwise approach to turf establishment and renovation and includes information on preparing the site for establishment, seeding, sodding, renovation, and care of newly-establishment.

SITE PREPARATION:

Planning is an often overlooked, but important part of establishing turfgrasses. It begins by visiting the site and determining how much area is to be prepared and planted, locating obstacles that may interfere with soil preparation, assessing the condition of the soil, and noting site conditions that may influence the type of grass use. Visiting the site will also give some idea of the materials and equipment needed to complete the job. Perhaps the most important phase of planning involves scheduling a time to prepare the soil and begin planting.

SOIL TEST:

A broad spectrum soil test will tell us exactly what lawn/amenity turf requires to produce healthy grass. Carrying out a test also means that can save money and time on the fertilisers that need to apply.

If a soil pH is less than 6.0 (acidic), then a lime requirement will be calculated. Limestone is used to raise the pH of acid soils.

- If the soil pH is greater than 7 (alkaline) Applying elemental sulfur at the recommended range given on the soil test report prior to lawn establishment will bring the pH down
- Analysis the nutrient levels.
- CEC(cation exchange capacity.(10-12 m.eq./100gm).

Cation exchange capacity (CEC) is a measure of the soil's capacity to hold nutrients; specifically, positively charged ions such as K, Ca, and Mg. Clay and organic matter contribute to cation exchange capacity; thus, soils with high CEC will retain nutrients better than low-CEC soils.

REMOVING EXISTING VEGETATION:

Eliminating weed problems existing on the site is an important first step. Perennial weeds such as quack grass or tall fescue, need to be controlled prior to lawn seeding or sodding. Weed control options include digging by hand, repeated soil tillage or using a systemic (moves within plant) nonselective herbicide, such as glyphosate, sold as Roundup and other trade names. Organic products are becoming more popular as well. Read, understand, and follow all label directions whenever using any type of control product to be sure getting the expected level of control necessary. Weeding also done by traditional flooding method by irrigating the area to its saturation level. allow the weeds to germinate and remove the germinated weeds from the lawn

PRE EMERGENT WEEDICIDES:

It is selective broad spectrum pre-emergence herbicide for transplanted rice. It has excellent against broad leaved weeds, sedges and grasses. It is taken up rapidly by the germinating weeds, and, to a lesser extent, by the roots of germinating weeds which die shortly after emergence.

LIST OF SOME PRE-EMERGENT WEEDICIDES:

SIDURON: Siduron is the only pre-emergent herbicide that will kill weedy annual grasses such as crabgrass, foxtail and barnyardgrass without damaging germinating cool-season lawn grass plants. It has no effect on broad-leaved weeds such as dandelions and can't be used on Bermuda grass or some strains of bentgrass.

TRIFLURALIN: Trifluralin is a product used by homeowners in garden beds rather than on lawns. It is also applied extensively to soybeans, cotton, vegetables, fruits, nuts and nursery crops. Toxic to both broad-leaved and grassy weeds, it is a general-use herbicide that varies in effectiveness.

BENEFIN : Benefin is primarily used to control annual grasses in turf, alfalfa, clover and some vegetables such as lettuce. It is not as effective against broad-leaved weeds. One shortcoming is its quick decay, sometimes necessitating a

second application in a few months. It is also available in combination with Trifluralin for use on a broader range of weeds.

ISOXABEN: Isoxaben is a weak grass killer, but controls broad-leaf weeds such as chickweed, henbit and bittercress well. It is also effective against perennial weeds such as dandelions, plantain and white clover. One drawback is the wait required before reseeding with lawn grass, at least two months.

DITHIOPYR: Dithiopyr is an excellent choice for pre-emergent control of crabgrass, even eliminating small crabgrass plants, and it also kills a wide variety of broad-leaf weeds. Reseeding must be delayed for at least three months after application.



Common broad leaf weeds in grassland cocklebur, lambs quarters, ragweed, velvet leaf, prostrate spurge, knotweed

MODIFICATION OF TOP SOIL:

In addition to modifying the soil structure organic matter contains micro-organisms that work together with the roots of plants to absorb the nutrients in the soil, so there are additional benefits of using organic matter as part of the soil building program. Incorporate these materials into the existing soil, rather than layering them on the surface. A goal is to have six inches or more of well-prepared soil, and beyond that is impractical around large trees where many roots are found within the dripline.

If the construction process has left with subsoil and excavation spoils, there is no way to know the soil's fertility status. if really can't work with existing soils, bring in new soil that is as close as possible in texture to the original soil. This

allows for continuity in water movement and rooting once the soil is in place. If the sandy soil, place it over the existing soil as a layer rather than tilling it into the existing soil. A layer of sandy soil should be at least 6 inches deep, after compaction, to provide an adequate root zone.

Do not till sand into clay soils in an effort to loosen up the soil or improve drainage. Research shows that adding sand reduces soil porosity and increases susceptibility to compaction until the sand content reaches approximately 80 percent by volume. Practically speaking, that are better off layering sandy soil on top. Tilling organic matter into existing soil is a common recommendation. Thoroughly composted organic matter can reduce bulk density of clay soils and increase water- and nutrient-holding capacity of sandy soils. In general, which can expect a short-term improvement in tilth. Some composted materials have significant fertilizer value and will increase soil fertility for several months after incorporation. Add organic matter annually to maintain the light, fluffy qualities



GRADING/ SLOPING:

- The subsoil grade (subgrade) should conform to the desired surface contour. However, it should be lowered to account for the addition of several inches of topsoil.
- The subgrade should be free of depressions where water can accumulate. If possible, the grade should slope gently away from any building foundation at a 1 to 4 percent slope (1 to 4 foot drop for every 100 feet)
- On sites where homes have been built into hillsides, drainage swales are needed around buildings. Where steep slopes exist and/or grades change drastically, consider installing retaining walls or ground covers.

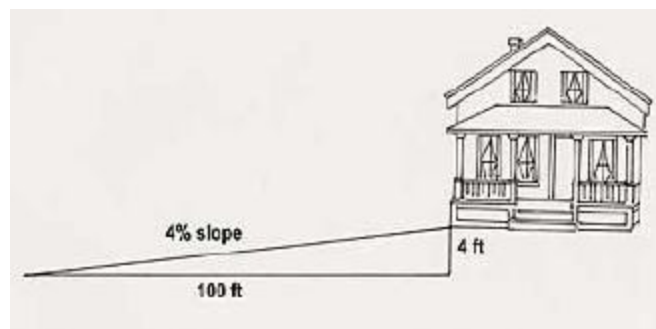
$$\text{Sloping} = \frac{\text{change in horizontal distance}}{\text{Vertical distance}} \times 100$$

the difference in elevation between the high and low ends of the slope. Find the run: the horizontal distance between the two ends of the slope. Then divide the rise by the run. Having a steep slope can lead to erosion problems. Flat ground that doesn't slope is prone to flooding. A slope of 1 foot in rise per 50 feet of run is ideal for proper drainage. Tie a string to the bottom of the top stake at ground level. Stretch the string to the next stake and wrap it loosely around the stake. Use a level to check that the string is level. Move the string up or down until the level is correct, then tie the string to the stake. Repeat until reached the bottom stake.

Measure the length of the string. Measure the distance from the ground to the string on the lowest stake. Make measurements use the same units; either inches or feet. A 50 foot run and a 12 inch rise should be calculated using 600 inches and 12 inches, or 50 feet and 1 foot, but not a mixture of the two.

Divide the rise by the run. A 1 foot rise divided by a 50 foot run is .02. Move the decimal two places to the right to convert the answer to a percentage. The slope is 2 percent. Things need to measure is given below,

- Stakes
- String
- Level
- Tape measure



APPLYING STARTER FERTILIZER:

Organic matter may be a beneficial amendment when soils have high sand or clay contents. Sandy soils lose water and nutrients quickly, thus, a good source of organic matter amended into these soils improves water and nutrient retention, reducing the need for irrigation and fertilizer. Clay soils typically are poorly drained and lack sufficient aeration for good root

growth. Organic matter additions to clay soils will provide better water and air movement through the soil, thereby improving turf root growth.

Although sphagnum peat products are ideal organic amendments for sand and clay soils, they can be expensive for use in lawn establishment. Good quality composts are usually less expensive than sphagnum peat and can be good organic matter amendments; although they contain less organic matter than high quality peats. Decide to use compost instead of peat, be aware that all composts are not alike and some are better for use in turf establishment than others. Make sure that the compost has been successfully used by other professionals for lawn establishment or has been successfully tested on turf at a university. Poor quality composts should not be used.

Sand is occasionally used to improve clay soils; however, large amounts are needed to achieve noticeable soil improvement. Clay soils must contain about 60% by volume of a coarse, uniform sand to achieve significant improvement in drainage. This would involve incorporating a three to four inch layer of sand into a six inch layer of clay soil. Although possible, this method is too expensive for most lawn establishments.

FINAL GRADING/ LEVELING:

Following rough grading, incorporation of amendments, and tilling, the soil should be ready for fine grading. Fine grading involves firming and smoothing the soil surface in preparation for seeding or sodding. Firming can be accomplished by dragging a heavy mat over the surface several times. The weight of the mat will firm-up the soil and the dragging will smooth the surface. If a mat is not available, a light-weight roller can be used instead. Mechanical firming should be done when the soil is relatively dry and with lightweight equipment so as not to overly compact the soil. An alternative to mechanical firming is to allow rainfall or irrigation water to settle the soil. Be aware that use of water to firm the surface to wait several days until the soil is dry enough to begin fine grading. Stones larger than two inches in diameter should be removed by hand with a stone rake and shovel or mechanically with a landscape raker.

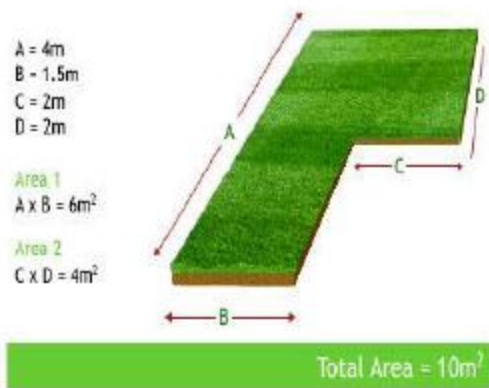
HOW TO MEASURE AN AREA OF THE LAWN?

- Get a piece of paper and sketch out the areas to be turfed.
- Break up the areas into basic shapes such as squares, rectangles and circles. See our full list below.
- Measure each area and write down your measurements.

- Calculate how many square metres are in each area using the easy formula below.
- Add the totals together.

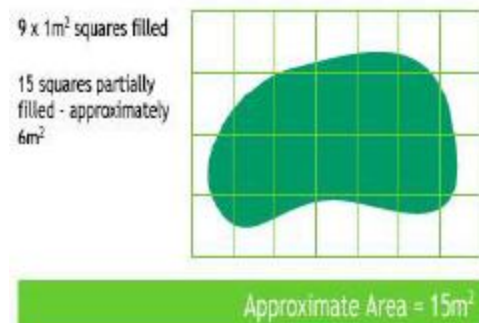
If the lawn is square or rectangular lawn, measuring its area is simplicity itself. Measure the width and the length, and multiply the two together. This gives you your area. then multiply it with constant factor. not all lawns are that easy to measure. As people take more of an interest in the design of their gardens, irregular shapes are increasingly popular. If the shape is relatively simple and made up of separate squares or rectangles, you can measure it by breaking it up as shown in the diagram below,

EXAMPLE:1



EXAMPLE:2

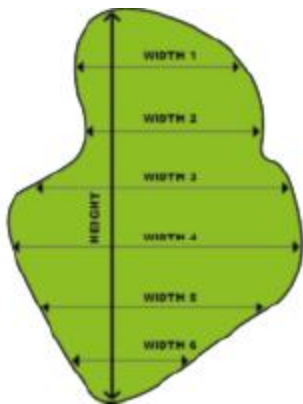
If the lawn is more complicated than that, use a piece of graph paper which helps to measure the area. Measure the width and the length of the garden at various points, and draw an approximation of the shape of the lawn to scale. By counting the number of squares the lawn fills, and "guess-timating" the rest from partially filled squares, it gives a reasonable result. If in doubt, it is always best to round your estimate up rather than down. Diagram illustrating how you might measure an irregularly shaped garden:



If your lawn is most complicated then implement some geometrical structures in an inappropriate shape like circle, square, triangle, rectangle, trapezoids, etc.,



EXAMPLE:3



Measure the metres by firstly dividing area into sections of regular shapes i.e.: circle, square and triangle.

To calculate the required amount of turf in square metres, apply the formulas for each shape and then add together to form total area. This calculation is only a rough guide; it is quite hard to determine the correct measurements for such an unusual area.

Example:

length 13.5m

width 1 = 3m; width 2 = 2.5m; width 3 = 4m; width 4 = 4m; width 5 = 3.5m;
width 6 = 1.8m;

$3m + 2.5m + 4m + 4m + 3.5m + 1.8m = 18.8m$

$18.8m/6(\text{total of widths measured}) = 3.13m$

$3.13 \times 13.5m (\text{length}) = 42.25m^3$

CALCULATING THE AREA OF DIFFERENT SHAPED AREAS: MEASURING A RECTANGLE

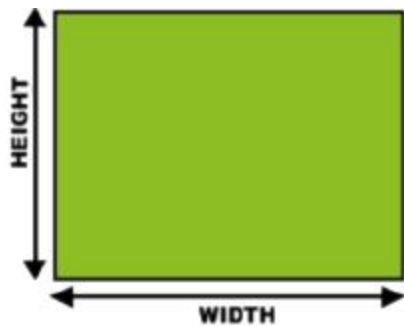
Measure the height and width of the square or rectangular area in metres.

To calculate the amount of turf required, multiply height x width

Example:

height 6m; width 15m

$$6\text{m} \times 15\text{m} = 90\text{m}^2$$



MEASURING A CIRCLE

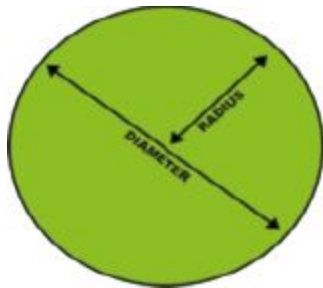
Measure the diameter of the circular area in metres. To calculate the amount of turf required, use this simple formula.

r = radius

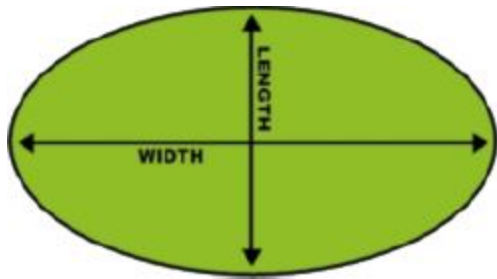
d = diameter

$$r \times r \times 3.14$$

Example: diameter 13m radius 6.5m $6.5\text{m} \times 6.5\text{m} \times 3.14 = 132.7\text{m}$



MEASURING AN OVAL



Measure the length and width of the oval area in metres. To calculate the amount of turf required, multiply length x 0.80 then by width.

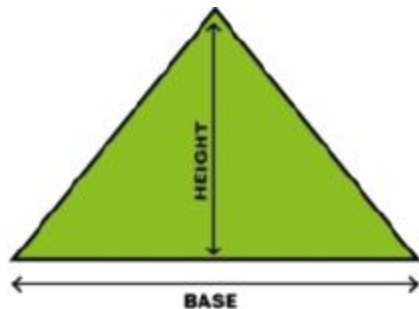
Example:

length 19m; width 10m

$19\text{m} \times 0.80 = 15.2\text{m}$

$15.2\text{m} \times 10\text{m} = 152 \text{ sq.m}$

MEASURING A TRIANGLE



Measure the base and height of the triangular area in metres. To calculate the amount of turf required, multiply base x 0.50 then by height.

Example:

base 16m; height 9m

$16\text{m} \times 9\text{m} \div 2 = 72\text{sq. m}$

HOW TO CALCULATE REQUIRED SOIL TO THE LAWN:

The amount of soil need can be easily calculated using the formula.

Multiply the area by the depth of the soil, and then multiply by 1.6. (Bulk density is the weight of soil in a given volume). Soils with a bulk density higher than 1.6 g/cm³ tend to restrict root growth. Bulk density

increases with compaction and tends to increase with depth. Sandy soils are more prone to high bulk density. Bulk density can be used to calculate soil properties per unit area) (e.g. kg/ha).

For example: $65\text{m}^2 \times 0.05 \times 1.6 = 5.2$ tonners of soil.

Whereas take , Area = 65m^2 , Depth= 0.05m

REQUIRED SOIL = AREA X DEPTH X C (BULK DENSITY OF THE SOIL=1.6)

4. BOTANY OF TURF GRASSES FOR IDENTIFICATION

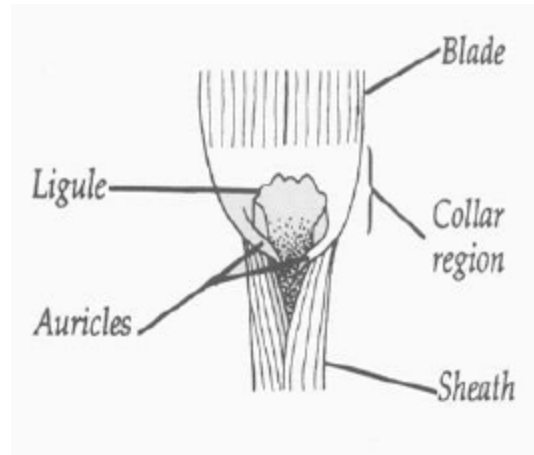
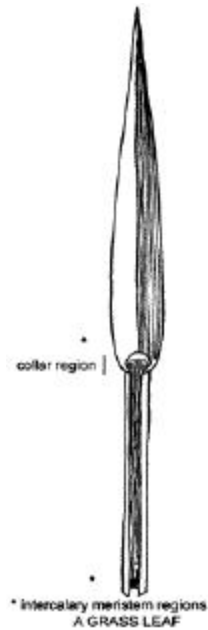
DEFINITION OF GRASS

- A surface layer of earth containing a dense growth of grass and its matted roots; sod.
- The surface or sward of grass-land, consisting of earth or mold filled with the roots of grass and other small plants, so as to adhere and form a kind of mat; Earth covered with grass.

MORPHOLOGY OF GRASS

Grasses, whether annual or perennial, are mostly herbaceous (not woody), monocotyledon plants with jointed stems and sheathed leaves. They are usually upright, cylindrical, with alternating leaves, anchored to the soil by roots. Grasses have leaves (blades that narrow into a sheath), a stem (culm), a collar region (where leaves attach to the stem), roots, tillers, and during the reproductive stage an inflorescence or seedhead develops. Grasses may have rhizomes or stolons and the collar regions have differing variations of ligules, auricles, and blades (laminas). Inflorescences of grasses also vary widely so during vegetative stages, the collar and leaves help in proper identification and during reproductive stages the inflorescence is very helpful.

Leaves - originate from the nodes. The lower portion of the leaf forms a sheath, which encloses and protects the young shoots. The second half of the leaf then opens out into the leaf blade.



Inflorescences are an arrangement of many spikelets composed of individual florets. Grasses have three main inflorescence (seedhead) types: panicle, spike, and raceme.

From a seed, primary (seminal) roots develop to nourish and anchor the seedling. Eventually fibrous or adventitious roots develop from lower stem nodes. Some grasses have underground stems called rhizomes which grow horizontally before pushing above ground to a new shoot. Some grasses have stolons which are above ground, trailing stems that produce leaves, roots, and flowering shoots from the nodes. Some grasses have both while some have neither.

Stems or culms are really a series of sections called internodes which are separated by nodes. This is why grasses are referred to as jointed or as "joints" (during the proliferation of marijuana). The internodes or sections are very close together near the stem and but lengthen or stretch out as the plant matures. The internodes are most often hollow but a few grasses have internodes of white pith, such as sorghum. The branching of leaves always occurs at the nodes and develops from a bud that is between the leaf-sheath and the stem. When branching results from nodes at the base of the plant it is called tillering (suckering, stooling).

All grasses have a distinctive collar region. Proper identification requires a look at this area where the leaf blade wraps around the stem. If the leaf blade is pulled back, the collar region reveals a unique combination of ligule, auricle, and meristemat tissue. Barnyardgrass has no ligule or auricles. But other grasses will have a ligule (hairy or membranous growth at the blade-sheath junction). Ligules vary in size, shape, and type. Many grasses will also have distinctive auricles (appendages that wrap the blade around the stem). The meristematic tissue will appear whitish and is the area of leaf blade growth and expansion.

IDENTIFICATION CRITETIA FOR DIFFERENT TYPES OF GRASSES

1. Auricles
2. Collars
3. Inflorescence
4. Leaf blade
5. Leaf buds
6. Leaf sheath
7. Leaf surface
8. Ligules
9. Presence of hairs
10. Propagation parts
11. Season of grass
12. Stem and sheath contact

SEASON OF GRASSES

❖ Cool season grasses

Cool season grasses start growth at 5 °C (41 °F), and grow at their fastest rate when temperatures are between 10 °C (50 °F) and 25 °C (77 °F), in climates that have relatively mild/cool summers, with two periods of rapid growth in the spring and autumn.[31] They retain their color well in extreme cold and typically grow very dense, carpetlike lawns with relatively little thatch.

- ✿ Bentgrass (*Agrostis* spp.)
- ✿ Bluegrass (*Poa* spp.)
- ✿ Feather reed grass (*Calamagrostis* spp.)
- ✿ Fescues (*Festuca* spp.)
- ✿ Ryegrasses (*Lolium* spp.)
- ✿ Tufted hair grass (*Deschampsia* spp.)

❖ Warm season grasses

Warm season grasses only start growth at temperatures above 10 °C (50 °F), and grow fastest when temperatures are between 25 °C (77 °F) and 35 °C (95 °F), with one long growth period over the spring and summer (Huxley 1992). They often go dormant in cooler months, turning shades of tan or brown. Many warm season grasses are quite drought tolerant, and can handle very high summer temperatures, although temperatures below -15 °C (5 °F) can kill most southern ecotype warm season grasses. The northern varieties, such as buffalograss and blue grama, are hardy to 45 °C (113 °F).

- ✿ Bahia grass (*Paspalum* spp.)
- ✿ Bermuda grass (*Cynodon* spp.)
- ✿ Buffalo grass (*Bouteloua dactyloides*)
- ✿ Carpet grass (*Axonopus* spp.)
- ✿ Centipede grass (*Eremochloa ophiuroides*)
- ✿ Grama grass (*Bouteloua* spp.)
- ✿ Kikuyu grass (*Pennisetum clandestinum*)
- ✿ St. Augustine grass (*Stenotaphrum secundatum*)
- ✿ Zoysia grass (*Zoysia* spp.)

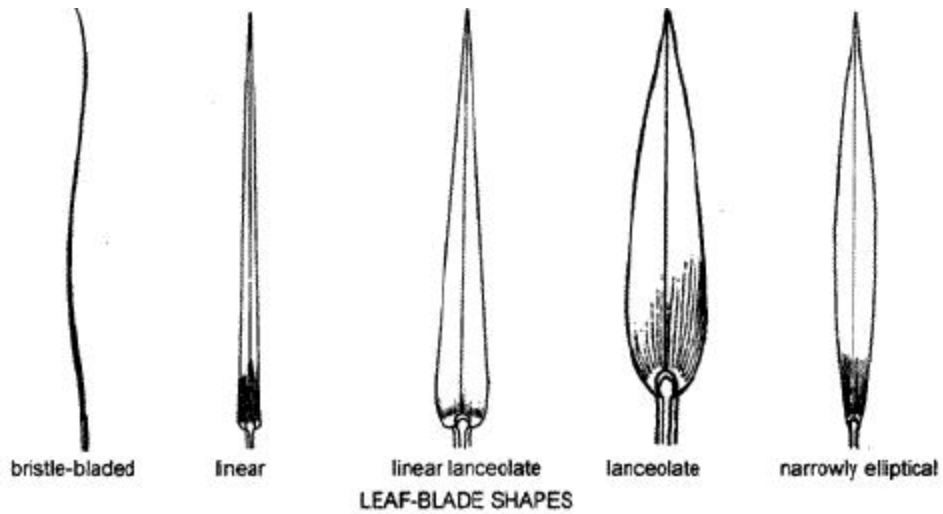
PROPAGATION PARTS

- ✗ Rhizomatous- producing rhizome eg: *Cyanodan dactylon*
- ✗ Stoloniferous- producing stolens eg: *Poa paratensis*
- ✗ Bunch type eg: *Festuca arundinaceae*

LEAF BLADE

SIZE

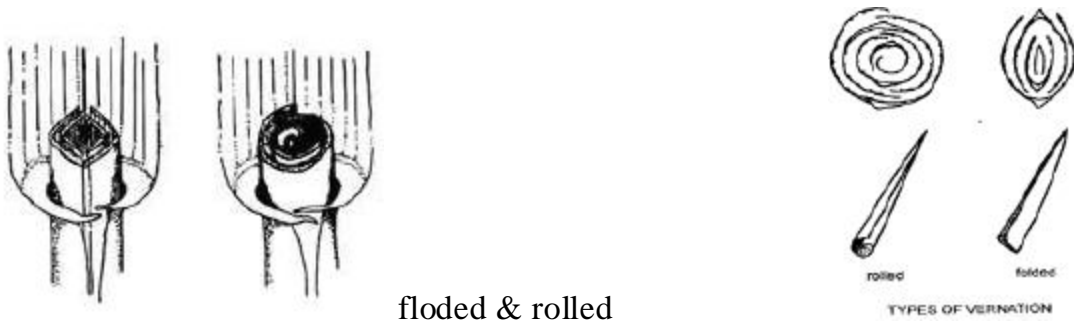
The main leaf blade emerges from the narrow sheath, which is located just above soil level. Leaf size varies from narrow and thin to large and flat, depending on the species. It varies from 1/8 inch to 1/6 inch (width).



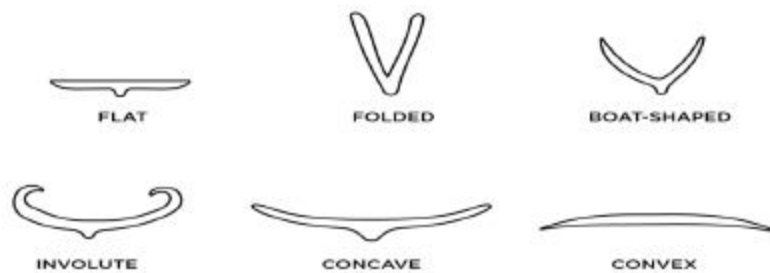
LEAF SHAPE

Leaf shape may vary from species to species. Some may be with pointed and some may be blunt. Some have midrib running up the centre of each leaf, and some without midrib. Some leaves have ribs on it.

LEAF BUD

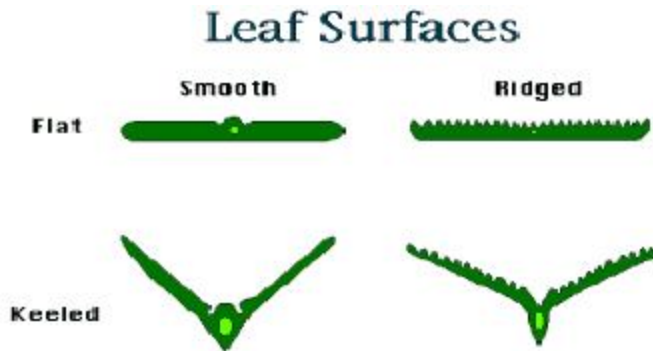


TYPES OF LEAF SHAPES



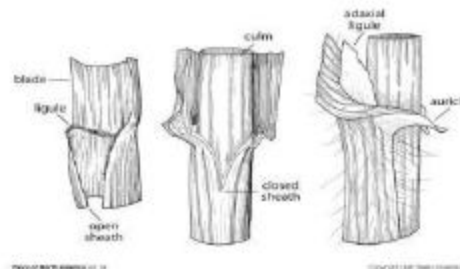
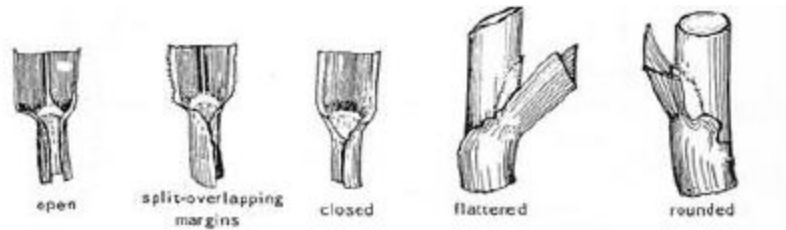
TEXTURE DIFFERENCE

A variety of factors can alter the texture of a grass blade. Tall fescue has hook-like hairs along the leaf surface, which can be seen. It also has vertical raised veins running down the entire leaf surface. Perennial rye grass has several raised ribs running along the vertical length of the grass blade on the front surface is smooth and almost shiny. *Zoysia* grass has hairs growing on the ligule, which is almost clear membrane visible where the leaf emerges from the lower surface.

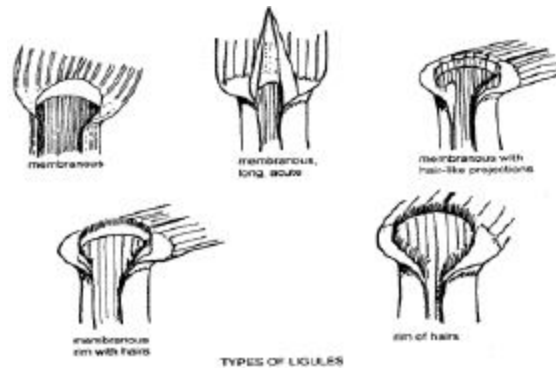


STEM AND SHEATH CONTACT

Bermuda grass leaf blade emerge from a central shoot at $\frac{1}{4}$ inch intervals. *Zoysia* grass leaf blades also emerge from a central stalk, but they grow at nearly a right angle to the stalk. St. Augustin, lay almost flat on the ground as they emerge from the central crown.



LIGULES



B3 Vegetative Plant Identification Characteristics – Grass Plants

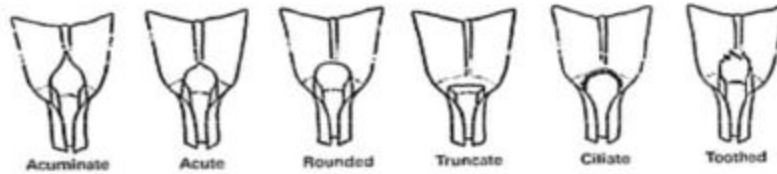


Figure 3.12 Ligule margins.

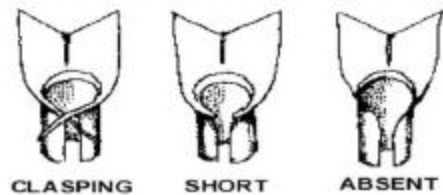
Ligule Shape

<http://www.tut.ac.uk/teaching/NRES330/week5/2010/ligule%20margin.pdf>

AURICLE

B4 Vegetative Plant Identification Characteristics – Grass Plants

AURICLE CONFIGURATION

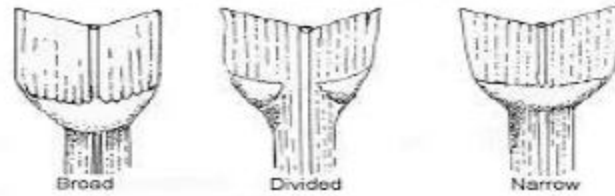


Auricles

<http://www.tut.ac.uk/teaching/NRES330/week5/2010/ligule%20margin.pdf>

COLLARS

Collar: Region of junction between blade and leaf sheath of grasses.



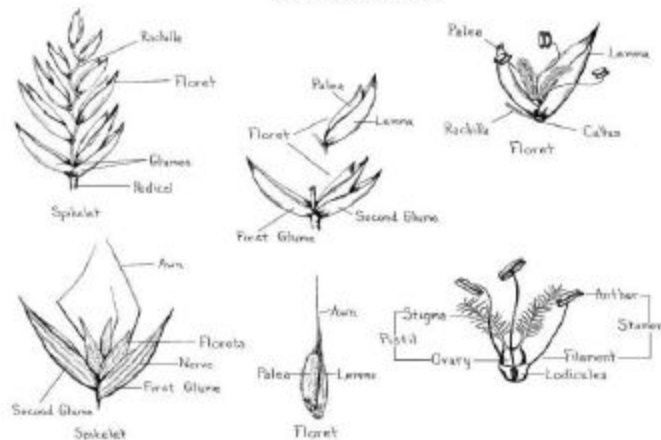
PRESENCE OF HAIRS IN LIGULES



INFLORESCENCE

The flower is usually bisexual. It consists of an ovary containing 1 ovule (the female part). The ovary is usually surmounted by two feathery stigmas and is surrounded by three stamens. Each stamen (the male part of the flower) consists of an anther and a filament. There are no petals or sepals. Instead, the flower is protected by two sets of scales. The first set consists of the LEMMA and the PALEA which enclose the flower. This whole structure is called a floret.

GRASS FLORAL PARTS



PARTS OF FLOWER

GLUMES

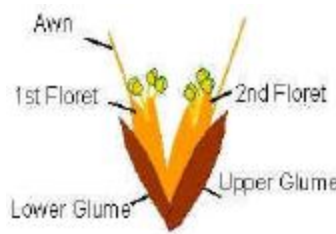
One or more florets may be arranged on an axis (the RACHILLA), with all of the florets being protected by a second set of scales at the base called GLUMES. The glumes enclose the florets before they are mature.

The whole unit is called a SPIKELET. The Lemmas (of individual florets) and/or the Glumes, may have bristle-like extensions called AWNS arising from them.



SPIKELET

A spikelet is made up of 2 florets. The spikelets are arranged into a flowering head (inflorescence) in a number of different ways depending on species.



TYPES OF INFLORESCENCE

PANICLE

When the spikelets are borne on stalks on branches from the main axis, the flower-head is called a PANICLE

RACEME

If the spikelets are stalked directly on the main axis, then the flower-head is a RACEME.

SPIKE

Where there are no stalks, and the spikelets are seated on the main axis itself, the flower-head or ear is known as a SPIKE.



PANICLE



RACEME



SPIKE

Examples of seedheads



Panicle: Triangular in outline with seeding branches around the main stem. Examples: Bluegrass, Redtop.



Spike: Spikelets attached at the top of an unbranched stem. Examples: Timothy, Fescue.



Slender seeding spikes attached at the top of the main stem. Examples: Crabgrass, Goosegrass.



Slender seeding spikes attached along the top of the main stem. Examples: Signalgrass, Dallisgrass.

Examples of spikelets



Forming clusters of seeds. Examples: Bluegrass, Ryegrass.



With long pointed awns. Examples: Nimbewill, Wild Oats.



Born singly on short branches. Examples: Witchgrass, Fall Panicum.



Containing several seeds. Examples: Sandbur, Buffalograss.

DIFFERENT TYPES OF GRASS USED IN TURF MAKING

1. *Cynodon dactylon*- Bahama grass, devil's grass, couch grass, Indian doab, arugampul, grama, wiregrass, scutch grass, Bermuda grass

- Medium to coarse textured grey-green grass.
- Leaf bud: Leaves folded in the bud.
- Ligule a fringe of hairs. Collar narrow, covered with long hairs.
- Auricles absent.

- ✿ Sheaths strongly compressed, sparsely hairy, split and loose.
- ✿ Blades short, 1/8 inch wide, rough along the edges, sharp pointed.
- ✿ Growth habit: Stoloniferous and rhizomatous.
- ✿ It loses its color and becomes locations during the cooler months of late autumn and winter.

2. *Stenotaphrum secundatum* – ST. Augustine grass

- ✿ It is a broad bladed, medium green grass.
- ✿ Leaf-sheaths keeled, leaves are folded in the bud.
- ✿ Ligule is a fringe of hairs.
- ✿ Collars are narrow and forms a short stalk or petiole for the leaf blade.
- ✿ Inflorescence composed of racemes. Racemes borne along a central axis.
- ✿ Habit: perennial, creeping, mat forming grass.
- ✿ Stolons are present that forms shoots at every node.

3. *Sporobolus* sp : seashore dropseed, marine couch, sand couch, salt couch grass, saltwater couch, coastal rat-tail grass.

- ✿ It is a spreading perennial bunch grass from 10 to 50 centimetres in height.
- ✿ Its flowers are green or purple.
- ✿ It reproduces asexually by use of both stolons and rhizomes

4. *Buchloe dactyloides* - Buffalo grass

- ✿ It is a fine textured grayish green grass.
- ✿ Leaves rolled in the bud.
- ✿ Ligule a fringe of hairs, short in the center, long at the edges.
- ✿ Collar broad, hairy.
- ✿ Auricles absent.
- ✿ Sheaths short, flattened, smooth.
- ✿ Blades are less than 1/8 inch wide, flat, twisted or curled, sparsely hairy.
- ✿ Growth habit: Stoloniferous, low growing grass.

5. *Penicium calandestinum* - kikuyu Grass

- ✿ It is a coarse textured light green grass.
- ✿ The leaf are floded in the bud.
- ✿ Ligule is a fringe of hairs and auricles are absent.
- ✿ Growing habit: rhizomatus and stoloniferous.

6. *Zoysia japonica*- Zoysia grass

- ✿ Leaves rolled in the bud.
- ✿ Ligule a fringe of hairs.
- ✿ Collar medium, covered with long hairs.
- ✿ Auricles absent.
- ✿ Blades short, 1/8 inch wide, sharp pointed sparsely hairy on top side.
- ✿ Growth habit: Stoloniferous and rhizomatous.

7. *Zoysia matrella* - Manila grass

- ✿ *Z. matrella* grows as a low, rhizomatous, perennial grass.
- ✿ Prostrate culms grow.
- ✿ Leaves grow stiffly with the blades often curled, 3-8 cm long and 1.5-2.5 mm wide.
- ✿ The leaf sheaths are smooth with a membranous ligule and hairy throat.
- ✿ The inflorescences are terminal with spike-like racemes up to 4 cm long.
- ✿ Spikelets yellowish brown to purplish brown, 10-30, loosely overlapping.
- ✿ The lower glume is usually absent; the upper glume is lanceolate, 5-veined with a prominent midrib.
- ✿ The lemma is oblong-ovate, 2-2.5 mm and the palea is lanceolate, half as long as the lemma.

8. *Zoysia tenuifolia*

- ✿ Sod-forming perennial species that possess both stolons and rhizomes.
- ✿ The grasses turn brown after the first hard frost and are among the first warm season grasses to green up in the spring.
- ✿ The species vary from extremely fine textured to coarse textured types and the leaf blades are very stiff due to a high silica content.
- ✿ Leaves are rolled in the bud shoot.
- ✿ Leaf blades are smooth with occasional hairs near the base, margins are smooth and blades are sharply pointed.
- ✿ Ligule is a fringe of hairs.
- ✿ Auricles are absent.
- ✿ Leaf sheath is round to slightly flattened, split, glabrous, but with a tuft of hair at the throat.
- ✿ Inflorescence is a short, terminal spikelike raceme with spikelets on short appressed pedicels.

9. a) *Festuca arudinacea*- Tall Fescue

- ✿ Leaves folded in the bud.
- ✿ Ligule membranous, very short. Collar narrow, indistinct.
- ✿ Auricles absent.
- ✿ Sheaths slightly rough, not compressed, wider than the blades, lower sheaths brown. Blades very narrow, 1/16 inch wide or less, bristle-like.
- ✿ Growth habit: Rhizomatous.

b) *Festuca rubra*- red fescue

- ✿ Leaves folded in the bud.
- ✿ Ligule membranous, very short. Collar narrow, indistinct.
- ✿ Auricles absent.
- ✿ It spreads very slow by very short rhizomes.

c) *F. Longifolia*- Hard fescue

- ✿ It is a fine bladed grayish to dark green grass.
- ✿ Leaves are folded in the bud.
- ✿ Ligule membranous, very short. Collar narrow, indistinct.
- ✿ Auricles absent.
- ✿ It is a bunch grass with a semi-erect growth habit and heavy roots.

10. *Agrostis stolonifera*- Creeping bent grass

- ✿ Leaf blade width - 2–5 mm.
- ✿ Inflorescence branches - the flowers are attached to branches rather than to the main axis of the inflorescence.
- ✿ Spikelet length - 2–3.5 mm.
- ✿ Leaf sheath hair type there are no hairs on the surface of the leaf sheath.
- ✿ Leaf ligule length - 0.7–7.5 mm.
- ✿ Leaves rolled in the bud.
- ✿ Ligule membranous, tall, rounded.
- ✿ Collar narrow.
- ✿ Auricles absent.
- ✿ Sheaths smooth, not compressed.
- ✿ Blades narrow, flat, veined, rough along the edges.
- ✿ Growing habit: stoloniferous, forms mat or thatch layer above the soil line.

11. *Poa annua* - annual meadow grass, annual bluegrass Annual grass

- ✿ Leaves folded in the bud
- ✿ Ripples on mature leaves
- ✿ Ligule membranous, medium long, slightly pointed and silvery.
- ✿ Collar narrow, smooth
- ✿ Auricles absent
- ✿ Sheaths slightly compressed, smooth
- ✿ Blades short, about 1/8 inch wide, the edges parallel to each other
- ✿ Leaves terminate in a "boat-shaped" tip
- ✿ Prolific seed production at any height.

12. *Poa trivialis* – Rough Bluegrass

- ✿ Leaves folded in the bud.
- ✿ Ligule membranous, very short, abrupt. Collar narrow.
- ✿ Auricles absent.
- ✿ Sheaths green, compressed smooth. Blades long, less than 1/8 inch wide, the edges parallel to each other, terminating in a prominent mid-vein, "boat-shaped" tip.
- ✿ Growth habit: Rhizomatous.

13. *Poa partensis* - Kentucky blue grass

- ✿ It is a dark green, medium textured turf.
- ✿ Leaves are folded in the buds.
- ✿ Auricles are absent.
- ✿ Ligules are present.
- ✿ Leaf blades have boat shaped tip, the side blades are parallel.
- ✿ Growing habit: underground rhizomes.

14. *Cynosurus cristatus* - Dogs tail grass

- ✿ Leaf blade width - 0.5–4.3 mm
- ✿ Inflorescence branches - the flowers are attached to branches rather than to the main axis of the inflorescence there are no branch points between the base of the inflorescence axis and the flowers, or they are not obvious.
- ✿ Leaf ligule length 0.5–2.5 mm.
- ✿ Growing habit: bunch forming.

15. *Elytrigia repens* - Quack grass

- ✿ Leaves rolled in the bud.
- ✿ Ligule membranous, very short.
- ✿ Collar broad, continuous.
- ✿ Auricles claw-like, slender, clasping the stem.
- ✿ Sheaths not compressed, lower sheaths with short hairs, upper sheaths smooth.
- ✿ Blades flat, 1/4 inch wide, rough on the upper surface, smooth below, pointed.

16. *Dactylis glomerata* - Orchard grass

- ✿ Very fibrous root system lacking rhizomes.
- ✿ Blades are bluish green and strongly keeled.
- ✿ Large membranous ligule.
- ✿ Growing habit: clumping perennial.

17. *Dichondra repens*:

- ✿ It is a bright green colored ground cover with broad, circular leaves.
- ✿ It is not a grass, but a low growing broad leaf ground cover.
- ✿ *Dichondra* is not recommended for sunny positions, but in shady or part shade position it will provide a good low maintenance lawn substitute.
- ✿ It needs no mowing.

Work done

Today we have identified three grass species with their morphological characters in our orchard. The grass species are as follows,

1. *Cyanodan dactylon* - couch grass
2. *Stenotaphrum secundatum* – ST. Augustine grass
3. *Zoysia* sp

Cyanodan dactylon



Stenotaphrum securdatum



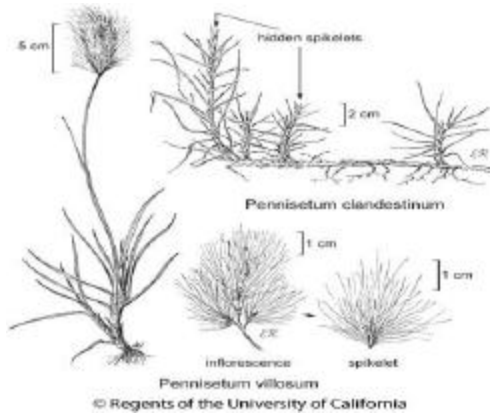
Sporobolus sp



Buchloe dactyloides



Pennisetum calandestinum



Zoysia japonica



Zoysia matrella



Zoysia tenuifolia



a) *Festuca arundinacea*



b) *Festuca rubra*



c) *Fesyuca longifolia*



Agrostis stolonifera



Poa annua



Poa trivialis



Poa partensis



Cynosurus cristatus



Elytrigia repens



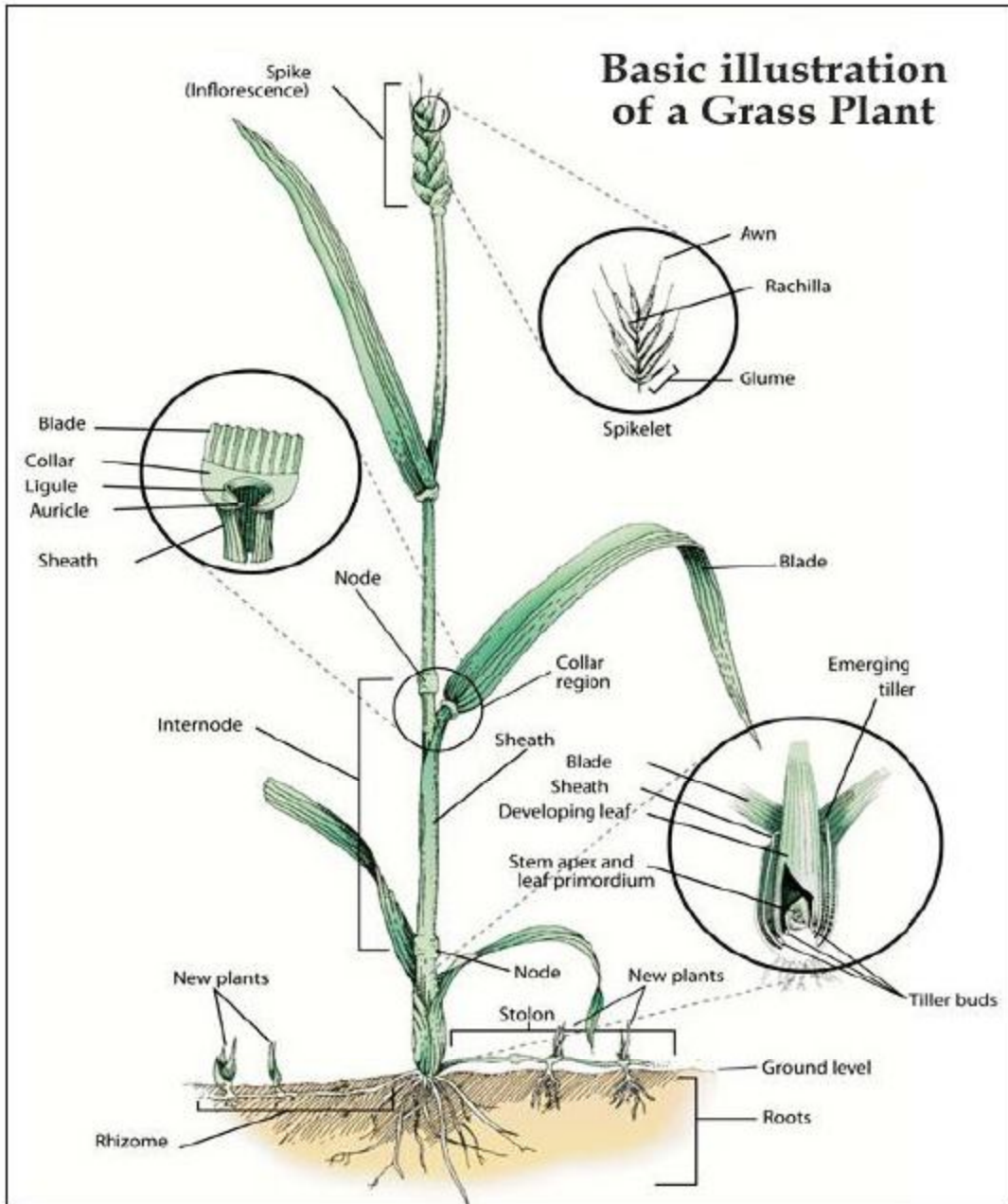
Dactylis glomerata



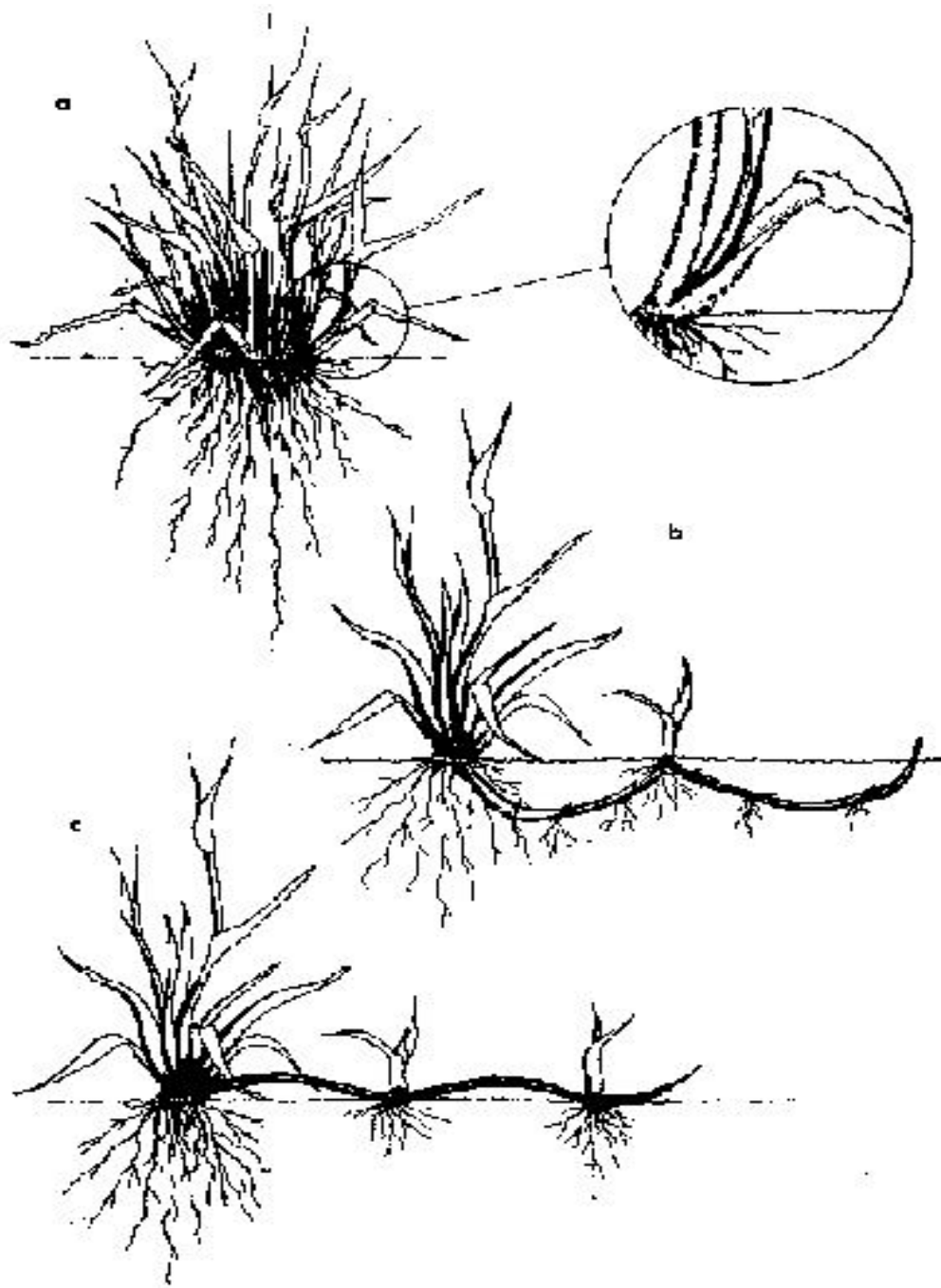
Dichondra repens



Basic illustration of a Grass Plant

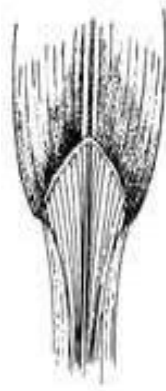


University of Missouri Extension



Turfgrass growth habits: (a) bunch type (insert shows tillering)
(b) rhizomatous, and (c) stoloniferous.

KENTUCKY BLUEGRASS (*Poa pratensis* L.)



Structural features of Kentucky bluegrass

- very short, flat, membranous ligule
- parallel-sided leaf blades
- rhizomatous growth habit
- medium-coarse to medium-fine leaf texture, depending upon cultivar and cultural intensity
- light to dark green color, depending upon cultivar, time of year, and cultural intensity



ANNUAL BLUEGRASS (*Poa annua*)

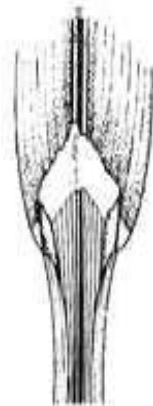


Structural features of annual bluegrass

- long, pointed, membranous ligule
- parallel-sided to slightly tapering leaf blades
- bunch-type to weakly stoloniferous growth habit
- light green color



ROUGH BLUEGRASS (*Poa trivialis* L.)

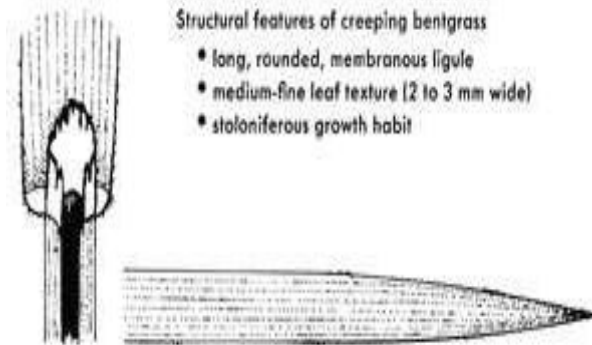


Structural features of rough bluegrass

- long, membranous, slightly toothed ligule
- tapering leaf blades that appear shiny on the undersides
- stoloniferous growth habit
- roughened, "onion-skin" appearance on lower portion of mature leaf sheath
- light green to yellowish-green color



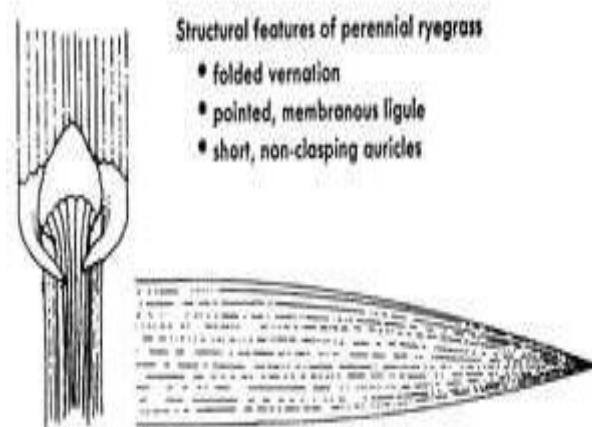
CREEPING BENTGRASS (*Agrostis palustris* Huds.)



Structural features of creeping bentgrass

- long, rounded, membranous ligule
- medium-fine leaf texture (2 to 3 mm wide)
- stoloniferous growth habit

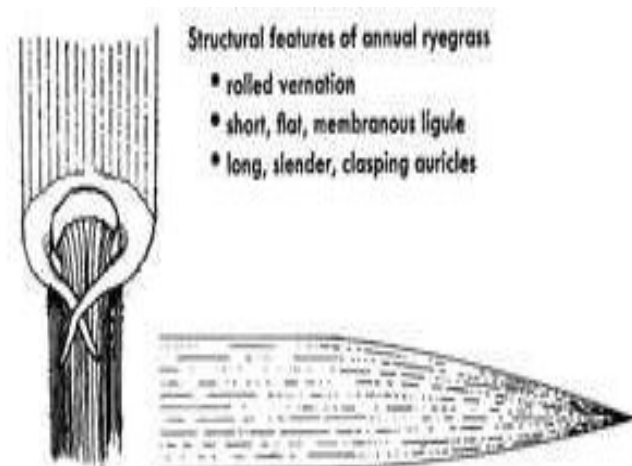
PERENNIAL RYEGRASS (*Lolium perenne* L.)



Structural features of perennial ryegrass

- folded vernation
- pointed, membranous ligule
- short, non-clasping auricles

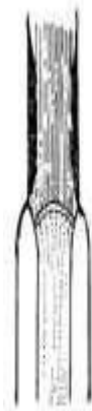
ANNUAL RYEGRASS (*Lolium multiflorum* Lam.)



Structural features of annual ryegrass

- rolled vernation
- short, flat, membranous ligule
- long, slender, clasping auricles

RED FESCUE (*Festuca rubra* L.)



Structural features of red fescue

- folded vernation
- very narrow leaves, folded or flat depending upon moisture conditions



TALL FESCUE (*Festuca arundinacea* Schreb.)



Structural features of tall fescue

- rolled vernation
- wide, stiff leaf blades with prominent veins on the upper side
- bunch-type growth habit, but sometimes with short rhizomes
- short, stubby auricles



BERMUDAGRASS (*Cynodon dactylon* (L.) Pers.)

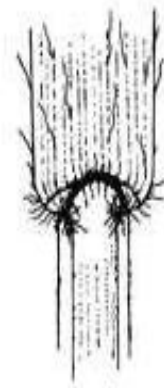


Structural features of bermudagrass

- folded vernation
- ligule is a fringe of hairs
- long hairs extending from the collar
- smooth leaf blade with short hairs
- both stolons and rhizomes present

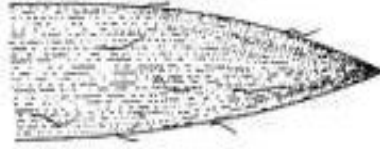


ZOYSIAGRASS (*Zoysia japonica* Steud.)



Structural features of zoysiagrass

- rolled vernation
- ligule is a fringe of hairs
- long hairs extending from the collar
- smooth leaf blade with long, slender hairs extending from the upper side
- both stolons and rhizomes present



5.VARIETIES, HYBRIDS AND CLASSIFICATION OF TURF GRASSES

Turf grass classification:

Cool-season turfgrasses

- Grasses with optimum growth at temperatures between 60 and 75°F (15.5 to 24°C).
- Eg: Creeping bent grass, Colonial bent grass, Fine fescue, Tall fescue, Hard fescue, Red fescue, Kentucky blue grass, Annual rye grass and Perennial rye grass.

Warm-season turfgrass

- Grasses with optimum growth at temperatures between 80 and 95°F (27 to 35°C).
- Eg: Buffalo grass, Bahia grass, Bermuda grass, Dichondra grass, Carpet grass, Kikuyu grass, Seashore paspalum, St. Augustine and Zoysia grass.

Turf grass species:

s.no	Botanical name	Common name	Texture	Situation
1	<i>Cynodon dactylon</i>	Hariyali or arugu or doob grass	Medium fine	Suitable for open sunny location, drought resistant
2	<i>Stenotaphrum secundatum</i>	St. augustine or buffalo grass	Coarse fine	Suitable for shady situation, require frequent watering
3	<i>Sporobolus tremulus</i>	Chain grass or upparugu	Fine	Suitable for saline soil and open sunny locations
4	<i>Poa annua</i>	Annual blue grass	Medium fine	Suitable for acid soils and suitable for higher elevation
5	<i>Pennisetum clandestinum</i>	Kikuyu grass	Rough	Grown well in acid soils and suitable for higher elevation
6	<i>Zoysia japonica</i>	Japan grass	Coarse	Suitable for poor sandy soil; open sunny

				situation,slow in growth
7	<i>Zoysia matrella</i>	Manila grass	Medium	Suitable for open sunny situation
8	<i>Zoysia tenuifolia</i>	Korean grass or velvet or carpet grass	Fine	Suitable for open sunny situation
9	<i>Cynodon sp.</i>	Bermuda or Hyderabad grass	Fine	Suitable for open sunny situation,needs mowing
10	<i>Cynodon sp.</i>	Dwarf Bermuda	Medium	Suitable for open sunny situation
11	<i>Festuca sp.</i>	Fescue grass	Coarse	Shade tolerant,survive on inferior soils
12	<i>Paspalum vaginatum</i>	Paspalum grass	Medium	Suitable for open sunny situation
13	<i>Paspalum notatum</i>	Bahia grass	Coarse	Utility turf,suitable for good road ways
14	<i>Agrostis stolonifera</i>	Bent grass	Fine	Suitable for golf greens and other intensive cultivated areas
15	<i>Poa pratensis</i>	Kentucky blue grass	Fine	General purpose turfs,home lawns, athletic fields and parks
16	<i>Centipede sp.</i>	Centipede grass	medium	Utility turf,low use lawn grass

VARIETIES AND HYBRIDS:

Bermuda grass:

Varieties:

Cheyenne, Guymon, Jackpot, Numex sahara,Sonesta, Sundevil, U3, Yuma

Hybrids:

Tifgreen, Tiflawn, Tifway

Sun turf is a natural hybrid of *C. dactylon* and *C. transvaalensis*. It is originated in S. Africa

and introduced in USA in 1949. The color of this hybrid is dark green. It forms a very dense

Turf with fine textures. It's a low growing variety. This is commonly used in lawns.

Tif green Bermuda grass is a hybrid of *Cynodon dactylon* and *C. transvaalensis*. This hybrid has the capacity to resist disease, poor irrigation circumstances, high traffic and droughts. It is low growing, dark green grass and spreads quickly. This grass can regenerate quickly as well.

Tif dwarf (*C.dactylon* x *C.transvaalensis*), this variety is a vegetative mutant of Tifgreen. Tifdwarf is mostly similar with Tifgreen but its leaves and internodes are much shorter than Tifgreen. The green colour is also darker than Tifgreen. Tifdwarf becomes reddish-purple in colour immediately after the winter. For its superior putting quality it is popularly used for golf greens, tennis courts and bowling greens and such.

Pee Dee (*C. dactylon* x *C. transvaalensis*) is also a mutant of Tifgreen. It is a dark green dwarf variety. The texture is very fine and can spread rapidly. For its fast growth, it is quite popular for use in golf greens.

Tif way type is the combination of nice looks and toughness. It is the product of cross between *Cynodon dactylon* and *C. transvaalensis* germplasm. It is dark green in colour with fine textured leaves. The specialty of this grass is that it is persistent, and can grow and spread quickly. It also has a property to recover quickly from injury. It is a high quality Bermuda hybrid. Tifway is primarily used for sports fields, golf course fairways, commercial and residential lawns. During winter, Tifway becomes dormant but can recover quickly when temperatures rise. This grass can also survive in shallow waters.

Tif way II is the next improved variety of Tifway. This variety has a better resistant capacity to nematode infestations. It can tolerate the cooler temperatures. But it is not as persistent as Tiflawn. It needs an extra maintenance care for keeping the lawn attractive.

Santa Ana is a thick grass with broader leaves. It can survive even in dry desert but needs continuous mowing for maintenance. It can resist smog. The main application of this grass is in the golf field, home lawns, tennis courts, sports fields etc. This type of grass can also be planted in low desert valleys.

Tif lawn is a very old variety. It is a dense turf with good texture. It has a good tolerance to drought. The growth is very fast and recovers quickly from adverse situations. It is an excellent choice for athletic fields, lawns with high traffic areas and parks.

FloraTex is an improved variety of common Bermuda hybrids. Its developed in Texas and Florida. It has a medium texture and has drought resistance capacity. It comparatively requires less fertilizer for growth and development. The mode of plantation of this variety is vegetative. It's commonly used in lawns.

Blackjack is a deep green warm season grass available in seed form. It has super fine texture with carpet like density. The growth is vigorous and has excellent cold tolerance capacity even in cold winter areas. The colour of the grass remains same all through the summer providing dense green lawn.

Ormond Bermuda grass is blue-green in colour. The grass has a medium texture and density. It can tolerate a number of leaf diseases but can't survive in cold. The grass is mainly used in golf courses, playground and sports fields.

Jackpot Bermuda Grass is good for Baseball Fields. It needs some good maintenance for proper growth. The quality of Jackpot depends on the sourcing locations.

Yuma is a dark green grass capable of forming dense turf. It is developed from the basic forage grasses. These days it finds its applications even in most exclusive golf greens. It has fair salt tolerance and drought resistant capacity. It requires sun and is a slow growing species. It remains dormant below 60 degree temperature but recovers quickly when temperature rises.

Oasis Blend is popular for its rapid growth and easy maintenance. It is green in colour and commonly used for golf course fairways, sports fields, home lawns, parks etc.

The new improved seeded Bermuda varieties include Princess-77, Riviera, Sahara, Savannah, Sultan, Sundance, Sundevil I & II, Sydney, Mohawk, Triangle Blend, Yukon, La Prima etc.

La Prima is the 2-way blend of improved turf type of La Paloma and SR-9554. It is dark green in colour and forms genetically stable turf having medium to fine texture with pest and disease resistant quality. It is mostly used for fast germination and rapid growth in short time. It has low maintenance requirements and is relatively less expensive.

Sahara (SR-9554) is a dense turf with beautiful green colour. It is wear and drought tolerant. Sahara is economical, easily seeded good choices for use in

lawns and excellent for athletic fields, parks areas and such. It needs very low amount of fertilizer to grow well.

Princess 77 is a special variety of improved common Bermuda and has very fine leaves. It is world's first dense, finest textured seeded Bermuda grass and available in seed form. Recommended mowing height of Princess 77 can vary between 3/16 inch to 1 inch.

Triangle Blend is a dark green improved turf type seeded variety with medium fine texture. It is a fast growing turf grass with excellent drought and cold tolerance capacity. It may not be as good in quality as other varieties, but considering price and performance, it can be very attractive. Recommended mowing height is between ½ inch to 2 inches.

Mohawk is an advanced synthetic turf-type Bermuda grass variety. The name of the variety Mohawk has come from the Mohawk Valley in Arizona from where it was produced. It is lush green with fine textures and a cold tolerant variety. It can survive in low winter temperatures in the Northern transition zone area. It is also a great choice for saline condition.

Yukon or OKS91-11 is a seeded variety created by the Oklahoma State University. It is one of the best varieties among the seeded Bermuda grass when it comes to cold tolerance ability. It has uniform, dark green colour and ultra-fine texture.

Princess 77 is economically available in 5 lb sizes especially for growing small lawn areas such as putting greens. It is used for both professional sports fields and for high end commercial / home lawns or anywhere a premium Bermuda Grass is desired.

Riviera Bermuda Grass is a high quality turf variety very similar to Princess 77 but with higher cold tolerance (winter survival). Riviera Bermuda Grass seed is planted for home putting greens and high input lawns where the ability to mow closely and grass leaf density is important.

Yukon is a popular variety due to it's dark green color (very similar to Tifway 419 in color) along with excellent cold tolerance and slower growth for less mowing. These varieties are not for use on high-speed modern Golf Greens but are excellent choices for seeded and fairways.

Pasto Rico is a mixture of common and giant bermuda.

Cheyenne II Bermuda is one of the newest seeded forage varieties that is attracting a lot of attention from ranchers for its excellent pasture grass performance.

Tierra Verde is an excellent cost economical pasture blend.

Bahia grass:

Pensacola: More cold tolerant and more attractive. Tolerant to salty soil and water.

Bent grass or creeping grass:

Penn eagle: It provides an excellent playing surface for tees, fairway, bowling green, or croquet courts. It has medium-fine, non-aggressive, semi-erect growth habit with a darker green colouration than other bent grasses.

Penn cross: It has a medium green colouration and has rapid establishment. It has excellent resistant to dollar spot. Seedling rate: 1.5 lbs. per 1000 sq. ft.

Seaside: It has medium-fine blade produces a dense stand of grass for high quality playing surfaces. It is often chosen for coastal golf courses.

Buffalo grass:

Cody: Premier warm season turf grass. Faster establishment, higher density, excellent winter hardiness, low water requirement, darker colour, fine texture and a wide area of adaptation give Cody the edge as the choice for low maintenance area.

Tatanka: Tatanka is a seeded, turf-type buffalo grass developed by the institute of agriculture and natural resources.

Prairie: It produces a thick turf carpet. It spreads faster and creates more uniform quality turf than other grasses.

Stampede: It is a semi-dwarf variety native to Texas. It exhibits all the drought tolerance and disease resistance. Low growing height enables stampede to remain attractive with even less mowing.

Fescue grass: Fine fescue

Aurora, Bighorn, Claudia, Flyer, Ensylva, Longfellow, Marker, Medallion, Reliant, Salem, Scaldis, Shademaster, Spartan, victory.

Tall fescue:Kentucky 31 and Alta, amigo, Avanti, Aztec, bonsai, Cimarron, Cochise, Crewcut, crossfire, duster, guardian, monarch, ninja, pixie, rebel Jr, Shenandoah, tomahawk, tribute, twilight, virtue, wrangler.

Some as rebel III, Earth save, Shenandoah, Titan II, Tarheel

Kentucky blue grass:

America, asset, A-34, Blacksburg, blue star, chateau, classic, eclipse, glade, Julia, logts 1767, midnight, Princeton 104.

Perennial rye grass:

Commander,dimension, Manhattan II, palmer, pennant, pick 715, Riviera, Saturn, SR-4000, and SR-4100.

HYBRIDS:

S.NO	NAME OF THE COMPANY	RELEASED HYBRIDS
1.	Gardner turf grass	Reveille (Kentucky blue grass× Texasblue grass)
2.	The Scotts company	Thermal blue (tall fescue× Kentucky blue grass) Solar green Thermal blue blaze Dura blue(tall fescue× Kentucky blue grass)
3.	Seed research of Oregon	Bandera Spit fire
4.	Turf seed Inc	Longhorn
5.	Others	Fire and ice Fahrenheit

Reveille:It is a hybrid turf grass. Crossing a native Texas bluegrass and Kentucky bluegrass.it has an appealing green colour, medium texture, is heat and full sun tolerant, cold hardy, and has resistance to fall armyworm, and

moderate resistance to rust and white grub. Reveille establishes easily from sod, but saline conditions should be avoided.

Thermal blue: It is a cool season grass. Thermal blue is resistant to brown patch and diseases, and aggressive rhizome development gives it remarkable wear tolerance.

SPF 30: SPF 30 has increased shade tolerance, allows sod to self-repair, reduces clumping and broadening of leaf blade width that occurs in other grasses with age. It has aggressive growth rate. Optimum mowing height of 2-5 inches.

Dura blue: In Dura blue, higher mowing height increases the quality. It requires frequent mowing as a result of their aggressive growth habit. It is susceptible to the disease dollar spot, indicating that fungicide applications are necessary to maintain a high quality turf during late summer and fall season.

Bandera: Texas × Kentucky bluegrass hybrid combines the extensive rhizomes and heat and drought tolerance of Texas bluegrass with the turf quality and density of Kentucky bluegrass. Sod growers and sports fields will benefit from its high performance.

Arcardia: Low mow tolerance. Excellent seedling salt tolerance. High sod strength. High wear tolerance. Dark green. Summer patch resistance.

Fielder: Rapid establishment. Excellent traffic tolerance. High year round density. Low maintenance.

Granite: Dark green. High density. Fine leaves. Great winter colour. High summer patch resistance. Low mow tolerance. High sod strength.

SR 2100: Resistant to summer patch.

SR 2150: Highly resistance to summer patch, dollar spot and typhula blight.

SR 2284: Drought and heat tolerant. Very fine leaf texture and high density. Shade tolerant. Rust and necrotic. Ring spot resistance.

Mercury: Drought tolerant. Rust and leaf spot resistant.

Spitfire: Texas × hybrid type. Fast establishment. High turf quality. Very dark green colour. Blends well with tall fescue.

Penncross



Bandera grass



Thermal Blue



SPF 30



Penn eagle



Tif green Bermuda grass



Thermal blue



Tif way Bermuda Grass



Tall Fescue



Red Fescue



Perennial Rye Grass



Bent grass



Bahia



Bermuda



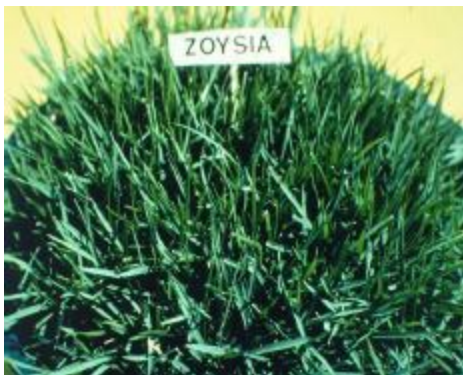
Centipede



St. Augustine



Zoysia



Kentucky Blue Grass



6.TURF GRASSES NURSERY TECHNIQUES AND MANAGEMENT

PROPAGATION OF TURF GRASS:

There are many different ways that turfgrass can be propagated. Turfgrass has a lot of unique characteristics that allow it to be reproduced in many different ways. Several of the ways that turf is propagated are by

Seeding,Sodding, Hydromulching,Sprigging, Plugging and Stolonizing.

STOLONIZING:

Stolonizing is the process of taking the stolon of the turf grass plant which is a reproductive structure and spreading them over the surface of the dirt much like seeding. This type of propagation only works with grasses that are stoloniferous. The most common stoloniferous grass is the bermudagrass and bent grass. The process is much more expensive task as compared to seeding which will be talked about later. The one benefit of stolonizing is that it can produce a very uniform turf that is all one genetic type. This can also be a very bad thing if there is a specific disease affecting that specific cultivar of grass so it is generally not recommended.

PLUGGING:

Plugging is the process where small pieces of sod,plugs are taken and placed throughout the area being filled in with grass. This process will leave a lot of the soil exposed which can be down side to this procedure. The plugs in the cause are supposed to take root and then spread to fill in the bare dirt. The general rule is that will take at least one to two seasons to complete the fill in the area. Since the plugged area has a lot of bare soil there can be a big problem with weeds. The big benefit is that plugging can be somewhat cheaper than sodding. A one thousand squarefoot piece of sod can cover one thousand squarefoot of plugs. Any grass type that spreads can theoretically be used for plugging but with the time it takes get fully established it generally is not done but the most commonly used grass for plugging are Augustine grass and zoysia grass.

SPRIGGING:

Sprigging is the another way of propagating turf grass. Sprigging is a vegetative propagation and it is used when the type of grass you want to use has a poor seed quality are the seed for the grass is not available. Sprigging is usably used for warm season grasses. sprigging is a processes that uses the stolon or rhizome of the grass plant and is cut so that each sprig has two to three holes on them and then he sprig is placed in the soil by manually or mechanically means so that a quarter of the sprig is till above ground. A quarter of the sprig left above the group so the plant will up.

SODDING:

Sodding is the quick way of good quality grass fast using so ,when establishing grass helps avoid erosion. The roots of sod are not established so the soil water neither the sod could still was away and unless the sod is stapled down. The sod could wash away. The biggest downside to using sod is price. It can be quite expensive to cover a large area with sod.

HYDROMULCHING:

Hydromulching is somewhat new but now is being used more. Hydromulching sometimes called hydroseeding. This process uses seed of the grass you want to mixed in with virgin wood mulching and water is sprayed on to the ground that you want seeded. The mulching helps to reduce the erosion and it helps keeps the soil moist, the process is somewhat expensive but is usually cheaper than the sodding.

SEEDING:

Seeding is the probably the most common propagation procedure seeding is usually cheapest option. The process is carried out by selecting the seed you want and then tilling the soil and leveling it. Then spreading the required amount of seed over the area and then lightly raking it into the soil. The biggest advantage to seeding is the time its take to get the final product.

ESTABLISHING A TURF FROM –SEED:

A well prepared seedbed is essential for the establishment of grasses. Purchase a high quality seed and prepare the soil for planting. When the soil has

been properly prepared, spread the seed at the appropriate time and rate for your species.

- i. Measure the area to be planted and determine the total amount of seed needed.
- ii. Divide the total amount of seed in half.
- iii. Sow half of the seed following a vertical pathway and sow the remaining half horizontally as sown at right.
- iv. Spread seed with a drop, broadcast, or handheld spreader.
- v. At low seeding rates, saw dusts, sand or other suitable material mixed with the seed aids in obtaining uniform coverage.
- vi. Cover the seed to a depth of 1/16 to 1/18 inch by raking it in and lightly rolling or firming the soil
- vii. The finished seedbed should have shallow uniform depressions about 1/12 inch deep and 1-2 inches apart.
- viii. For summer turf establishment, a thin layer of mulch (no more than 1/4 inch thick) can be spread over the seeds with a peat spreader to protect the seeds and keep the soil moist.
- ix. Keep the soil moist during the germination period (usually 1-weeks) by applying frequent, but light irrigation.
- x. Large lawns or hand-to-reach areas may be better hydro seeded.

From -Sod

Prepare the soil

Be careful not to make deep footprints or wheel tracks before planting, as these depressions restrict root development and give an uneven appearance to the installed sod.

Order sod and install immediately

On hot summer days, water the soil just before laying sod to avoid placing the turf grass roots on a dry, hot surface.

Sod can be laid anytime of the year, but when possible, it is best to avoid very hot or very cold weather.

Generally it is the best to lay sod during the active growing period of your turf grass species. Cool-season grasses do best when planted during the early fall or early spring and the warm-season grasses do best when planted mid-late spring.

From–Sprigs, stolon's, plugs

Some warm –season grasses cannot be established from seed and must be sodded or vegetative established using sprigs, stolon's or plugs. Prior to planting the soil should be prepared properly.

- i. Dig holes with a garden trowel about 6-12 inches apart
- ii. Moisten soil
- iii. Plant plugs in holes
- iv. Cover the holes and make sure the plugs are level with the ground
- v. After planting ,lightly roll the area
- vi. After planting ,keep the area moist until the grass becomes established

Sprigging/Stolonizing

- i. Broadcast stolons over an area and cover lightly with soil by disking or plant in rows, in 2-inch deep furrows 6-12 inches apart.
- ii. Place nodes so they are in contact with the soil.
- iii. Fill the furrows and then lightly roll the area.

Keep the area moist until the grass becomes established.

7.TURF ESTABLISHMENT METHODS

Turf can be established by different methods.such as,

1. Seeding
2. Sodding
3. Sprigging/stoloniferous
4. Plugging
5. Turf plastering
6. Hydroseeding
7. Artificial turfs(Astroturfing)

SEEDING:

It is the most common method of establishing a lawn.you need about 35 g of seed for every square metre of lawn.For an even spread, sow half your seed from left to the right across the plot, and the other half from front to back. Cover the seed to a depth of the length of the seed. The ideal sowing depth is 1 cm.In dry weather, keep the seedbed permanently moist for the first two to three weeks.If the seed is applied unevenly or too little seed is applied the end result will be a patchy uneven lawn.Avoid excessive seeding that can produce crowded, weak, unthrifty plants and increase seedling disease invasion.The best seeding tool is a drop spreader, preferably one that has been calibrated to deliver the proper amount. Every seed will not produce a grass plant, a healthy mature lawn about six to eight turf plants per square inch.

Different turf grasses have different seeding rates;

Seed rate vary according to the size and weight of turfgrassspecies.For example,

- Kentucky bluegrass (*Poa pratensis*)has a small seed and a high seed count per kilogram.
- Perennial ryegrass (*Lolium perenne*) has a large seed and a lower count per kilogram.

After	Species name	Seed rate(per100m ²)
	Kentucky bluegrass	0.5 - 1.0 kg
	Fine fescues	1.0 - 3.0 kg
	Perennial ryegrass	2.0 - 4.0 kg
	Tall fescue	2.0 - 3.0 kg

seeding, there are two activities important for successful turf establishment:

- The first is making sure there is a good seed-to-soil contact. Accomplish this task by using a lawn **rake** to lightly mix the seed into the upper 5mm of soil. Follow the raking with a light rolling to produce a firm seedbed. A light rolling can be accomplished by using an empty water-ballast roller. **Rolling** not only increases seed-to-soil contact, but also firms the seedbed and slows drying of the soil. Mulch with a thin layer of clean straw to prevent drying. You do not have to remove the straw after the grass seed germinates. Raking off the straw would injure the young grass seedlings.
- At the time of planting, irrigate frequently and lightly, wetting the upper 15mm of soil. Continue watering during the period of germination. Average germination times vary according to the turfgrass species and the conditions under which germination takes place.
- During the cooler months of the year as an aid to quicker germination a layer of frost protection or **shade cloth** can be laid over the site where the grass seed was planted.
- This speeds up the germination process and causes the seed to germinate more consistently, it also helps to retain surface moisture longer and helps prevent rain out washing of seeds on sloping ground. Remove the cloth when the young grass plants have reached between 10mm and 20mm.

SOME BENEFITS AND CONCERNS OF SEEDING A LAWN:

ADVANTAGES:

- The desired species or cultivars can be used.
- It is less expensive than hydroseeding or sodding.
- Stronger initial root system development.

DISADVANTAGES:

- Initial establishment takes longer.
- Time of seeding is limited mainly to late summer and early fall or mid spring after soil temperatures reach 50°F..
- It is necessary to supply consistent moisture to young seedlings.
- Re-seeding areas with poor germination may be required.

DIBBLING:

- It is cheapest and slowest method of lawn making but it is the most common method.
- Rooted or uprooted grass cuttings can be dibbled when the soil is slightly moist.
- The dibbling may be done at a spacing of 10-12 cm apart and frequent watering should be done till the grass starts sprouting.
- The roots spread and grow underground in the course of 3-4 months making a fairly compact lawn.
- The grass gets ready for first cutting in 5-6 weeks.
- This method takes about 4-5 months to establish a good lawn.

SPRIGGING:

- Pieces of short stems or runners are called **sprigs** which may also be used to establish a lawn.
- This method of lawn establishment is called sprigging and accomplished by placing the sprigs in shallow about 1-2 inches furrows at about 4-6 inches spacing.
- Using plant runners, cuttings, or stolons without soil attached to start new lawns.
- Sprigging is slow if done by hand.
- It Can be done by broadcasting plant parts and rolled or disked into the soil.
- Usually used on larger areas such as golf courses.

PLUGGING:

- Using small plugs or blocks of sod to plant in holes about 1 foot apart.
- This process will leave a lot of the soil exposed which can be a down side to this procedure.
- The plugs in this case are supposed to take root and then spread to fill in the bare dirt.
- The general rule is that it will take at least one to two seasons to completely fill in the area.
- Since the plugged area has a lot of bare soil there can be a big problem with weeds.
- The big benefit is that plugging can be somewhat cheaper than sodding.
- A one hundred square foot piece of sod can cover one thousand square feet of plugs.
- Most commonly used grass for plugging are St. Augustine grass and zoysia grass.

TURFING/SODDING:

- Sod is often faster and more reliable than seed, which requires more time and care to establish.
- Sod is especially popular when there is an immediate need to reduce erosion or reduce the amount of soil that gets tracked indoors.
- Sod allows you to establish a lawn even when seeding conditions are not optimal.
- Small pieces of well prepared lawn or turf are cut into square or rectangular shape preferably.
- Turf is a piece of earth with compact grass on it.
- Selected small piece of grass should be cut uniformly thick selected from a place free from weeds and grasses along with soil are placed on prepared ground side by side closely.
- Slightly beat down flat into position.
- Any cavity or interspaces found should be filled with fine soil.

Season for sod installation:

Fall is the optimum time of year to establish cool-season species such as

- Tall fescue
- Kentucky bluegrass.
- A fall planting date will allow adequate time for the roots to develop prior to the next summer.
- Lawns sodded in the spring and summer will not survive droughty conditions well the first year. For these reasons, it is essential to provide proper irrigation for summer-established sod until the turf can establish a new root system.
- Due to construction deadlines, it is sometimes necessary to install sod during the winter. Dormant sodding can be successful but is more risky than fall sodding due to the increased risks of winter desiccation and injury.
- However, you can establish warm-season grasses (such as zoysia grass and bermudagrass) almost any time of the year although early summer is best.

Roll Sod Into the Soil :

Lightly roll the lawn after installation. Rolling eliminates irregularities, removes air pockets, and establishes good contact between the sod and soil.

Water Thoroughly:

As soon as the sod is installed and rolled, begin to thoroughly water it .Water the sod to keep it sufficiently moist, and then irrigate daily in the morning until the sod becomes well rooted, usually about 10 days after installation.Sod may take longer to root when temperatures are above (summer) or below (late fall and early spring) optimum. During warm, dry periods it may be necessary to water multiple times each day.Lack of irrigation is the number one reason dormant sodding is unsuccessful.

ADVANTAGES:

- Rapid establishment of a lawn.
- Good for slopes or areas prone to erosion.

- Sod can be installed any time during the growing season (provided water is available).
- Sodded lawns can be safely trafficked sooner than seeded lawns.
- Dust and mud is practically eliminated.

DISADVANTAGES:

- The cost is higher than for seeding.
- Choice of turfgrass species and cultivars used in sod production is limited.
- Sod is not produced in shaded environments.
- Incompatibilities between sod-farm soils and soils at the planting site can cause sod to perform poorly.
- Sod may shrink, allowing weeds to invade between pieces.
- The speed of sod rooting changes with the season.

TURF PLASTERING:

- Grass is chopped properly into small bits of 5-7 cm long.
- Two baskets of chopped grass pieces should be mixed with one basket garden soil and fresh cow dung and a shovel of wood ash with required quantity of water to form a thick pasty substance.
- This mixture is then spread uniformly on the surface of a levelled ground to a thickness of at least 2.5 cm and watering should be done.
- Then ground should be rolled.
- The grass will shoot up in a fortnight. Lawn mower is used after three months.

HYDROSEEDING:

- Hydroseeding involves mixing seed, a fiber mulch, fertilizer, and perhaps a tacking agent in a tank of water .
- This mixture is sprayed through a large hose and nozzle and applied much like paint over the prepared seedbed.
- This method generally is performed by contractors.

- It is a very effective way to apply seed and is useful on hilly sites prone to erosion and on windy sites where seed might be blown away.

SEEDS USED FOR HYDROSEEDING:

Pensacola Bahia, Argentine Bahia, Carpet Grass, Zoysia, Bermuda, Native Grasses, Seaside Paspalum ("Sea Spray").

MULCHES USED FOR HYDROSEEDING:

- Hydra Matrix (*Heavy Erosion Control*)
- Bonded Fiber Matrix (*Heavy Erosion Control*)
- Geo skin Cotton Based Mulch (*Hydroseed & Erosion Control*)
- 100% Wood Fiber Mulch (*Hydroseed & Erosion Control*)
- 70/30 Blend Mulch (*Hydroseed & Erosion Control*).

The advantages and disadvantages of hydroseeding a lawn are:

ADVANTAGES:

- The desired species or cultivars can be used.
- An effective method for applying seed on hills prone to erosion and windy sites where seed can be blown away.
- It also works well on flat protected areas.
- The seed is mixed with water and the mulch holds the moisture, so hydroseeded lawns come up quickly.
- Establishment costs is less than sodding or plugging.
- Fertiliser and growth stimulants can be added together with the mulch.
- Very even distribution of seed gives excellent uniformity of turf.
- Rain or irrigation does not easily wash seeds off slopes.

DISADVANTAGES:

- Initial establishment takes longer.
- Time of seeding is limited mainly to late summer and early fall or mid spring after soil temperatures reach 50°F.

- It is necessary to supply consistent moisture to young seedlings.
- Re-seeding areas with poor germination may be required.
- Weed encroachment can be a problem
- A constantly moist seedbed is required during germination this is however aided by the addition of the mulch
- Birds eat the seed.

ASTRO TURFING/ARTIFICIAL TURFING:

- Artificial turf is a surfacing material used to imitate grass. It is generally used in areas where grass cannot grow, or in areas where grass maintenance is impossible or undesired.
- It was developed by chemists at Monsanto in the mid 1960.
- It was first known as Astroturf, when it was installed as the sports surface at the Houston Astrodome in 1996.
- They usually require less maintenance.

Step1:

APPLY FOUNDATION FOR THE ARTIFICIAL:

- Remove all existing grass and/or existing surface, leaving room for the base material.
- Install a base of either tiny gravel or sand.
- Level the surface and then apply an embankment of 4 to 5 cm.
- If the artificial turf is enclosed with paving, curbs or something similar, the sand/gravel must be kept 1 to 2 cm below the rim.

Step 2:

APPLYING PRESSURE CLOTH:

- Roll the pressure distributing cloth over the base material and cut it to size with a Stanley knife.
- Make sure that there is an overlap of 5 to 10 cm.

- In order to reduce weed growth, the cloth should connect as closely as possible to the edges.

Step 3:

ROLLING OUT THE GRASS:

- Roll out the turf so that you are looking against the grain.
- Take care when rolling out the turf; make sure that you have a excess of 2 to 3 cm on both sides, ensuring there is room for corrections.

Step 4:

CUTTING ARTIFICIAL GRASS TO SIZE:

- Always use a sharp knife and cut diagonally from the bottom (backing) to avoid damaging the fibers.
- If artificial grass is cut along the borders or curb always cut from the top. Cut the first pool of artificial grass with excess 'backing' at the sides of the roll.
- Afterwards lay the cut to measurement pieces of artificial grass in succession.

At least four specialized tools are needed for artificial turf maintenance:

1. A brush for the fibers.
2. A rake to stir the infill (to keep it from getting too compact).
3. A sweeper to pick up debris.
4. A sprayer to disinfect and spray anti-static material.

The advantages of synthetic turf are:

- Reduces water usage and waste through irrigation or sprinklers.
- Reduces dust, dirt and allergens around the property.
- Does not require mowing, edging, trimming or fertilizer.
- Stays green and beautiful year round with a minimum amount of care and grooming.
- Reduces the need for pesticides and may reduce mosquitoes, fleas and other common pests.
- Can stabilize slopes, increase usable backyard space, enhance the look and appeal of the property.

- Can be installed on non-porous areas, reducing radiant heat and glare from side yards and patios.
- Can increase the form and function of a property with entertaining amenities such as bocce, golf & yard games.
- Easily rejuvenated if neglected, repaired if damaged and modified if changes are desired.

The disadvantages of synthetic turf are:

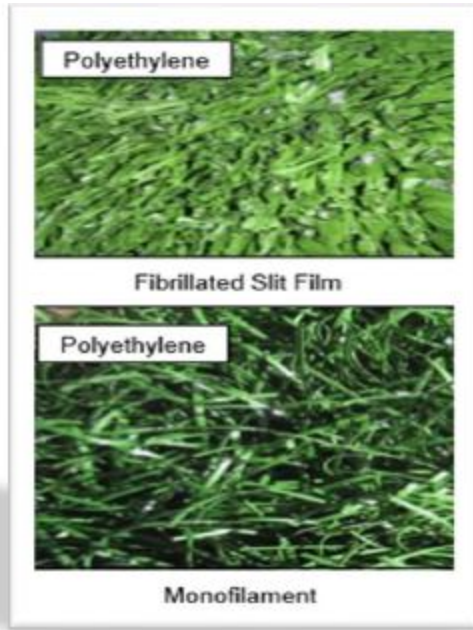
- The initial investment is somewhat costly.
- It can be labour intensive.
- In full sun, on hot days, the surfaces can become uncomfortably hot.
- If animals are defecate upon the surfaces, feces should be removed as soon as possible and the surfaces must be cleaned and sanitized with basic household products (enzymes, vinegar and green cleaners).

➤

SURFACE MATERIALS USED FOR ARTIFICIAL TURFING

1.Polyethylene (PE):

- i. Slit film styles (made popular in sports field installations) tend to be a wider blade, resembling some natural fescue grasses or a Bermuda grass.
- ii. while monofilament fibers are more like a natural lawn of rye or blue-grass.

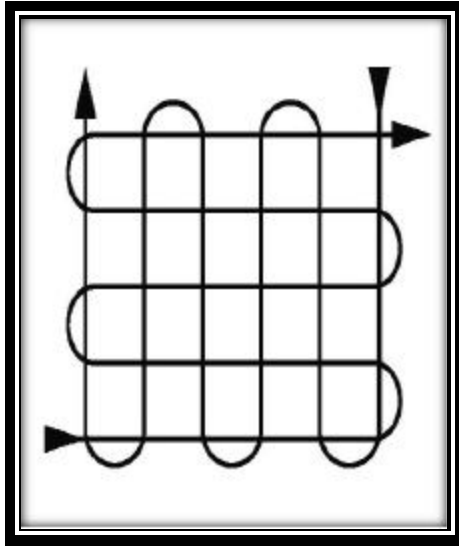


2. Polypropylene (PP)

3. Nylon (PA)



SEEDING METHOD



DIBBLING



PLUGGING



SPRIGGING



SODDING



HYDROSEEDING



ARTIFICIAL TURFING (ASTROTURFING)



iv.

8. TURF IRRIGATION MANAGEMENT

IRRIGATION

To supply of water to land or crops to help growth, typically by means of channels.

IRRIGATION WATER QUALITY:

1. P^H

Acid and alkalinity of irrigation water is burning of turf grass. Adding the rain water

to Neutralize the irrigation water.

2. ELECTRICAL CONDUCTIVITY (EC) and TOTAL DISSOLVED SOLIDS (TDS)

$$\text{TDS (ppm or mg/L)} = \text{EC (mmhos/cm or dS/m)} * 640$$

Acceptable TDS con. For turf irrigation 200 to 500 mg/L (EC=0.31 to 0.78mmhos/cm)

TDS con. Higher than 2000 mg/L (EC=3.1 mmhos/cm) can damage grass.

TDS con. Higher than 500 mg/L attention should be focus on irrigation duration and frequency, drainage, and turfgrass species selection.

3. SODIUM

> 70mg/L foliar burning

4. SODIUM ABSORPTION RATIO (SAR)

The relative concentration of Ca, Na & Mg are important to the irrigation water.

Ca and Mg – maintaining the structure of clay soil.

Excess Na, low Ca & Mg – break down of structure, precipitation of OM, reduced permeability.

SAR < 3.0 – very safe for turf grass.

SAR >9.0 - structural damage .

Sandy soil are not as susceptible to structure and permeability problems, & can tolerate higher SAR values (SAR=10).

5.CHLORIDE

100 mg/L – Tolerant to turf

>355 mg/L - Injury to turf.

6.BORON

Turf grass are more tolerant of B & growing B-10 mg/kg in soil.

But the water B < 2mg/L

NUTRIENTS IN IRRIGATION WATER :

Nutrient concentration of irrigation water is very important because is fixing the fertilizer schedule of lawn.

Nutrient con. In irrigation water (mg/L)

MACRONUTRIENT	LOW	NORMAL	HIGH	VERY HIGH
NITROGEN	<1.1	1.1-11.3	11.3-22.6	>22.6
NITRATR	<5	5-50	50-100	>100
AMMONIUM	<2	2-75	75-100	>100
PHOSPHORUS	<0.01	0.1-0.4	0.4-0.8	>0.8
POTASSIUM	<5	5-20	20-30	>30
CALCIUM	<20	20-60	60-80	>80
MAGNESIUM	<10	10-25	25—35	>35
SULFUR	<10	10-30	30-60	>60

MICRONUTRIENT	ACCEPTABLE RANGE	SUGGESTED MAXIMUM CONCENTRATION
IRON	2.4-4.0	5.0
MANGANESE	<0.2	0.2
COPPER	<0.2	0.2
MOLYBDENUM	<0.1	0.1
ZINC	<0.3	2.0
BORON	<2.0	2.0

TECHNIQUE TO IDENTIFY INDICATION OF WATER REQUIREMENT:

1.COLOUR TEST:

When water is unavailability of long time a lawn show Bluish-gray color

2.FOOTPRINTING:

Walk across the lawn and examine the lawn behind you to see if your steps left any “foot prints”. Your foot print will appear in lawn when the grass plants have low level of water in their tissue. If foot prints remain for an extended period of time the lawn should be watered to prevent the grass from becoming dormant.

3.LEAF CHECK:

During a dry period the lawn grass shows Wilting, rolling folding. This symptoms signal that watering is necessary to prevent the turf grass from turning brown and becoming dormant.

HOW MUCH WATER DOES A LAWN NEED: Turf grass need about ¾” -1” of water per week to green color and active growth.

TIME OF IRRIGATION:

The 1st few warm days of summer does not automatically mean to water lawn. In fact, allowing lawns to start to go under mild drought stress actually increases the rooting.

WATER AS INFREQUENTLY AS POSSIBLE:

Thoroughly water when you do water so moisture soak down to the roots.

But newly seeded lawns where the surface needs to stay moist, newly sodded lawns that have not yet rooted into the soil or when summer patch disease is problem.

Otherwise avoid frequent watering that promote shallower root system and weeds

(e.g, Crab grass).

Water early in the day if possible:

The best time of day to water lawns is early morning.

Avoid midday watering due to excessive evaporation and at night due to potential increased chances of some diseases gaining a footholds. The lawn should have time to dry before the sun sets.

Spread the water uniform across the lawn.

WATER CONSERVATION:

- Mow your lawn at a higher than the normal height, avoid applying an excess of N as warm weather approaches, limit traffic over the lawn, improve turf rooting, control thatch & soil compaction, avoid pesticide use on drought stressed lawns.
- Avoid over watering:
- Hold the watering after fertilization and hold off fertilization if heavy rains are expected:

WATER SAVING IDEAS

- You don't have to water the entire lawn. Consider only those area that need water.
- In lawns on compacted clay soil where water does not penetrate easily, considered aerifying the lawn. Loosening up the soil with a spread fork or use a powered machine that create holes or pores in the lawn by the action of spoons or tines mounted on a drum or reel.
- Use a automatic sprinkler irrigation system.
- Check for damaged sprinkler heads and replaced heads that leak.

MANAGE THE LAWN DURING THE STRESSFUL SUMMER:

- Maintain adequate levels of P & K to encourage deep rooting and drought tolerant.
- Reduce the thatch layer thicker than half an inch by dethatching. Heavy thatch layer may contain more grass roots than soil, thus making the grass plants less tolerant to drought and more susceptible to heat injury.
- Do not water when rain is forecast.

AUTOMATIC IRRIGATION :

- Global navigation satellite system, GPS, GIS, remote sensing ,hydraulic sensing are used.
- Remote sensing is the science of deriving information about an object or phenomena through analysis of data acquired by a device that is not in contact with the object or phenomena under investigation.
- GPS is a world wide radio navigation system that allows to users to determine their exact location, velocity and time 24 hours a day, in all weathers condition anywhere in the world.

CONNECTING TO THE TIMER:

If using an automatic timer, connect the control valves to it with electrical wires through a waterproof pipe. Timer are often installed in the garage. Be sure to arrange the control valves so that areas that have different water requirements can be watered and programmed separately.

METHODS OF APPLICATION:

Watering cans are impractical except on extremely small areas.

Hose pipes can be used for small lawns, and are particularly useful in awkward place such as banks. Apply as a fine spray with an adjustable nozzle attachment.

Perforated plastic tubes are useful for grass paths and awkward places but give a less even application than sprinkler.

Sprinklers may be either static , rotary- armed, popup & oscillating.

1st 3 types sprinkler cover a circular area.

Oscillating covers a rectangular area.

Oscillating types adjustable to give angled coverage or changeable spray pattern.

Popup sprinkler installed below the surface lawn. Then are lifted up and set in motion by the pressure of the water.

Portable sprinkler:

Least expensive

Portable heads attached to a hose.

No initial installation costs are involved, portable sprinklers have several drawbacks over a long term.

To operate properly, someone needs to be present to move the sprinkler from spot to spot.

All spots have been watered uniformly.



BRIGGS IRRIGATION

It is a self travelling rotary irrigators or 'Roto Rainers'.

4 wheel chassis, fully galvanized drum, full hydraulic package and remote SMS monitoring and control.



SPTINKLER HEAD REVIEWS

1. Hunter PGP ultra rotor sprinkler heads:

Water a large portion of lawn.

Full circle adjustment (50-360 degree)

Easy to change length, angle & size, adjustable arc, 5 hunter PGP 2.5 nozzle.

Dirty water tolerance.

A complete package that is ready to use



2.Melnor Xt turbo oscillating sprinkler

Infinity turbo motor for a smooth operation in both high & low pressure.

Integrated flow control dial helps in the adjustment of the watering pattern.

Smooth operating tabs regulate the length of the watering .

Cover a large area, easy to adjust

Price is quite high

Plastic construction.



3. Toro 3-inch popup sprinkler head

Easy to install

Includes seals to keep debris out

Adjust the pattern of watering easily.

3" popup height ideal for use on short lawns.

Seals designed to prevent leakage.



4. Rain bird rotor heads 5000 rotor sprinkler head

3.0 GPM preinstalled nozzle

Top adjust arc adjustment that only requires a flathead screwdriver.

40-360 degree arc rotation

4 Rainbird 5000 sprinkler heads

Provides a lot of water pressure

Easy to install and adjusted

5004PC 4-Pack 3.0 Nozzle Pre-Installed



5.Orbit 62100 yard enforced motion activated sprinkler:

Heavy duty construction with metal dual step spike and brass hose.

Deterrent sprinkler with day and night detection options.

120 degree arc motion sensor that detect intruders from 40 feet

Sensor tech. to help conserve water and energy.

30 min time watering setting.

Water proof battery compartment.

Batteries don't last long.



6.Adjustable rotating head:

Circular lawn coverage up to 5800 square feet.

A sturdy ABS plastic construction .

Arc adjusted 25-360 degree.

Ring button on the top to adjust the distance the water will cover from 26 – 32 feet.



7.Rain bird 25PJDAC brass impact sprinkler

Covers up to 5200 square feet.

Water saving die cast PJTM spray arm control to prevent side splash of water.

Deflect flap that allow you to adjust the stream length from 20 to 41' radius.

Diffuser screw that breaks water into small droplets.

Adjust 20-360 degree .

Heavy duty sprinkle featuring brass, bronze and stainless steel construction.

CONS:

Zero instructions

Clips are quite hard to remove for 360 degree coverage.



Rain bird SPIDAC

8.Orbite 57353 3-valve heavy duty preassembled manifold

Available in 2-3 valve models

Built with Uv- resistant & durable high impact plastics.

Work with poly pipe systems PVC both ¾" & 1" system

Easy to install

Solid construction

It doesn't leak

Clear instruction manual

Valves are easy to remove.



9. Automatic 360 adjustable garden sprinkler

Sprinkler covers 3600 sq.ft

Construction with high quality of ABS plastics and a rust proof polymer.

Light weight, simple & easy use,360 degree angle

Multi-adjustable arms for small & big lawn.

CONS:

Doesn't come with different size adapters



10.Orbit 55662 voyager II professional 4” adjutable popup gear drive rotor:

Operate quietly

Include an adjustment key

It's compatible with a variety of brands

Easy to install and adjust

Great quality

Clear instruction

Provides a great coverage

Versatile with a variety of spray pattern.

CONS:

It doesn't water enough, close to the sprinkler.



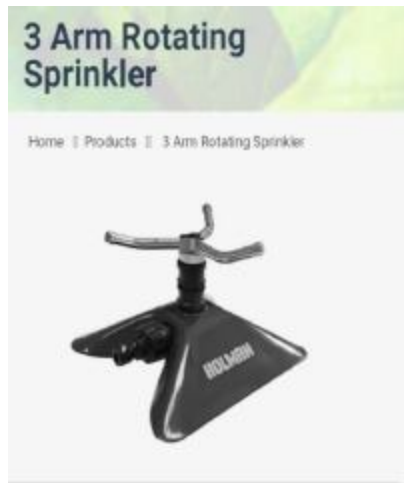
**Orbit 55662 voyager II professional 4”
adjutable popup gear drive rotor :**

11. 3 arm rotating sprinkler

Adjustable nozzle

Circular covering this is connects to any standard 12mm hose.

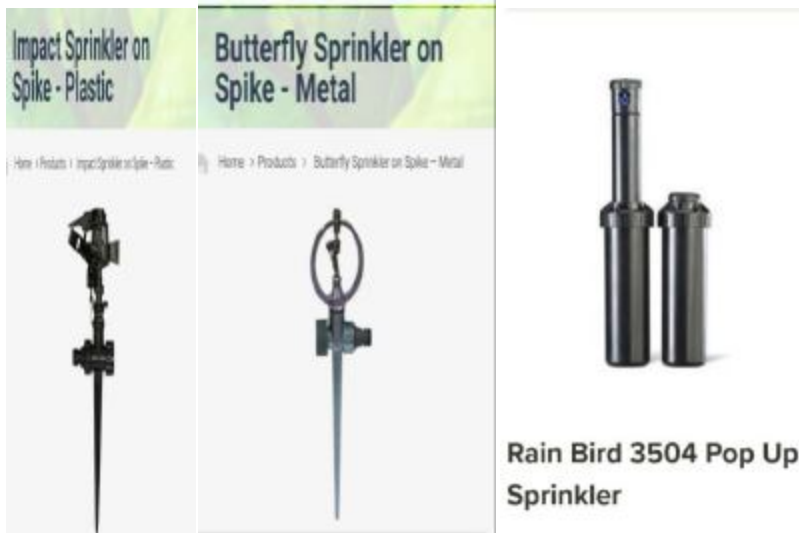
2 years products warranty



OTHER LAWN SPRINKLER ON LAWN

- Butterfly sprinkler on spike- Metal
- Impact sprinkler on Metal foot base- metal
- Dome sprinkler- metal
- Impact sprinkler on spike- plastic
- Impact sprinkler on wheel base- metal
- Lawn sprinkler base- plastic
- Oscillating sprinkler adjustable –plastic
- Pyramid sprinkler
- Rotary sled Sprinkler- metal
- Sprinkler sled base-plastic
- Adjustable rotary arm sprinkler
- Rotary arm sprinkler
- Adjustable turret sprinkler
- Rotary drum sprinkler
- Adjustable turret sprinkler
- Rotary drum sprinkler

- Hunter 1-90 rotor
- Raingun irrigation
- Rainbird 2045-PJ impact sprinkler
- Jak działa dyszy R-VAN 18 rainbird



Rain Bird 3504 Pop Up Sprinkler



Rain Bird 1800 4" Pop Up Sprinkler Body

Rain Bird Variable Arc Nozzles - Various Sizes



PERMANENT UNDERGROUND SPRINKLER SYSTEM

STEPS FOR DESIGNING AN IRRIGATION SYSTEM

1. Measure your yard and map out the lawn area close to scale as possible

Include all area of yard such as tree , planting beds,, or other plants.

These plants have different water requirement from turf and must be separate into zones.

2. Indicate where the pipe and control valves would be placed.

3. In the lawn area, mark the placements for each sprinkler head; be aware of slopes or construction that may hinder good coverage.

4. To obtain uniform coverage, place sprinkler heads so that the out put of each one overlaps neighboring ne by 50% ; spray should extend from sprinkler head to sprinkler head.

Square or triangular shaped patterns are common.

INSTALLING A TURF IRRIGATION SYSTEM

1. Plan the system.
2. Access the water line.
3. Dig trench and fit the pipe together.
4. Connect to the main water source.
5. Install the valve manifold.
6. Run the PVC pipe.
7. Attach risers and flush out the system.
8. Install the sprinkler head.
9. Connect to timer.



Plan the System



Access the Water Line



Dig the Trench



Install the Valve Manifold



Run the PVC pipe



Install the Sprinkler Heads



Install the Controller

9.TURF DRINAGE MANAGEMENT

DRAINAGE

Drainage is the natural or artificial removal of a surface's water and sub-surface water from an area with excess of water.

When constructing a new lawn, a through working of top soil and breaking up the sub-soil, with the textural improvement where necessary, should ensure that surplus moisture is not held at the surface.

If, however, the site is known to be wet places then form of drainage should be installed

ADVANTAGES OF SUBSURFACE DRAINS

- Provides aeration to root zone
- Improves soil structure and maintains soil temperature
- Facilitates easy movement of farm Machines
- Decreases chances of flood hazards
- Occupies no surface land
- Small capacity drains are required
- Less maintenance cost compared to surface drains

DISADVANTAGES OF SUBSURFACE DRAINS

- Require high initial cost
- Requires steeper gradient
- Repair works are costly and inconvenient
- Only seepage water is removed
- Construction is difficult

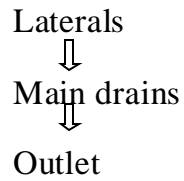
INVESTIGATIONS FOR SUB-SURFACE DRAINAGE

- Topographic map of the area
- Data of soil physiochemical properties
- Position of ground water table and its fluctuation
- Quality of groundwater
- Logs of soil and subsurface mater

- Irrigation practices and their Requirements

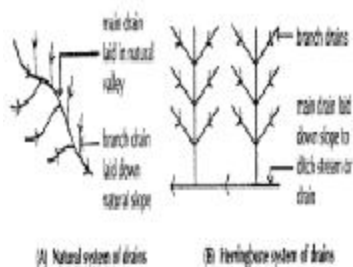
LAYOUT OF DRAINAGE SYSTEM:

Drainage system comprises of laterals, main drains and an outlet

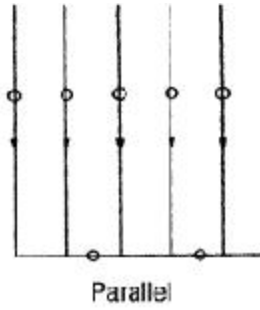


DIFFERENT LAYOUTS OF DRAINAGE SYSTEM:

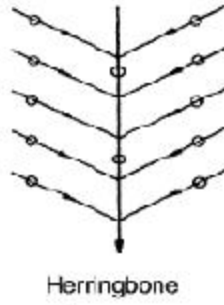
- a) Natural system
- b) Parallel system
- c) Herringbone system
- d) Grid iron system
- e) Random system
- f) Intercepting system
- g) Double system
- h) Grouping system
- i) Composite system
- j) Zig zag system
- k) Sink hole system



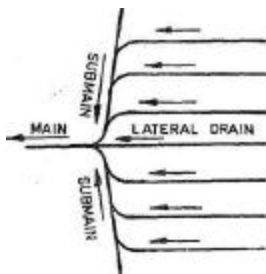
b) Parallel system:



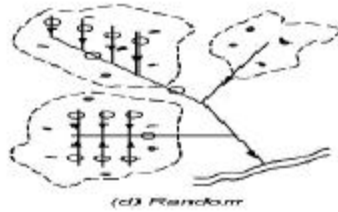
c) Herringbone system:



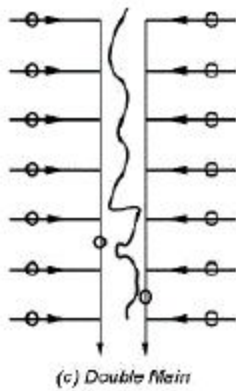
d) Grid iron system:



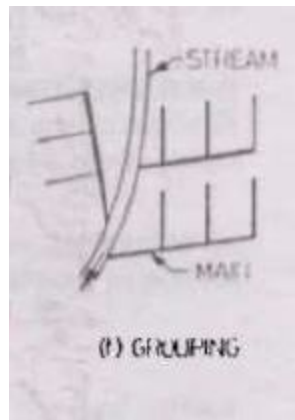
e) Random system:



g) Double system:

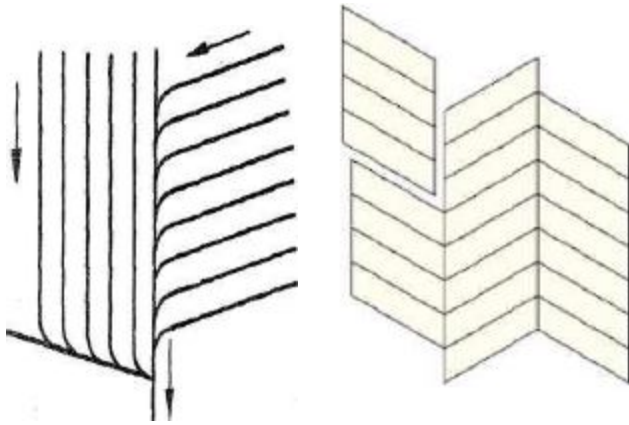


h) Grouping system:



i) Composite system:

j) Zigzag system:



DEPTH AND SPACING OF TILE DRAINS:

Depth and spacing are closely inter related Depends on:

- Texture of soil.
- Hydraulic conductivity.
- Extend of surface drainage.
- Outlet conditions.
- Topography of land.
- Salt content of soil.

Drain depth:

From ground surface to the bottom of the tile, usually 1-1.5m.

Deeper the drain, wider the spacing, lesser the number of drains required.

(EPIC) Environmental Passive Integrated Chamber

From a sustainability and cost-savings standpoint, the EPIC System has many benefits,

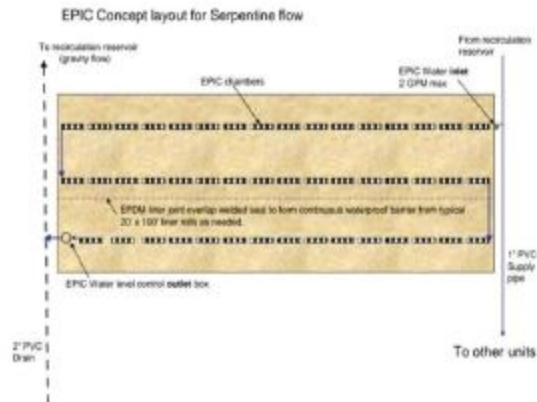
especially in Athletic Field Design.

The EPIC System provides superior drainage with its sand-based soil profile as well as strong root systems through the sub-surface capillary rise irrigation methodology.

EPIC captures rain during storm events and stores it to be used during drier times. All the while, it removes 70-85% of the suspended solids and up to 35% of pathogens through natural sand filtration.

This process results into healthier water for irrigation and discharge into waterways, virtually eliminating Point Source Pollution.

The EPIC System, combined with Netlon Advanced Turf System (ATS) technology can be used for sports fields, grass overflow parking, utility and emergency vehicle access areas or equestrian facilities



FRENCH DRAIN

weeping tile (also trench drain, filter drain, blind drain, rubble drain, rock drain , drain tile, perimeter drain, land drain, French ditch, sub-surface drain, sub-soil drain or agricultural drain) is a trench filled with gravel or rock or containing a perforated pipe that redirects surface water and groundwater away from an area.

A French drain can have perforated hollow pipes along the bottom to quickly vent water that seeps down through the upper gravel or rock.

Alternatively, French drains may be used to distribute water, such as a septic drain field at the outlet of a typical septic tank sewage treatment system.



FILTERS AND ENVELOPES

1) Filters

Permeable materials, typically non-woven fabric, may include sand and gravel,

Placed around the drainage pipe or envelope to restrict migration of non-colloidal particles from the surrounding soils.

2) Envelopes

Gravel, stone, rock or surrounding pipe.

These are permeable materials placed around pipe or drainage products to improve flow conditions in the area immediately around the drain and for improving bedding and structural backfill conditions.

Sizing considerations

Depending on the expected level and volume of rain water or runoff, French drains can be widened or also founded on 2 or 3 underground drain pipes.

Multiple pipes also provide for redundancy, in case one pipe becomes overfilled or clogged by a rupture or defect in the piping.

A pipe might become overfilled, if it is on a side of the drain which receives a much larger volume of water, such as one pipe being closer to an uphill slope, or closer to a roofline that drips near the French drain.

When a pipe becomes overfilled, water can seep side ways into a parallel pipe, as a form of load-balancing, so that neither pipe becomes slowed by air bubbles, as might happen in a full-pipe with no upper air space.

CROSS SECTION OF FRENCH DRAINAGE



Variations of French drain include:

Name

Description

Curtain drain

This form comprises a perforated pipe surrounded by gravel. It is similar to the traditional French drain, the gravel or aggregate material of which extends to the surface of the ground and is uncovered to permit collection of water, except that a curtain drain does not extend to the surface and instead is covered by soil, in which turf grass or other vegetation may be planted, so that the drain is concealed.

Filter drain

This form drains groundwater.

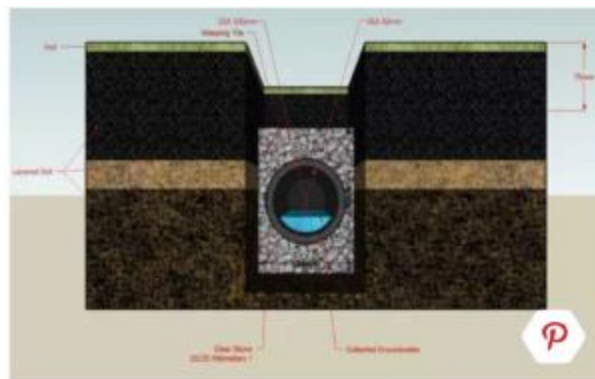
Collector drain

This form combines drainage of groundwater and interception of surface water or run off water, and may connect into the underground pipes so as to rapidly divert surface water; it preferably has a cleanable filter

Interceptor drain	to avoid migration of surface debris to the subterranean area that would clog the pipes.
Dispersal drain	This form distributes waste water that a septic tank emits.
Fin drain	This form comprises a subterranean perforated pipe from which extends perpendicularly upward along its length a thin vertical section, denominated the "fin", of aggregate material for drainage to the pipe. The length is 200 mm (7.9 in). This form is less expensive to build than a traditional French drain.

SMALL AREA DRINAGE:

For a small lawn or wet corner, a soak away provides sufficient drainage. To build one first dig a hole 2-3ft square by at least 3ft deep at the lowest part of the lawn. Fill it with clinker, broken brick or stone to 8 in from the surface and add a 2 in layer of coarse sand, grit or upturned turves to prevent the soil from washing through to the coarse material below. Finally, fill in the hole by adding a 6 in layer of top soil.



HERRINGBONE OR GRID DRINAGE SYSTEM:

Very wet site a herringbone system may be needed. Single line of drainpipe laid diagonally across the site, or through a wet section and feeding into a sump, is sufficient. For this, use clay or 3 in diameter plastic lateral or collector pipe. If several lines are being laid, space them about 10ft apart on heavy soil and up to 30ft apart on light soils. Their depth should be about 2ft and they have a fall of between 1:80 and 1:100. A herringbone of lateral 3 in pipes should feed into a 4

in man drain or ditch 0check beforehand with the appropriate authorities that this is permissible.

Pipe drainage should be installed only after the site had been leveled. Excavate the soil carefully so that firstly, the pipes will just fit into the bottom of the hole and secondly the top soil and subsoil are kept separate. Place a small piece of turf with pipes, then cover with clinker or gravel to within 8 in of the surface. Finally, add a 2in layer of coarse sand and grit or fine gravel, then replace the top soil discarding the subsoil.



10. NUTRIENT MANAGEMENT FOR TURF GRASSES

INTRODUCTION

One of the major requirements of proper maintenance as adequate fertilization is to ensure the optimal growth and development of roots, leaves and others parts of the plant.

NUTRIENT REQUIREMENT OF TURF GRASS

Turf grass requires at least 16 nutrients for normal growth and development. Nine of the sixteen required nutrients are needed in much large quantities than the other seven. These nine nutrients are carbon, hydrogen and oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulfur are called macro-nutrients. C, H and O make up to 90-95% of plant dry weight. They are never deficient in turf grasses because they are derived from carbon-di-oxide (CO_2) and water (H_2O). The major nutrients are Nitrogen, Phosphorus and Potassium. Calcium, Magnesium and Sulfur are secondary nutrients needed only in the form of lime. The micronutrients such as Iron, Manganese, Zinc, Boron, Copper, Molybdenum and Chlorine are required only in minute amounts and rarely supplied to turf grass through fertilization.

FERTILIZER

A Fertilizer is any material containing at least one of the essential elements for plant growth that is added to the soil for the purpose of supplementing the plant nutrient supply.

SOIL AND TISSUE TESTING

Soil testing is an important step in developing turf grass fertility program to determine how much fertilizer the turf needs. A soil test programs involve sampling, laboratory analysis, interpretation and recommendations, the sampling depth and whether thatch should be included in the sample, sample should be taken at 12 sub samples per location in a regular grid pattern with a sampling depth of 2 or 3 inches and discarding thatch. Mix all subsamples, the take about 1/3 pint of this mix be careful not to contaminate the sample with

lime or fertilizer during sampling and mixing. Soil test should be taken three years. Soil test labs vary in how they analyse soil and interpret test results.

TISSUE TESTING

Leaf tissue testing is also a means of diagnosing nutrient deficiencies, verifying diagnosis made from visual deficiency symptoms. It is becoming more popular to sample leaf tissue for nitrogen to determine fertilizer nitrogen requirements.

TOP SOIL OR TOP DRESSING

Soil in general consists of sand, silt and clay an organic content of dead and living plants, insects, invertebrates and animals, water content with many dissolved substance and finally air.

- Lawn top dressing is the process of adding material to the surface of the lawn includes:
- Addition of organics and humus to poor, very sandy or heavy clay soil.
- Addition of loam soil to very sandy soils.
- Addition of loam soil if the depth of existing top soil is less than 4”.
- Amending or improving a soil is not a matter of adding an occasional top dressing of the appropriate material to an existing lawn. Often 2” to 6” of the new soil need to mix with original soil.

BENEFITS OF TOP DRESSING

- Smoothing the lawn surface
- Improves soil drainage
- Help in control thatch and renovating or overseeding.

TURF GRASS NITROGEN SOURCES

Developing a nitrogen fertility program is an important decision that can affects the quality and durability of turf. Because of differences insiteconditions, uses of a turf, level of turf quality desired and cost consideration. Before selecting a nitrogen sources for the program, understand how quickly the nitrogen in the product is released and under what conditions this occur. The nitrogen sources are divided in to quick release sources and slow release sources.

QUICK RELEASE SOURCES

Quick release sources are also called “quickly available”, ‘fast acting’ soluble readily available, Nitrogen content ranging from 11-46 percent and less expensive. Being water soluble, they may be applied in liquid as well as in dry form. They give a rapid green up response and frequent application at low rates is suggested for reducing excessive growth and fertilizer burn. This group includes compounds containing Ammonium, nitrate or urea.

SLOW RELEASE SOURCES

Slow release nitrogen sources also called controlled release, slowly available,” slow acting and water insoluble is important part of turf grass fertility programs. They provide a longer duration of nitrogen release than the quick release sources and are safer to use on turf because of their lower burn potential. These are less likely to leach into ground water.

DISADVANTAGES

High price and reduced efficiency, hence it is mixed or blended both slow and quick release sources. Slow release sources can be grouped into several categories, including the natural organics, urea –form, urea- formaldehyde products, sulfur coated urea and polymer- coated nitrogen.

NATURAL ORGANICS

The natural organics are by-product from the plants and animal processing industries or waste products. It can be characterized by relatively low nitrogen contents, the presence of water insoluble nitrogen. Release of nitrogen is dependent on microbial activity and is highly variable among products. Environmental conditions affecting breakdown of natural organic fertilizers include temperature , soil moisture and oxygen and soil ph. Examples include hoof, horn and feather meal, fish scrap and meal ; seed meals and composted manures.

PHOSPHORUS IN TURF

Phosphorus is extremely important for rooting, seedling development, cell division and the synthesis of various compounds used by plants. Phosphorus is present in inorganics and organics forms in mineral soils and both are important sources of plants. The phosphorus is unavailable to turf because

it forms insoluble complexes with other complexes because it is fixed to clay particles. The most important factors affecting phosphorus availability to turf grasses are soil PH and concentration of Fe, Al, Mg and Ca in soils.

The soil pH drops to 5.5 and below, enough phosphorus can be rendered unavailable to cause deficiencies in turf. As the soil pH approaches 8.0 or above significant amount of phosphorus is unavailable to turf grasses. Maximum amount of plant- available phosphorus (both organics and inorganics) are obtained by keeping the soil pH between 6.0 and 7.0. Inorganics phosphorusfertilizers include Super Phosphates and Ammonium Phosphates. Phosphorus is largely immobile in soils takes long time to move from turf surface into the root zone. Phosphorus should be incorporated into the soil prior to seeding or sodding at the amount recommended. Although phosphorus is not readily leached from turf. Soils into groundwater. Phosphorus deficiency is expressed in early stages of seedling development, appearing as a purple or red colouring of leaf blades and reduced growth and tillering.

POTASSIUM IN TURF

Potassium is a primary turf grass nutrient and is usually supplied annually as fertilizer to lawns. Its primary role involves regulating several important physiological processes. This potassium activates plant enzymes used in protein, sugar and starch synthesis. It also plays a key role in maintaining turgor pressure in plants. It has a strong influence on drought tolerance, cold hardiness and disease resistance. Potassium is available to turf grass in the ionic form (k^+) and occurs in the soil solution and on negatively charged soil particles. Potassium is mobile in plants and sometimes can be taken up in amount greater than needed for optimum growth. This phenomenon, called luxury consumption is generally considered in-efficient use of the nutrient. It is difficult to determine if luxury consumption is a problem in turf culture since very little information is available on the optimum concentration of potassium in turf grasses. However, most fertilizer potassium is derived from inorganic sources, in particular, Muriate of potash and sulfate of potash. Both of these fertilizers are water soluble.

SECONDARY NUTRIENTS IN TURF

Calcium, Magnesium and sulfur are applied usually when soil pH is below optimum for turf grass growth. By liming soil, supplying turf with calcium or calcium-Magnesium containing limestone. Calcium is recommended

for a lawn with an adequate Ph, gypsum as a source of calcium. Gypsum improves soil structure in sodic and high- salinity soils. Sulfur is sometimes used to lower soil pH where a high soil pH can cause turf problems.

MICRONUTRIENTS IN TURF

The seven micronutrients required by turf grasses include Iron, manganese, Zinc, Copper, Molybdenum, Boron and Chlorine.

IRON

Iron plays an important role in chlorophyll formation if deficient; symptoms include a yellow discoloration called chlorosis. The application of Fe generally solves the problem in 24-48 hours. A summer induced form of chlorosis is common in recent years. This type of chlorosis generally requires higher rate of Fe than those usually needed to overcome normal chlorosis. Fe chlorosis takes place on high Ph soils.

MAGNESIUM

The problem often express itself as N deficient and generally responds quickly to N with a green up and increase in growth. If does not respond to more Fe, consider next Mg deficient particularly in low ph sands. The problem can be solved by applying Epsom salts or dolomite lime, a product containing Mg and Ca. The turf will respond very quickly to Mg containing fertilizer.

CALCUIM

Its deficiency symptoms are reddish discoloration of the leaves occurs under very acidic condition and solved by application of lime.

SULFUR

Sulfur deficient grass becomes chlorotic similar to Fe and Mg. Application of sulfur containing fertilizer is common.

MANGANESE

Deficiency occurs in very high pH or very low pH particularly in sand based systems. Micronutrient “packages” available that contain Mn solves the problem.

The amount of fertilizer to apply depends on the fertilizer product, the square area of lawn and the purpose of the lawn surface.

AT PLANTING

Fertilize soil before planting, seed, sod, plugs or stolons. A general recommendation for a pre-plant fertilizers for most soils are to apply 16: 21: 0 per 1000 square feet of ammonium phosphate – sulfate into the top 4 to 6 inches (10 to 15 cm) of soil.

EXISTING LAWNS

Most mature lawn benefit from about 2kg /100 m² of nitrogen per year. Grasses growing in less shade require less fertilizer than grass growing in full sun. Turf grass under grass cycling program need slightly less nitrogen, heavy wear from foot traffic or sports require more nitrogen to encourage faster growth to repair damage. Generally a maximum of 0.5 kg/ 100 m² should be applied at one time when using a soluble chemical fertilizer. Nitrogen is the soluble element and has the most potential for burning the grass if applied too heavily. Often, less (0.25-0.5 kg /100 m²) can be applied at a time is the usual recommendation. Slow release fertilizer can be safely applied at high rates.

APPLICATION OF FERTILIZER

Fertilizing by hand spreading and by mechanical spreaders. Mechanical spreaders are of two types, the broadcast spreaders and drop spreader. Correct use of the broadcast spreader avoids stripping, a common problem with the drop spreader. In contrast, drop spreaders avoid overthrow of fertilizer into streets or sidewalks. Liquid fertilizers must be applied accurately and evenly, just as with dry fertilizers. Watering removes the fertilizer from leaves, reducing the foliage burn. Over irrigation after fertilizer application can cause water containing dissolved nutrients to run-off or its can leach the nitrogen below the turf root system, where it is unavailable to the grass.

SOIL TEST PROCEDURE



TOP DRESSER



POTASSIUM RICH TURF



IRON DEFICIENT TURF



APPLICATION OF LIME



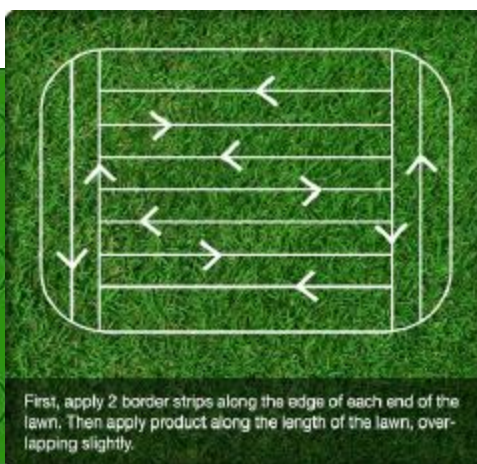
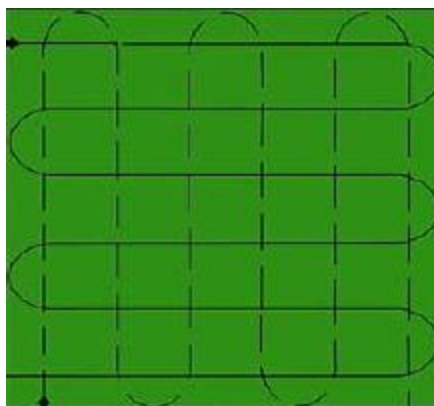
LIME REQUIRED TURF



COMPARISON OF FERTILIZER APPLICATION OVERFERTILIZER



FERTILIZER APPLICATION PATTERN



11.SPECIAL PRACTICES IN TURF MANAGEMENT (MOWING & AERATION)

MOWING:

Mowing is the process of cutting turf grasses using lawn mower to improve aesthetic appearance of turfgrass, to provide a good playing surfaces for a game and to control the weed control.

MOWING NEW LAWNS:

New lawn need time for their roots to become established before they can be mowed for the first time. To avoid tearing out new turf.

Time taken for first mowing:

Methods of establishment	Time taken for first mowing
Seeded lawns	2 months
Sod	2 to 3 weeks
Sprigs, stolons, & plugs	3 to 6 weeks

TYPES OF MOWERS:

1. Reel mower

A mower that cuts turf by means of a rotating reel of blades that passes across a bed knife fixed to the mower frame, thus giving a shearing type of cut.

2. Rotary mower

A mower that cuts turf by high-speed impact of a sharp blade rotating in a cutting plane that is parallel to the turf surface.

MOWING HEIGHT:

The distance above the ground surface at which the turfgrass is cut during mowing.

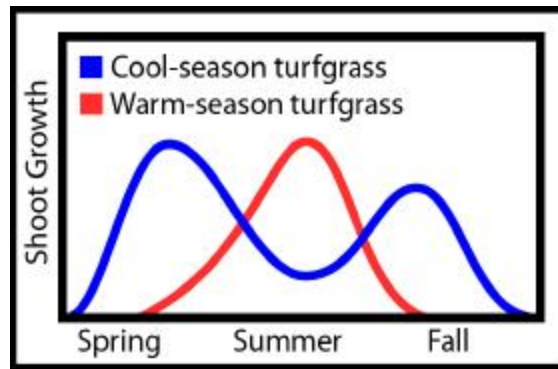
Recommended Mowing Heights for different grasses:

- St. Augustine grass 1.5 - 3 inches (38.1 – 76.2 mm)
 - Bermuda grass (common) 0.75 - 2 inches (19.05 – 50.8 mm)
 - Bermuda grass (hybrid) 0.5 - 1.5 inches (12.7 – 38.1 mm)
 - Zoysia grass 0.75 - 2 inches (19.05 – 50.8 mm)
 - Centipede grass 1 - 2 inches (25.4 – 50.8 mm)
 - Buffalo grass 1 - 3 inches (25.4 – 76.2 mm)
 - Bahia grass 2 - 4 inches (50.8 – 101.6 mm)
 - Kikuyu grass 0.5 - 1 inches (12.7 – 25.4 mm)
 - Paspalum (Seashore) 0.5 - 1.5 inches (12.7 – 38.1 mm)
 - Kentucky Bluegrass 1.5 - 3 inches (38.1 – 76.2 mm)
 - Tall Fescue 2 - 3 inches (50.8 – 76.2 mm)
 - Perennial Ryegrass 1.5 - 3 inches (38.1 – 76.2 mm)
 - Fine Fescues 2 - 3 inches (50.8 – 76.2 mm)
 - Creeping Bent grass 0.25 - 0.75 inches (6.35 – 19.05 mm)
- ❖ A lower cut produces shorter roots, less stress tolerance and allows more weed invasion.
- ❖ Mowing has major impact on weeds.

MOWING FREQUENCY:

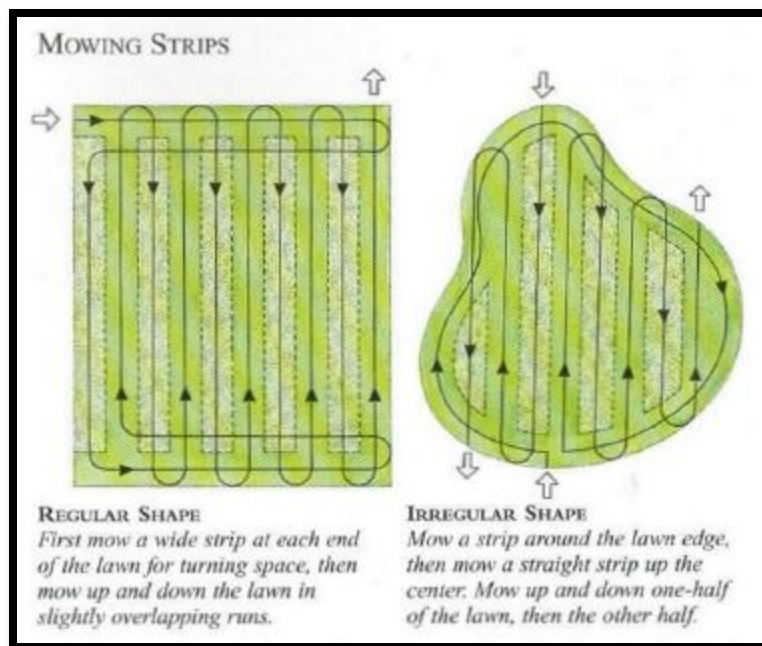
The number of times the lawn is mowed per week or month. Grasses require more frequent mowing during their active growing period.

- ❖ Cool - season grasses are most active during the spring and fall.
- ❖ Warm – season grasses are the most active during the summer months.



MOWING DIRECTION:

To prevent your lawn from appearing to lean one way or the other, vary your mowing direction each time you mow. This will keep your grass looking straighter as well as prevent a washboard effect.



Some basic guidelines to mow the turf:

- ❖ Mow early in the morning or in the evening. Mowing during the heat of the day can cause the plant to go into shock.
- ❖ Mow when the grass is dry. The mower will work better and there is less likelihood that disease will be spread from plant to plant.
- ❖ Change directions each time of mowing. Mowing causes the grass to lie over slightly. When we alternate directions with each mowing, it will keep the grass straighter and stronger. It will also reduce soil compaction by changing the areas that the wheels of the mower travel.

- ❖ Keep Lawn Mower Blades Sharp.
- ❖ The most important feature of any lawn mower is its blade, and yet it is often the most neglected part of the machine. If the lawn mower blade sharp, the lawn will benefit. A sharp mower blade provides a clean cut that minimizes numerous lawn problems such as disease and pests, it also makes mowing the lawn a lot easier.
- ❖ A good time to sharpen the blade is at the beginning of each growing season.
- ❖ Leave Grass Clippings on the Lawn
- ❖ Leaving grass clippings on the lawn is called grasscycling, recycling, or mulching. Clippings are full of nutrients and can actually reduce the need for fertilizers by as much as 50%.

AERATION:

Aeration is the process of making holes in the turf to improve air exchange, help water penetrate, drainage, decrease the soil density and organic matter. Aeration promotes growth, helps manage thatch buildup and relieves soil compaction.

An aerator pulls plugs out of the soil coring, spiking or slicing into the soil.

- ❖ Core aerations the most effective method. It uses spoon-shaped or hollow tines to remove columns of soil and deposit them on the surface of the lawn.
- ❖ Spiking uses solid tines to create holes in the soil.
- ❖ Slicing uses rotating blades to cut narrow slits in the soil.



1. Hollow tine core cultivation:

Unlike other aerification methods, this method improves drainage, reduces organic matter and relieves compaction by pulling cores from soil.

Types of Core Aerators (2 types)

a) Vertical motion - hollow tines

Advantages:

Deepest penetration, least surface interruption

Disadvantages:

Relatively slow - 10 min /1000 ft²

Lawns: use larger diameters (1/2 to 3/4")

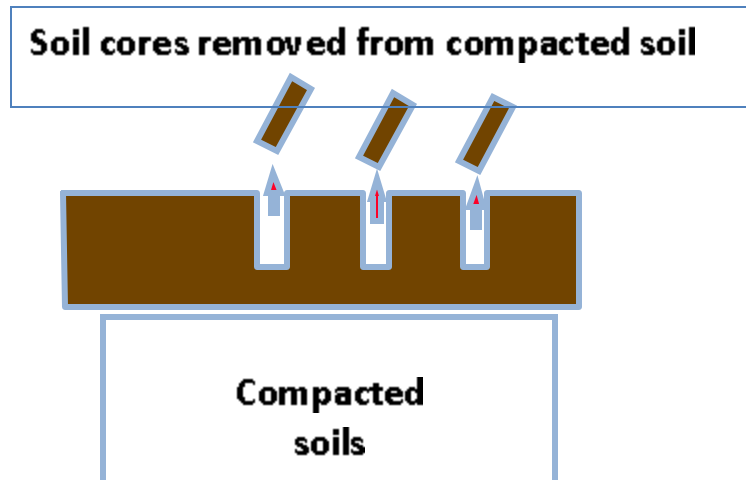
b) Drum-type aerators - hollow tines or open spoons

Advantage:

Relatively fast.

Disadvantages:

Severe surface disruption; shallow penetration.



2. Solid Tine Cultivation:

- No cores removed.
- Compaction at sides and bottom of holes.

When to Aerate the soil:

- Soften the soil a few days before it will be aerated by watering.
- Leave cores on the lawn. They will break up due to watering and mowing and return to the lawn as a topdressing material.
- Aerify the soil during the spring when grasses are actively growing.
- Avoid aerifying during the summer months when high temperatures may be detrimental to lawns.
- Practice fields should be aerated one to three times a year.
- Lawns should be aerated one time a year or less depending on use.
- Heavily used turf may require aeration up to four times a year.

SLICING & SPIKING:

It is the process by which a turf is penetrated to a depth of 3-4 inches by a series of V-shaped knives mounted on disks. It is typically practiced on

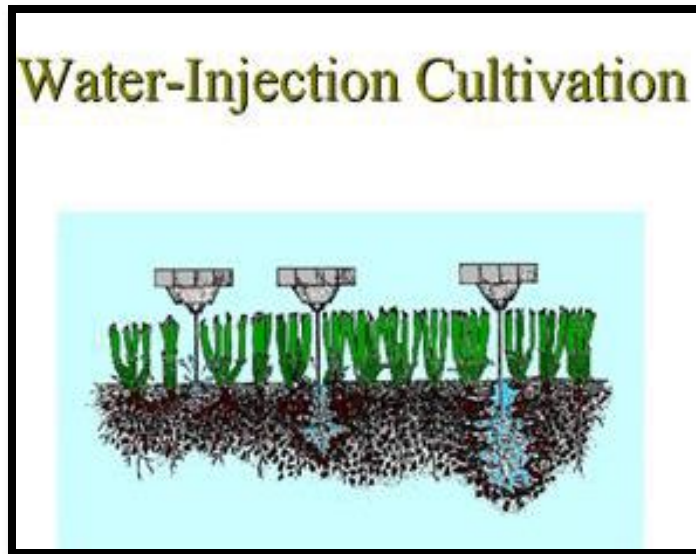
fairways and other heavily traffic turfs during mid summer stress periods when coring might be too injurious.

- Minimal surface disruption.
- Spikes can be used for over-seeding.

WATER INJECTION CULTIVATION:

It is a relatively new method of handling compaction. Instead of metal tires, a stream of water under high temperature is released through small diameter nozzle. It is used to loosen the soil and to improve water infiltration and root growth.

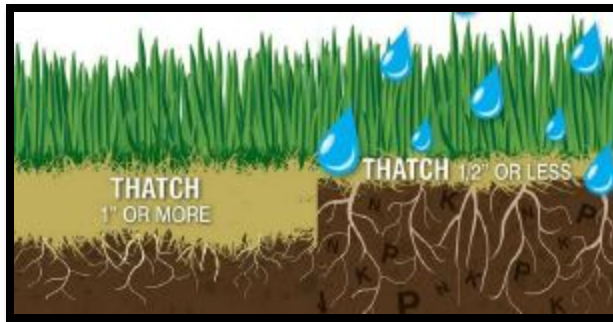
It is similar to aerification.



12.SPECIAL PRACTICES IN TURF MANAGEMENT (DETHATCHING, OVERSEEDING, RAKING, TOP DRESSING, MATTING, ROLLING, SYRINGING, TURF COLOURING AND LAWN STRIPING)

THATCH:

Thatch is the dense, fibrous layer of living and dead grass shoots, stems, leaves and roots that accumulates between the green vegetation and the soil surface. A thatch layer becomes undesirable, when it exceeds a depth of ½ inch.



DETHATCHING:

To remove an excessive thatch accumulation, usually by a mechanical practice such as vertical mowing.

There are several names for effective dethatching equipment are

- ✓ Vertical mowers.
- ✓ Verticutters.
- ✓ Dethatchers or power rakes.

Some basic guidelines to dethatch the turf:

- ✓ Do not dethatch when the lawn is wet because it can damage the equipment.
- ✓ Don't attempt to remove the entire thatch layer with one pass over the lawn. Cover the area from north to south; then use a leaf rake to remove the organic material that has been dislodged. Repeat this process, covering the lawn from east to west.
- ✓ Grass clippings do not cause thatch and they are good for the lawn. When mowing, it is recommended that leave the clippings on the lawn to provide nutrients for the grass and the soil.

PROBLEMS WITH THATCH:

- ✓ Insects: Chinch bug, cutworm.
- ✓ Diseases: Patch diseases.
- ✓ Shallow rooting.
- ✓ Pesticide adsorption.
- ✓ Fertilizer sink.
- ✓ Water barrier.
- ✓ Scalping (turf is mowed at a much lower height than normal)

OVERSEEDING:

Overseeding is the practice of adding grass seed to an existing lawn. This may be done only in spots where bare areas show, or over a larger expanse of lawn to improve the density of grass that has become thin.

For example, when cool-season turf is seeded into warm-season turf during the winter.

- Overseeding is a common practice in the transition zone, the geographical area between parts of the country where warm season and cool season grasses converge.
- Overseeding a cool-season grass into an existing warm season grass lawn will provide color and active growth during the cold-weather-related dormant period of the warm-season grass.
- If 50 percent or more of the existing lawn is in good condition, overseeding can be a workable solution. If more than 50 percent of the area is in poor condition, it will want to consider a new lawn installation.
- After aerifying, allow the holes about a month to heal before seeding.
- Usually a single pass is sufficient, but bare areas require multiple passes in two to three directions to provide sufficient seed
- Over-seeding rates can be less than a normal seeding rate
- Spikers, hollow-tine aerifiers or vertical mowers may also be used to expose soil to aid seedling establishment.

RACKING:

- ❖ Scraping and raking are always beneficial to maintain the tenderness of the turf.
- ❖ Due to constant rolling and mowing a hard crust forms on the surface and lower part of the grass become woody.
- ❖ If the condition of turf is good only raking is sufficient to loosen soils.

TOP DRESSING:

Topdressing is a sand or prepared soil mix applied to the surface of the lawn. The term topdressing also is used for the process of applying the material.

- ❖ For continuous and healthy growth of turf, continuous supply of nutrients is important. It can reduce thatch buildup by encouraging decomposition.
- ❖ It can be used following seeding, overseeding or sprigging to protect the developing plants from dehydration during the establishment process.
- ❖ When applied following core aeration, the topdressing material filters into the holes opened by the aeration process, speeding grass recovery.
- ❖ The topdressing material differs from the composition of the soil to which it is applied. For example, on soils with a high clay content, topdressing containing sand or a combination of organic materials can improve water, air and fertilizer absorption.

MATTING:

It is the procedure by which a heavy steel mat or similar device is pulled across a turf. Matting is usually necessary after top dressing to remove soil adhering to foliage and to work it in to turf.

- ❖ When the surface irregularities exist, the matting re-distributes top dressing soil to fill in low areas.
- ❖ Care must be exercised to minimize the physical damage to the turf.

ROLLING:

Lawn rollers are heavy cylinders that are attached to an axle, pulled to smooth topsoil and flatten out bumpy or irregular yards.

- ❖ The purpose of rolling is to bring the grass in contact with the soil and also to keep the ground levelled.
- ❖ Avoid rolling when the soil is too wet.

Time to roll the lawn:

- ❖ Rolling a new lawn after seeding.
- ❖ Rolling after overseeding.

- ❖ Rolling a new lawn after sodding.
- ❖ The turf should be rolled after every weeding or at weekly intervals.

Other than these times, rolling a lawn will not good and will only create issues with the turf grass

SYRINGING:

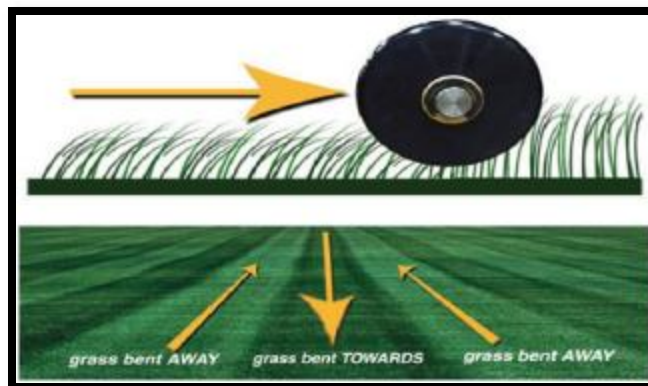
It is the process of applying light application of water to the surface of the turf which can be used to modify the micro-environment of green during high temperature period.

TURF COLORANTS:

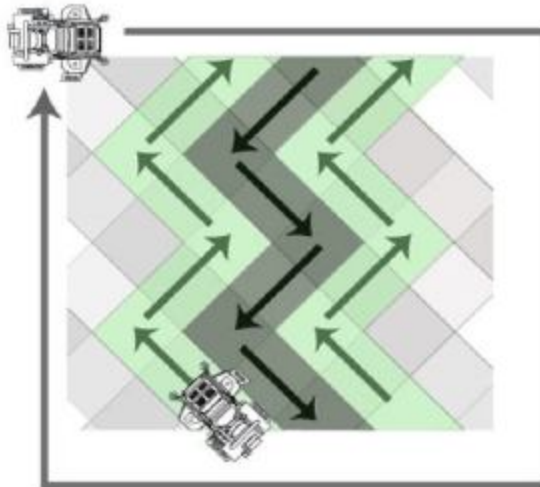
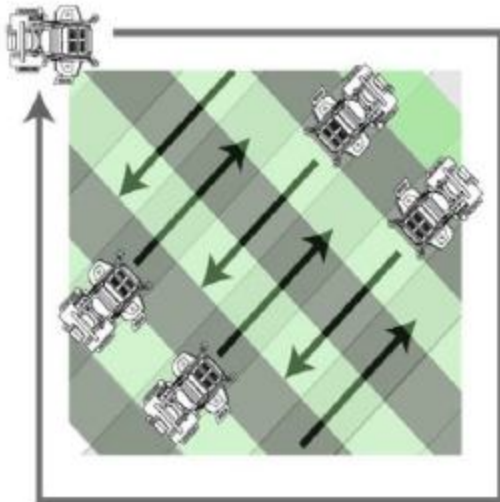
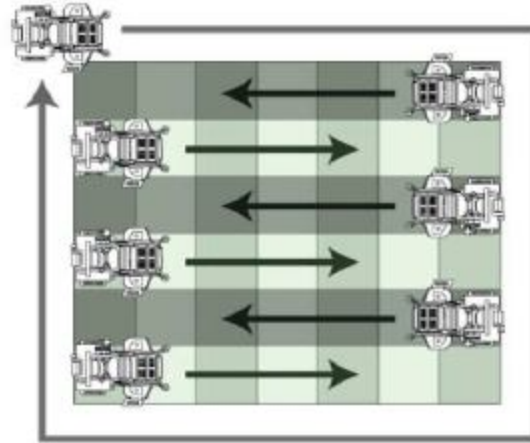
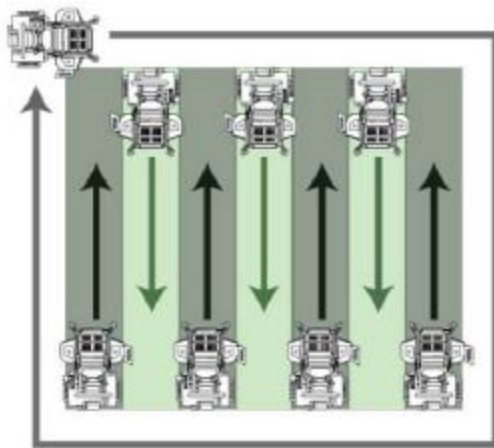
These are used for varieties of purposes including artificial coloration of dormant turf grasses, cosmetic effect on diseased or discolored turf and marking areas that have received sprays of fungicides or other materials.

LAWN STRIPING AND LAWN PATTERNS:

Lawn striping is a simple mowing technique, to enhance the aesthetic appearance of turf. The direction that the grass is bent determines the "light" or "dark" colored stripe



Different patterns of striping:



13.REPAIR AND REJUVENATION OF OLD TURF.

Turf:

The upper stratum of the soil bound by grass and plant roots into a thick mat.

Repair and Rejuvenation:

Rejuvenation is the improvement of turf grass stand without complete reestablishment.

Factors causing turf grass to decline:

Factors causing turf grass to decline include

- ✓ Improper mowing, watering and fertilizing
- ✓ Poor drainage
- ✓ Soil compaction
- ✓ Excessive thatch
- ✓ Incorrect pesticide usage
- ✓ Turf Pests such as insects or weeds
- ✓ Sometimes problem relate to
- ✓ Growing a non-adapted grass species
- ✓ Excessive shade
- ✓ Tree and shrub root competition
- ✓ Winter injury

Steps for repairing and renovation:

- The first step is to examine the turf carefully.
- If coarse grasses and troublesome weeds or mosses are predominant reclamation may not be possible.
- The best time to begin renovation is in spring.
- If faced with a neglected lawn in late spring or summer.
- The first step is to cut back the lawn in spring to about 2 in from soil level.

- This removes dead grass, weed stalks and seedheads, leaving the grass fresher in appearance.
- For this first cut use a rotary-bladed mower, which can be hired, or use shears if the area is small.
- Do not mow too closely at this stage since this can weaken the grass and make it liable to infestation from weeds and moss.
- After mowing rake thoroughly to remove the cuttings and any accumulated dead material and debris present on the lawn.
- Leave the lawn for a week or so and then mow with a cylinder mower, setting the blades as high as possible.
- Reduce the height of the blades over the following two or three weeks to reestablish normal levels of cut and frequency
- Then feed with a general purpose spring turf fertilizer.
- Apply a weed killer but do not apply it with fertilizers high in nitrogen after August.
- If the work is to start in late autumn cut the lawn back to 2 inch but do not attempt to reduce it to normal levels until spring because this would weaken the turf and leave it more susceptible 10 to 14 days afterwards, taking care to avoid any recently seeded areas.
- During April seed-in any bare patches or sparsely grassed areas, and do not neglect irrigation during dry periods.
- In early July feed with Sulphate of ammonia to keep the grass growing strongly.
- Do not do this earlier than five to six weeks after applying the general turf fertilizer dressing.
- Reexamine the lawn in late August or early to infestation from weeds and mosses.
- After cutting back scarify the lawn to remove dead material and debris.
- Then spike where necessary and apply an autumn turf fertilizer.

The following spring continue the process of reclamation with the recommended program given below

- September for the signs of unhealthy turf and worm activity.
- In early September fork out patches of coarse grass and re-seed.
- In colder areas do this in late August.

- During early to mid-September scarify and aerate where required.
- Then top dress and apply an autumn turf fertilizer.

This completes the program of renovation.

PROCESS FOR REJUVENATION:

Step 1: Determine the cause for fall of turf.

Step 2: Test the soil.

Step 3: Eliminate all undesirable weeds or turf grass species.

Step 4: Mow the area lower than normal and remove the clippings, leaves and other debris by sweeping or raking.

Step 5: Remove excessive thatch. Thatch is a layer of partially decomposed plant material that builds up on the soil surface.

Step 6: Cultivate or aerate the soil by tilling to relieve soil compaction.

Step 7: Apply fertilizer and lime according to soil test result.

Step 8: Seed, sprig, plug or sod new grass into the area.

Step 9: Apply water immediately after planting and keep the soil moist, not wet, until the seedlings or sprigs become well established.

14.EQUIPMENTS FOR TURFING

There are many turfing equipments such as

Landscape rake:

- Also referred as leveling rakes,available either with wooden or stainless steel heads and long handles.
- Main purpose is to level the soil prior to plantation,and for sowing seeds.
- The pointed ends create small burrows and facilitate better sowing.
- The rake can also be used with the head turned over to give a smoother finish to the patch of land.

Drop spreader:

- It's better to use a spreader when sowing seeds or adding fertilizer to the ground,rather than using the hands.
- A drop spreader basically does the function of spreading seeds or fertilizer proportionally over the patch of land where it is hovered upon.
- It requires the use to drop seeds or fertilizer into the plastic hopper(green basket like structure in the illustration) and roll the spreader across the patch proposed for cultivation.
- When buying one ensure that the hopper is sturdy with holes large enough for seeds to pass through.
- Also the ground clearance should be ample to avoid obstructions of any kind,the wheels should be durable,and the handle should be at a comfortable height with proper grips.

Rain barrel:

- A traditional but very effective technique to give adequate water to the soil is by using a rain barrel or watering can.
- During plantation, when the soil needs to be watered, a rain barrel is the tool required.
- A very basic but useful garden tool and must have.Check the capacity while buying.Smaller one is comfortable.

Lawn mower:

- When the grass grows too much and feels spiky, it's time to mow it.
- Lawn mowers have become very popular among hobbyists, especially the fuel/electric powered ones.
- The traditional push me lawn mower also does the job, but the level of human effort is too high.
- Electric powered one is cheaper to maintain and the emission level is low, which makes it more eco-friendly.
- A costlier option is a ride-on lawn mower, which is necessary for bigger lawns, where pushing the lawn is not feasible.
- Mowing the lawn would make it softer and less spiky.
- When using a lawn mower, always read its manual and take all the necessary precautions to avoid accidents.

String trimmer:

- Tool to trim grass which the mower is unable to reach, especially areas around fences, walls, walkways, tight-corners, and the like.
- The machine uses a nylon string which rotates at very high speeds to cut the blades of grass.

Leaf rakes:

- Leaf rakes are used to scrape dead stalks, moss, and other material on a lawn, which is called thatch.
- A leaf rake should be forcefully scratched across the whole patch of lawn in both horizontal and vertical directions.
- These rakes can also be used to get rid of leaves in the lawn during fall, and are quite easily available, besides being very cheap.

Besom:

- Similar to broom. Besoms are an effective alternative to stiff brooms because they are made up of wiry brushwood, which really proves useful when sweeping leaves and removing grass clippings after trimming or mowing.

Leaf blower:

- Leaf blower is used to clear away leaves after fall without breaking a sweat,even better than a besom or leaf rake.
- A small hand held blower for a small garden is perfect;they can be either gasoline powered or electric ones.

Turfing iron:

- Tool used to remove turf from the lawn,and slice underneath,severing the grass roots.

Half-moon edger:

- A half-moon edger is a sharp tool used to make crisp edges or clean cuts on the turf.
- Edger's are used to cut lines where the lawn meets a walkway and flower beds.

Broom:

- A stiff bristled broom is the most basic gardening tool.
- It is prominently used for brushing top-dressing into the holes created by aeration.
- It is also used as a utility tool to clean walkways,clear off dirt or debris,and keep the garden neat.

Sprayer:

- A sprayer is used to spray pesticides or herbicides.
- An herbicide is a chemical used to kill unwanted plants and vegetation.
- Two types of sprayers are available in stores;one being a backpack style sprayer,and the other a canister sprayer.
- For a small garden,a 2-3 gallon canister sprayer is recommended.

Garden cart:

- A cart which hauls everything from lawn tools,to fertilizer,to lawn waste.

Sprinkler:

- Sprinklers are add on to basic garden requirement.
- Sprinklers are meant to save human effort, and are ideal for bigger lawns.
- Sprinklers proportionally sprinkle water all over the lawn at regular intervals.

Equipment organizer:

- Most important tool.
- When it comes to so many gardening tools, finding them in one place is necessary.
- It keeps all the important tools together, like the broom, rake, trimmer, edger, shovel, etc.

Basic tools:

Digging tools:

Pointed and square-edged shovels: For turning loose earth.

Spade: For digging up just about anything.

Spading fork: Square-tined implement that won't bend out of shape.

Hoe: Long-handled for cultivating; scuffle hoe for cutting weeds.

Pick: For piercing.

Mattock: For cutting and chopping roots.

Hoses: 50-footers are standard, with a 1-inch diameter and cast solid brass connectors.

Dandelion tool: A chisel-like tool that can fit in your back pocket.

Cutting tools:

Pruners: With a sheath.

Loppers: For chopping off heavy branches.

Pruning saw: For getting in between branches.

Hedge shears: The low-tech manual type for shaping topiaries, electric or gas shears for hedges.

Commercial tool and blade sharpener: To keep cutting edges sharp.

Grading tools:

Lawn roller: A heavy device (usually filled with water) that's used to level lawns.

Hand tamper:For compressing soil,gravel or crushed stone.

Power tamper:The same as a hand tamper,but gas powered.

Vibratory plate compactor:For compacting soil on big jobs.

Measuring tools:

Sighting level:Surveying instrument used to measure the angle of inclination between the user and a target.

Tape measure:Most useful in longer lengths like 100 feet.

Measuring wheel:For taking onsite measurements.

Marking tools:

Marking paint applicator:Device used to put down lines on grass,concrete and various other surfaces.

Chalk wheel:For drawing temporary lines.

Flagging tape:For surveying,mapping,tagging and other marking applications.

Miscellaneous:

Sledge hammer: Long-handled,two-faced hammer used to drive stakes into the ground or for other heavypounding.

Single jack:A short-handled sledgehammer.

Stake driver:Hammer for driving tree stakes.

Basic carpenter's tools:Including hammers,hand saws, power saw,drill,level,square,and plumb bob.

Other tools

These other tools are not essential but can assist in a lawn care program.

- Thermometer
- Rain Gauge

- Magnifying glass
- Soil probe
- Soil thermometer
- Various weed removal hand tools

Equipment for turfing

Landscape rake



Drop spreader



Rain barrel

Lawn mower



String trimmer

Leaf rakes



Besom

Leaf blower



15. PLANT GROWTH REGULATORS FOR TURF MANAGEMENT

Plant growth regulators (PGRs), are specialized chemicals produced by plants in small amounts, applied to promote or interfere with the growth of the plant development process.

Natural PGRs are,

- Auxins
 - Gibberellins
 - Cytokinins
 - Ethylene
 - Abscisic acid.
- Plant growth regulators used to suppress the vegetative growth of turfgrass as well as to enhance turf quality and performance.
 - Plant growth retardants (PGR's) or inhibitors are increasingly being used to suppress seedheads and leaf growth due to rising mowing costs and danger posed to operators and other personnel.
 - The other significant factor in the use of PGRs is that they exhibit different degrees of regulation depending on the turf species.
 - Traditionally, plant growth retardants have been used to suppress bahiagrass (*Paspalumnotatum*) or tall fescue (*Festucaarundinacea*) seedhead production exclusively in low maintenance areas such as highway roadsides, airports, and golf course roughs.
 - Plant growth inhibitors Maleic Hydrazide (MH) have been used to suppress the growth of bahia grass or tall fescue.
 - Commonly applied growth retardants in the turfgrasses are BE-995, Phosphon, ethrel, MH, chlorflurenol, gibber-ellins and kinins.
 - several growth regulators have recently been developed for use on hybrid bermudagrass fairways and St. Augustinegrass.
 - Vertical topgrowth (clippings) is suppressed, but horizontal spread (runners) is not.

- Therefore, turf recovery from golf club divots and other injuries occurs while topgrowth remains suppressed.
- Other uses involve areas where mowing has been discontinued due to heavy rains, equipment failure, etc., but topgrowth remains suppressed if the grass is treated.
- These retardants used on hybrid bermudagrass and St. Augustinegrass do not satisfactorily suppress seedhead development.

TYPE I GROWTH REGULATORS:

- Type I growth regulators inhibits cell division.
- Type I growth regulators are foliar absorbed.
- Most type I growth regulators are older materials that causes some phytotoxicity on grasses.

Type I growth regulators include:

- Maleic Hydrazide (MH)
- Mefluidide (Embark)
- One of the first products used successfully in turf was maleic hydrazide (MH).
- MH suppress foliar growth and seedhead formation of Turf grass species.
- Mefluidide (Embark) is utilized more than any other type I growth regulators, but it yellows and thins turf when used during hot weather conditions.
- More recently, mefluidide has been used primarily for *Poa annua* seedhead suppression on golf courses.
- Mefluidide is absorbed by the leaves (most effectively at the base of the leaves) and does not move through the plant.
- Once it penetrates through leaf it begins to primarily affect cell division with a lesser influence on cell elongation.
- Consequently, when it contacts a flowering stem (*Poa annua*) during seedhead formation, it causes it to distort and prevents seedhead emergence from the leaf sheath.

- Proper time application of PGRs for seedhead suppression is important where applications made after seedhead emergence may not be effective.
- Under optimal conditions, applications can result in 85 – 95% *poaannuaseedhead* suppression.

Type II growth regulators :

- Type II growth regulators work by inhibiting biosynthesis of gibberellin.
- Gibberellin cell elongation, primarily through inhibiting GA synthesis.
- **Type II growth regulators include :**
 - Cutless (flurprimidol),
 - Limit (amidochlor),
 - Primo (trinexapac-ethyl),
 - TGR Turf Enhancer (paclobutrazol)

these products primarily affect cell elongation and not division.

- Flurprimidol and Paclobutrazol are both primarily root absorbed while Trinexapac-ethyl and Ethephon are foliar absorbed.
- Aamidochlor is less damaging to turf than type 1 growth regulators, but should not be used on high maintenance turf.
- Type II growth regulators are used to reducing *poaansuppressingnuaon* golf courses.
- Cutless and TGR Turf Enhancer are most effective in *Poaannua* but they also cause yellowing .

Other benefits of type II growth regulators include:

- ✓ Reduced mowing
- ✓ Increased shoot density
- ✓ Reduced water use
- Flurprimidol and Paclobutrazol have been shown to reduce the dollar spot disease incidence on creeping bent grass.

New Classification Scheme for TGRs:

A new way to classify growth regulators has been developed using classes A,B,C and D.

Class A materials are GA inhibitors that interfere with GA synthesis late in the biosynthesis pathway .

Example: Trinexapac-ethyl

Class B materials interfere with GA synthesis early in the biosynthetic pathway .

Examples: Flurprimidol and Paclobutrazol are included in this class.

Class C materials inhibit mitosis .

Examples: hydrazide, mefluidide and amidochlor.

Class D materials are phytotoxic (can kill plants) but have a growth regulating effect at very low rates.

Examples: Glyphosate (roundup) and chlorsulfuron(Telar)

Currently Available Plant Growth Retardants:

Low Maintenance Bahiagrass, Bermudagrass and Tall Fescue

- Sulfometuron-methyl (Oust 75DG).
- Chlorsulfuron (Telar 75 DG).
- Metsulfuron (Escort 60 DF).
- Sethoxydim (Vantage 1.0 lb./gal.; Poast 1.5 lbs./gal.).
- Maleic hydrazide (Retard 2.25 lbs./gal.; Royal Slo-Gro 1.5 lbs./gal.; Liquid Growth Retardant 0.6 lbs./gal.).
- Glyphosate (Roundup Pro 4 lbs./gal.).
- Imazapic (Imazapic Applicators Concentrate, Plateau).
- Mefluidide (Embark 2S).

For Bermudagrass, Tall Fescue and St. Augustinegrass:

- Mefluidide (Embark 2S, Embark Lite 0.2S).

- Trinexapac-ethyl (Primo 1EC, Primo 25WSB).
- Paclobutrazol (TGR Turf Enhancer 2SC).

Foliar Suppression of Annual Bluegrass in Bentgrass or Overseeded Bermudagrass:

- Flurprimidol (Cutless 50WP).
- Mefluidide (Embark 2S, Embark Lite 0.2S).
- Paclobutrazol (TGR Turf Enhancer 2SC).

Characteristics of various plant growth regulators used in turfgrass management.

PGR Common Names	PGR Trade Name	Absorption Site	Mode of Action	Comments
Maleic hydrazide Mefluidide	Retard, Royal Slo-Gro, Liquid Growth Retardant, Embark, Embark Lite	Foliar	Inhibit cell division (mitosis)	Effective seedhead suppressors. Growth inhibition is rapid, within 4 to 10 days, and lasting three to 4 weeks.
Sethoxydim Glyphosate Imazameth Imazethapyr + imazapyr Sulfometuron Metsulfuron Chlorsulfuron	Poast, Vantage, Roundup Pro, Plateau, Event, Oust, Escort, Telar	Foliar Foliar and root	Inhibit fatty acid biosynthesis Inhibit amino acid biosynthesis	Usually low in cost, but turfgrass tolerance is low and rate dependent. Use is restricted to low maintenance turfgrasses.
Flurprimidol Paclobutrazol ¹ Trinexapac-ethyl	Cutless TGR Turf Enhancer Primo	Root, Foliar	Interfere with gibberellin biosynthesis	Initial growth response is slower compared to cell division inhibitors, but duration of activity is usually longer, 4 to seven weeks. Rainfall, irrigation, or high application volumes are required for activating root absorbed PGRs.

16.WEED MANAGEMENT IN TURF

Weeds are undesirable because they disrupt turf uniformity and compete with desirable grass species for moisture, light, and nutrients. Weeds often invade turfgrass that is over or under-watered, improperly fertilized, improperly mowed. Total eradication of weeds is not a realistic or necessary goal for most lawns and park turfgrass; however, with proper maintenance a lawn can be practically free of weeds without the extensive use of chemicals.

WEED IDENTIFICATION

Identifying weeds and knowing their life cycles are essential to management. Three general categories of weeds may be found in lawns are [broadleaves](#), [grasses](#), and [sedges](#). We should Take care to distinguish weedy grasses from similar-looking lawn grass species.

ANNUAL WEEDS

Annual weeds are commonly identified as either cool-season or warm-season annuals and survive only one season. If not controlled before they flower, they can produce seed that will sprout the following year or sometimes in the same growing season. .Some of the annual grasses affecting the lawn area are annual blue grass,crab grass,goose grass, banyard grass, foxtail.

BIENNIAL WEEDS

Biennial weeds survive for two growing seasons, reproducing vegetatively or by seed; however, seed is not produced until the second year.

PERENNIAL WEEDS

Perennial weeds survive for many years, and though they produce seeds, many primarily reproduce vegetatively by creeping stems (stolons and rhizomes), tubers, or fleshy roots. Perennial weeds are the hardest to control once established.perennial weeds affecting the lawn area are bermuda grass,dalis grass,buckhorn grass,white clover,dandelion,creeping wood sorrel,english daisy,etc

MANAGEMENT

Selection of species

It is essential to choose a planting time that allows the turfgrass species to establish quickly and be competitive with weeds. Warm-season grasses should be planted from mid-spring to midsummer. Cool-season grasses should be planted in early spring or fall. Lawns planted from seed, stolons, or plugs can take up to 2 months to become established and are, therefore, more susceptible to weed invasions.

Site preparation

Before planting, remove existing vegetation and prepare the area for planting. If you expect annual weeds to be a problem, irrigate the site to allow weeds to germinate and apply non selective herbicides. For perennials, dig out and remove as many as possible. Soil solarization can be very effective at controlling many weed species prior to planting.

Irrigation

Many turfs are watered incorrectly. Poor irrigation practices can weaken turfgrass, allowing weeds to invade. Annual bluegrass, crabgrass, and nutsedge are just a few weed species that thrive in poorly irrigated lawns.

Fertilizing

To maintain a healthy lawn fertilization approximately 6 weeks after planting is necessary. In general, lawns need to be fertilized about four times a year while they are actively growing.

Thatch

Regular thatch removal will help to keep the turf grasses healthy and competitive with weeds. Thatch is a layer of organic matter (stems, stolons and roots) that develops between the turf grass blades and the soil surface. A thin layer of thatch is normal and even beneficial; it can help to limit weed germination.

Hand weeding

Remove weeds while they are still young and before they set seed or produce rhizomes or tubers. Making this a regular habit will greatly reduce the number of weeds in your lawn. Be sure to remove the entire weed, including the root.

Mowing

Mow grasses more frequently when they are actively growing. A standard guide is to remove no more than 1/3 of the leaf blade at each mowing. If too much is removed at one time, it can take some time for the grass to recover, giving weeds a chance to invade. Mow weedy lawns frequently enough to avoid this patchy appearance and prevent flower and weed seed formation. Washing the mower's deck and underside afterwards will remove weed seeds. The same applies if mowers are moved from weedy lawns to other lawns, to avoid transporting weed seeds and propagules. Avoid mowing lawns when the soil is wet, such as after rain or irrigation; moving a mower over wet soil can lead to compaction.

Herbicides

If the is properly maintained, herbicides will generally not be necessary. When they are needed, use them as part of an integrated management program that includes good cultural maintenance practices. No single herbicide will control all lawn weeds, and not all herbicides can be used on all lawn species. Herbicides are classified in several ways:

- Preemergent or Postemergent
- Contact or Systemic
- Selective or Nonselective.

Pre-emergent herbicides

In lawns they are primarily used against annual grass weeds such as annual bluegrass and crabgrass, but there are also preemergence herbicides that are effective against many broadleaf weeds.

Contact herbicides

Contact herbicides cause localized injury where the chemical comes in contact with the plant and are most successful when applied to young weeds. Examples :Diquat, Carfentrazone, Plant oils and Herbicidal soaps

Selective herbicides

Selective herbicides kill target weeds without damaging desirable turfgrass species. They are toxic to only certain plants or weeds. For example, 2,4-D selectively kills only broadleaf plants and not grasses; fluazifop selectively kills only grasses and not broadleaf plants.

Non selective herbicides

Nonselective herbicides kill all or most vegetation including turfgrass. They should only be used prior to planting a lawn, during renovation, or as spot treatments. Eg: glyphosphate

CRAB GRASS



BANYARD GRASS



ANNUAL BLUE GRASS



FOX TAIL GRASS



CREEPING CHARLIE



WILD VIOLET



17. BIOTIC STRESS MANAGEMENT IN TURF

Stress implies some adverse effect on the physiology of a plant induced upon a sudden transition from some optimal environmental condition where homeostasis is maintained to some suboptimal condition which disrupts this initial homeostatic state. Plant stress is divided into two categories

- Biotic stress
- Abiotic stress

BIOTIC STRESS

Biotic stress in plants is caused by living organisms, specifically viruses, bacteria, fungi, nematodes, insects, arachnids, and weeds. In contrast to abiotic stress caused by environmental factors such as drought and heat, biotic stress agents directly deprive their host of its nutrients leading to reduced plant vigor and, in extreme cases, death of the host plant.

TURF PESTS

Lawn ecosystems often include a variety of insects, some of which are direct pests of grass, or pests to humans and pets in lawn. Some may be predators or parasites of other insects, or harmless scavengers. Through complex interactions between the insects and other factors, the lawn ecosystem becomes more or less balanced . the major pest affecting the lawn are

- White grubs
- Bill bugs
- Bermuda grass mites
- Chinch bug
- Army worms
- Dichondra flea beetle
- Sod web worm

WHITE GRUBS (*Phyllophaga spp*)

White grubs are the larval stages of scarab beetles such as masked chafers, rose chafer, may beetles, green june beetle, and japanese beetle. The body is whitish, fat, and usually curled into a c-shape. Size varies from 1/8 to 1 1/2 inches long depending on the age and species.

SEASON: *Adults - mid-June to September, Larvae - March to May, July to December*

DAMAGE: The grubs occur in large patches of sod an inch or so below the soil line where they consume the anchoring roots of grass. During dry weather, the infested sod may die for lack of water

BILL BUGS: (*Sphenophorus venatus vestitus*)

An adult billbug is a black beetle (weevil) that has a "bill" or snout. The chewing mouthparts are at the end of the snout

SEASON : *Adults - May to early June, Larvae - June to August*

DAMAGE : Zoysiagrass and bermudagrass are preferred hosts, and most damage occurs in fall and spring. The grass consistently wilts in an area of the turf despite proper irrigation

DICHONDRA FLEA BEETLE (*Chaetocnema repens*)

Adult flea beetles are black and very small, about 1/25 inch (1 mm) long with enlarged hind legs. The larvae are white with fine bristles and a light brown head capsule. Larvae live in the soil and are not usually seen.

DAMAGE : On bermudagrass, damage appears in March through September. White, linear banding occurs along the length of the leaf blade. The turfgrass appears bleached or burned.

BERMUDA GRASS MITES (*Eriophyes cynodontiensi*)

The bermudagrass mite (*Eriophyes cynodontiensi*), also called bermudagrass stunt mite, is a very small, elongate, creamy white or translucent-colored mite

DAMAGE : This damage causes a witch's broom effect on bermudagrass stems as the mite feeding reduces the elongation of grass stems and causes a swelling of leaf sheaths.

CHINCH BUG (*Blissus insularis*)

The southern chinch bug is the most important insect pest of St. Augustinegrass, but may also feed on other turfgrasses and weeds. Adults are about 3/16 inch long and are black with white patches on the wings

SEASON : *Adults - June to late*

DAMAGE: Infested grass turns yellow, then a burnt-reddish color, and dies. Chinch bugs tend to feed in groups, so dead patches of grass appear and seem to get larger as the insects spread through the grass

SOD WEBWORMS (*Herpetogramma phaeopteralis*)

The adult stage of the pest is a small buff moth that is often seen fluttering over lawns at dusk and at night around lighted doorways about two weeks before larvae become numerous

SEASON : *Adults - late June – late August, Larvae - Late April -early June*

DAMAGE: Sod webworms graze baseball-sized patches of grass that turn brown and die. Patches of grass that are clipped off at the soil surface may be numerous and run together to form large dead areas

ARMY WORMS (*Spodoptera frugiperda*)

Armyworms, including the true armyworm and the fall armyworm, are characteristic caterpillars about 1-1/2 inches long when full grown. They vary in intensity from year to year, but during outbreaks they may move across an area in army fashion completely stripping grasses in their path. Fescue is more often attacked than bluegrass

ANTS (*Lasius niger*)

Controlling ants in the lawn becomes important where their hill building causes root damage to grass and unsightly mounds. These colony insects settle in large numbers and build intricate labyrinths in grass root systems. Ant hills in grass may pose a hazard to foot travelers and mower blades

NEMATODES:

- Sting nematode (*Belonolaimus* sp.)
- Stubby-root nematode (*Paratrichodorus* sp.)
- Lance nematodes (*Hoplolaimus* sp.)
- Ring nematode (*Criconemella* sp.)
- Root knot nematodes (*Meloidogyne* sp.)

SUSCEPTIBLE VARIETIES : Bermudagrass, St. Augustine, Zoysia, And Centipede Grass

SCOUTING TECHNIQUES

Correct scouting techniques are designed to effectively gauge the level of insect populations while minimizing turf disturbance. Different techniques are adapted depending on the lawn area. Commonly followed techniques are

- Soil sampling
- Soapy flush technique
- Core float technique

SOIL SAMPLING

Dig three sides of a square, 6 inches on a side (=0.25 sq. ft.) and 4-6 inches deep. Flip upside down on flat surface, e.g., a plywood board. Use a trowel to beat soil and roots on bottom of sod in order to dislodge larvae. Remove larvae and put in a container to count totals. Replace sod, water well, and sod should re-root. Alternatively, use a cup cutter to pull samples.

SOAPY FLUSH TECHNIQUE

Add 1 to 2 tablespoons of lemon scented liquid dish detergent to 1 gallon of water; pour over area 2 ft. by 2 ft. Caterpillars, earthworms and adults of some species will be irritated and crawl to the surface within 5 minutes (usually more quickly). Collect caterpillars and/or insect adults and put in a container to count totals. If sampling in mid-summer, rinse the area after counting insects to avoid scalding turf

CORE FLOAT TECHNIQUE

Take a sample with a cup cutter, gently break apart turf and thatch, and look for insects. Place all material in dishpan with lukewarm water. Insects will float to surface.

MANAGEMENT

- Reduce environmental stress and maintain plant vigor
- Use high quality sod free of turf damaging insects during renovation and establishment
- Mowing to optimal height
- Uses appropriate traps depending on the type of pests
- Endophyte-enhanced cultivars tend to be vigorous even under conditions of stress and exhibit a level of resistance to foliar feeding insects
- Insecticide applications should be made only when sampling has demonstrated that a pest population has reached the threshold level
- Preventive insecticide should be used in conjunction with proper cultural practices that provide the best agronomic conditions for turf health

TURF DISEASES

Many diseases occur on the different turfgrasses that are used throughout Tennessee. Most of the diseases are caused by fungi and nematodes. Some problems such as wilt, cold damage, heat, high soluble salts, soil compaction or chemical damage that resemble diseases are caused by environmental or management factors. Careful identification of the cause of the problem is important when selecting proper control methods. The major diseases affecting turf grasses are

- Slime moulds (*Physarum cinereum*)
- Dollar spot(*Sclerotinia homeocarpa*)
- Summer patch(*Magnaporthe poae*)
- Brown patch(*Rhizoctonia solani*)
- Mushroom fairy ring(*Marasmius oreades*)

- Rust (*puccinia* sp.)

SLIME MOULDS (*Physarum cinereum*)

Slime molds are commonly found on lawns in warm, moist weather. This fungal growth on grass leaves may be either a small, crust-like, light to dark mass with a sooty appearance, or a tan to orange shapeless mass.

DAMAGE: The fungus causing this unsightly problem does not infect the grass blade; it simply uses it for support. The only effect it has on the plant is to temporarily reduce food production by the grass leaf as a result of shading.

DOLLAR SPOT (*Sclerotinia homeocarpa*)

Dollar spot affects a wide variety of grasses, including Kentucky bluegrass, bermuda, perennial ryegrass, zoysia, tall fescue, and bentgrasses. The fungus is active throughout the growing season, especially when there is low soil moisture and an excess of dew or fog.

DAMAGE: A large number of spots can come together and form larger dead areas. Leaf spots are usually found along the edges of the grass blade and may come together across the blade, causing the tip to die.

SUMMER PATCH (*Magnaporthe poae*)

This disease affects Kentucky bluegrass and annual bluegrass. Circular to irregular patches of dead turf up to 1-2 feet in diameter develop during hot weather in mid- to late-summer.

DAMAGE : Below ground, roots and crowns of affected plants are brown and decayed, a result of fungal colonization. A tuft of healthy, green grass is sometimes evident in the center of affected patches, giving them a characteristic “donut” appearance

BROWN PATCH (*Rhizoctonia solani*)

Brown patch is a common fungal disease of fescues, perennial ryegrass and bentgrass. The disease develops most readily when daytime highs exceed 80°F and nighttime lows are in the mid- 60's°F or higher. Brown patch is one of the more common turf diseases, especially in tall fescue

DAMAGE: Brown patch is characterized by nearly circular areas of dead leaves that may be a few inches to several feet in diameter.. Affected areas are generally tan or brownish in bent and ryegrass. Affected fescues usually have straw-colored leaves

MUSHROOM FAIRY RING(*Marasmius oreades*)

Fairy ring can occur in any turf. The ring appears as a circular discoloration of grass from several inches to many yards in diameter. Mushrooms (toadstools) may appear at the edge of the ring during warm, moist periods.

DAMAGE: The ring of grass is generally a darker green than the grass inside and outside the ring. During periods of moisture stress, the grass inside the ring may die. Fairy rings gradually increase in size.

RUST(*Puccinia sp.*)

Rust is a problem on Kentucky bluegrass, fescue, zoysia, perennial ryegrass, and bermuda grasses. Rust infection results from rust spores which are blown to the plant from distant areas or from nearby alternate hosts. Large numbers of spores are produced in the leaf spot (pustule). These spores are then the source of new infections. The disease is most frequently found during cool, humid weather during autumn.

MANAGEMENT

- Apply fertilizer according to current recommendations and based on a soil test.
- Excess nitrogen will cause succulent growth that is more susceptible to disease, and some diseases are encouraged when nitrogen is deficient.
- Adjust pH according to soil test recommendations. Disease occurrence may increase at pH extremes (too high or too low).
- Time fertilization and liming to avoid disease critical periods
- Time irrigation in order to minimize duration of leaf wetness. Dry turfgrass blades reduce disease by reducing infection
- Minimize wounding and shredding of grass blades by keeping blades sharp and adjusted properly.

- Mowers should be washed and mowing order of lawns should be modified when some lawns have active disease to avoid spreading pathogens
- Modify the landscape where needed to improve air circulation and reduce shade

WHITE GRUB



BILLBUGS



DIDHONDREA FLEA BETTLE



BERMUDA GRASS MITE



CHINCH BUGS



ANTS



ARMY WORM



SOD WEB WORM



SCOUTING TECHNIQUES

SOIL SAMPLING



SOAPY FLUSH TECHNIQUE



CORE FLOTATION TECHNIQUE



DISEASES

SLIME MOLD



DOLLAR SPOT



SUMMER PATCH



FAIRY RING



BROWN PATCH



RUST



18.ABIOTIC STRESS MANAGEMENT IN TURF

ABIOTIC STRESS

Abiotic problems are non-biological (non-living) agents that have the potential to cause turf damage or impart stress. Abiotic stresses and associated problems, including improper cultural management techniques, can influence turf function and quality as well as pest activity.

RECOGNITION OF ABIOTIC PROBLEMS

S.NO	PROBLEM	DAMAGE
1.	Acid and alkaline soil	Overall poor growth. Soil test indicates inappropriate pH for grass growth.
2.	Winter desiccation	Large areas of straw-colored grass especially where exposed to wind with little snow cover.
3.	Frost	New growth killed back.
4.	Chilling injury	Straw-colored or rotted grass, especially where water collects on frozen soil.
5.	Salt damage	Dead or yellowed grass along sidewalks, driveways, or roads where salt has been applied
6.	Compaction	Soil is hard. Turf is thin. Rooting is poor.
7.	Nutrient deficiency	Yellowing or other discoloration; generally poor growth
8.	Over fertilisation	Exaggerated turf color, along with rapid growth rate; tissues succulent.
9.	Drought	Turf loses its luster, appears slightly off-color and foot printing occurs

10.	Over watering	Soil is saturated; grass is overly lush and may mat down easily.
11.	Poor drainage	Waterlogged soil, puddling.
12.	Shade	Turf is thin; leaves may appear elongated and succulent.
13.	Poor air circulation	increased leaf wetness duration, increased disease incidence.
14.	Traffic stress	Bruising and crushing injury to turf, compacted areas, loss of stand density
15.	Animal urine damage	Spots of browned or yellowed turf, perhaps with extra green growth around them
16.	Chemical contamination	Sudden scorched areas of turf.

MANAGEMENT

- ✓ Select proper species and cultivar selection, sound fertility, judicious irrigation, proper mowing and cultivation, integrated pest management strategies, and other appropriate cultural practices to avoid or mitigate abiotic problems.
- ✓ Increase surface and soil drainage; soil grading; reduce irrigation regime; avoid traffic.
- ✓ Select heat tolerant grasses. Syringe turfgrass canopy with water
- ✓ Remove soil; bioremediation; use activated charcoal to absorb chemical; apply pesticides according to label in case of chemical injury
- ✓ Maintain adequate nitrogen levels
- ✓ Adjust mowing height; follow proper mowing frequency.
- ✓ Visually scout turf areas at each site visit, noting conditions which may lead to turf damage or actual symptoms of abiotic problems
- ✓ Use of modern technologies such as remote sensing to find out the problems at early stages

ABIOTIC STRESS

SALINITY



COMPACTION



FLOODING



DROUGHT



FROST DAMAGE



NUTRIENT DAMAGE



19. TURFING FOR CRICKET GROUND

Cricket pitches should be prepared hard and flat to produce a good playing surface. The aim is to have a pitch that offers assistance to the batsman and the bowlers. Cricket pitch preparation goes against most of the standard turf management practices. For example, compacting soils and cutting the turf very short are not desirable turf management practices. In pitch preparation, compaction and closely mown turf are needed to produce a good pitch that is hard and fast. We need to let the pitch recover after games and change to another pitch due to these practices. Good pitches promote the game and develop good cricketers.

SELECTION OF GRASSES:

- 1) Warm season (C₄) - Couch / Doob grass
- 2) Cool season (C₃) – Perennial Ryegrass.

WARM SEASON GRASSES:

They are suitable for sub-tropical and tropical climate (25-32°C)

Couch Grass: *Cynodon dactylon*

It is an excellent grass for cricket pitches. Because,

- It is actively growing,
- Hard wearing grass,
- Heat and drought tolerant,
- It can handle high levels of salt in the soil,
- Be closely mown as well as withstands rolling and has good recovery due to its capacity to creep by rhizomes and stolons.
- On the down side of *Cynodon* it goes dormant when the temperature is too low.

Which couch grass variety to choose?

Choose one that grows well in your area.

VARIETIES:

- Princess
- Riviera
- Legend
- Conquest
- Grand Prix

HYBRID:

Santa Ana - *Cynodon dactylon X Cynodon transvaalensis*

It is a finer grass than most common couches. It is more dense and has a shorter dormancy however it usually produces more thatch than most common couches.

COOL SEASON GRASSES:

These perform well in a temperate climate (15 – 22 °C)

Perennial Ryegrass - *Lolium perenne*

Is the best of the cool season grasses for cricket pitches. Because,

- It is quick germinating,
- It has quite good wear tolerance,
- It is a dark green color and is visually pleasing,
- It retains its green color on cricket pitches.
- On the down side it does not like to be cut too low,
- It has poor recovery if there are bare areas as it cannot creep,
- It has poor heat and drought tolerance.

VARIETY: SR4600

WICKET SOIL

- Clay soils are required to get the pitch hard.

- Sandy soils on the other hand do not mold together or aggregate into clumps or clods.
- They cannot produce a hard surface; however, they do drain well, they have plenty of room for roots to grow and room for oxygen in the profile so roots can have access to oxygen.
- Soils need to be tested for their suitability for cricket pitches.
- Some of the tests that could be undertaken are,
 - Particle size
 - Cracking pattern
 - Linear Shrinkage
 - Crushing Strength

Example of a Clay Sieve Analysis	Percentage %
Gravel	1
Very coarse sand	2
Coarse sand	5
Medium sand	4
Fine sand	3
Very fine sand	4
Silt	26
Clay	55
Total	100

TERMINOLOGY

Wicket table:

- The area where the heavy clay is, usually in the middle of the oval.
- This is the area where the cricket pitches are prepared.
- The size of this area will vary depending on how many pitches you have on the wicket table.
- The size is generally 25 meters long by 15 meters wide based on a five wicket table.
- Curator:
- Is the person responsible for the pitch and oval. He is the manager of the turf and is sometimes called a “grounds man”.

Wicket:

- The stumps and the bails make up the wicket. Sometimes the playing surface or the pitch is referred to as the wicket.

Pitch:

- This is the area that the game of cricket is played on. It should be flat and hard and have the crease markings painted on. The markings will be 66 feet long by 8 feet 8 inches wide however you usually cut and roll a bigger area than this, 10 feet wide and around 78 feet long.

Role of grasses in the turf pitch:

- The turf grass draws water from the soil profile through transpiration and this helps the pitch dry out deep in the profile.
- Evaporation will only dry the pitch down to about 3 cm, but the grass root system that takes moisture out of the soil profile deeper down and this helps create a harder pitch. So it is important to have a full cover of grass and a deep root system.
- Full cover of grass helps to hold the pitch together.
- If the pitch had no grass cover it would crack open and where the cracks start they will dry out more than where there are no cracks.

- The cracks will be exposed to more evaporation and will crack open even more. So by having a full cover of grass the pitch will dry more evenly and not crack open as quickly or as much.
- If the grass cover is uneven and you have some parts of the pitch with grass and other sections of the pitch with no grass cover you will get areas of the pitch that are harder than other areas and that will mean an inconsistent pitch.

If the pitch is too soft:

- It will be slow
- The ball will make indentations in the pitch
- The ball may seam around slowly
- The ball may pop up dangerously

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- The ball will make indentations in the pitch
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- The ball may pop up dangerously

If the pitch is too dry:

- It will break up easily
- It will crumble
- It will take spin
- It may have lots of small cracks that do not hold together and come away from the pitch making it dangerous
- Grass cover will help hold a dry pitch together
- If it is too dry when you are rolling you will not get adequate compaction, in fact, you will break up the pitch

If the pitch is too hard:

- The pitch cannot be too hard when the game starts, our aim is to produce a hard surface.
- Hardness is a desirable characteristic and you are aiming to achieve this with good compaction in the rolling process.
- During the preparation stage the pitch should not dry out too much and become too hard. As this will induce stress on the grass, reducing the deeper drying effect the grass cover has in the pitch through transpiration.

The ideal pitch:

- Will offer something for everyone
- Allow bowlers to get pace
- Will enable batsmen to play their shots
- Will enable all fielders to be involved in the game
- Has an even cover of turf grass
- Has a straw colored appearance
- Has a shiny finish
- Is visually appealing and gives the players confidence

EQUIPMENTS NEEDED FOR PITCH PREPARATION

Roller: There are two main types of rollers.

- 1) Walk behind roller
- 2) Ride on roller

1) Walk behind roller:

- That is powered by petrol driven motors.
- The roller may be empty, water filled, sand filled or concrete filled.
- The roller will vary in weight depending on what it is filled with.

- A water filled roller is the most commonly used and it will weigh about one to one and a half tones.

2) Ride on roller:

- These have a roller at the front and one at the back and the operator is seated in the middle.
- These usually weigh about 2 ½ tonnes or more.

Cylinder mower:

- This mower cuts the turf grass like a pair of scissors.
- It has a blade at the front of the mower on the bottom known as a bed knife.
- Above this is a cylinder with blades that rotate around on an angle and touch the bed knife to cut the grass. On the back is a roller and on the front is a small roller.
- The grass clippings are thrown forward into a catcher.
- This mower stripes up the grass with a dark and light color when cut in one direction and back in the other.

HEIGHT BAR:

- This small tool is used to set the height of cut for the cylinder mower.
- The height is set by measuring the gap between the bar and the underside of the nut.
- It is simply adjusted by screwing the nut in or out and adjusting the mower.
- The underside of the nut is placed on the bed knife and the ends of the bar are placed on the front and back roller.
- Ensure the height is the same all the way across the cut. In the photo below the height is set at 20 millimeters.

Scarifier:

- This is also known as vertical mowing. Steel grooves cut into the turf and soil to remove debris from the wicket table.
- This should be done after the football season as part of the renovation process, or to thin out turf grass cover during the season.
- It may also be done after laying sods when the roots are growing. This is to get an even grass cover, to mask any sod joins and to stimulate root growth.

TASKS IN PITCH PREPARATION

1) String line the outside of the wicket

2) Watering the pitch

3) Rolling the pitch

- Longitudinal rolling
- Cross rolling
- Diagonal rolling

4) Cutting the pitch

5) Applying grass clippings

6) Marking up the creases

7) Covering the pitch

8) Ready for play.

1) String line the outside of the wicket:

- The preferred method is to have the corners of the wicket table defined either through a dot of paint or a flat metal peg. Once you have the corners of your table defined it is a simple case of measuring across from corner to corner of the wicket table.
- Putting a peg on each corner of your new pitch. Next you need to tie the string around each peg and pull it tight.

2) Watering the pitch:

- Thoroughly wet up the soil profile to depth.
- Shallow water is difficult, to produce a hard, bouncy surface.
- Clay soils for cricket wickets are predominantly made up of very small particles.
- These particles retain the water and do not allow the water to flow through the profile quickly.
- Clay soils have a low infiltration rate and an understanding of this is important when wetting up a cricket pitch.

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- These particles retain the water and do not allow the water to flow through the profile quickly.
- Clay soils have a low infiltration rate and an understanding of this is important when wetting up a cricket pitch.
- All wicket tables should have a slight fall from one side of the table to the other, usually a minimum of 1% fall. This allows excess rainfall to run off the table so the wicket table is not constantly wet, both during the football season and the cricket season.
- We need to apply water numerous times in small amounts and allow it to soak into the profile.
- Wetting up the wicket slowly until puddles appear on the surface and then stop.
- Then come back about an hour later when that water has soaked into the profile and apply more water.

- This may be done with an automatic irrigation system or a hand held hose.
- Ensure the wicket receives an even amount of water.
- You may need to repeat this process up to five or six times during the day for this initial wetting up of the pitch on the Monday.
- To check if you have wetted up the soil profile to depth push down with a metal probe or stake or knife to feel if water has infiltrated down to about 100mm in depth.
- Be sure not to walk on the pitch when watering it otherwise you will damage it with your footprints. Walk on the adjacent pitch.
- After rolling, the turf will be stressed so we may need to apply a small amount of water to renew the turf and wet up the top few millimeters of the profile. If we wet up much more than this we will be undoing the benefits of our rolling by softening up the pitch.
- If we don't apply a small amount of water, the plant will be stressed and won't function properly, and this will reduce the deeper drying capacity of the grass in the soil profile.
- This should be done late in the afternoon if it is hot. This water will assist the supply of water that has been evaporated from the surface. The roots play an important role of drawing moisture out deeper in the profile and if our turf grass is overly stressed then this will not occur efficiently.

3) Rolling the pitch:

- The pitch needs to be firm enough to get a roller on it and to enable compaction but not too hard as little or no compaction will occur.
- Don't do rolling when the pitch is too wet.

- 1) This may bring moisture up,
- 2) Blacken the surface,
- 3) Create deep indentations on the pitch
- 4) The soil may stick to the roller and these damages the pitch.

- The weight of the roller will have an influence on when you are able to carry out your first roll on the pitch.
- Use light rollers to wetter soil and heavier rollers to drier soil to achieve the best compaction.
- If the surface is ready to commence rolling, you should be able to push your thumb into the pitch and make a slight indentation. If this is the state of the pitch then it is ready to begin rolling.
- This will occur about a day or two after the deep watering depending on weather conditions.
- Rolling pushes the small clay particles into the gaps or pore spaces between the soil particles and this creates a more dense soil profile.
- For this to occur you need some moisture in the soil and some air.
- The water acts as a lubricant allowing the clay particles to slip into the gaps.
- If the pore spaces are filled with water you cannot get compaction as the water is not compressible and will only be pushed around in the profile.
- Rolling a wet pitch can create a wavy uneven surface so do not roll a wet pitch.
- We need to evenly roll the pitch, and the length of rolling is usually around 30-40 minutes.
- The soil get good compaction at a moisture content known as optimum moisture content (OMC).

There are three main directions when rolling a pitch.

- Longitudinal rolling
- Cross rolling
- Diagonal rolling

Longitudinal rolling:

- It is simply going up and down the pitch in the direction of play.

- This is the most common and efficient way to roll.
- As stated earlier you need to evenly roll the pitch so when you get to the end of the pitch with the roller adjust your roller when it is still moving to place it on an angle to return up the pitch about half a roller width from your last run.
- If you try to move the rollers' angle when it is stopped it is very heavy and difficult to move. You can damage the turf surface and your back.
- If longitudinal rolling, use the string lines as a guide to keep a straight edge on the sides of your pitch.
- The best way to do this with a motorized walk behind roller is put the edge of the front small roller on the string line when rolling backwards.
- If you do this when going forward it is difficult to keep a straight line, however it is much easier doing this going backwards.

Cross rolling:

- It is simply rolling the pitch from side to side, the opposite direction to longitudinal rolling.
- So you only travel 10 feet and come back at an angle to the other side of the pitch.
- This is done to flatten out any undulations in the pitch that are not able to be leveled with up and down rolling.
- The down side to cross rolling is that it can damage the edges of the pitch where you adjust the angle of the roller to make your way back across the pitch.
- After cross rolling it is a good idea to have a couple of longitudinal rolls on the outside edge of the wicket where the turns have occurred to flatten out any creases made by the edges of the roller.

Diagonal rolling:

- It has a similar result as cross rolling however it allows you to take longer runs.

- Usually you would go at a 45 degree angle to the pitch and next time you diagonal roll do it from the other side of the pitch which is at the opposite angle.
- The main aim is to try to achieve a flat pitch.
- Some curators diagonal roll at numerous angles and for a large amount of their pitch preparation.
- Cross rolling and diagonal rolling are sometimes done on the whole wicket table before renovation, during winter and at the start of the season to level any undulations on the whole wicket table.

4) Cutting the pitch (Mowing):

- The pitch should be cut with a cylinder mower.
- The mowing height will depend on the grass types used, the time of year and your personal preference.
- You should keep in mind the height should be the best for root development as this is most important for good pitch performance.
- Generally the wicket table should be maintained at around 10 mm height. This may be higher at the start of the season to protect the wicket table, letting this get longer towards the end of the season to around 15 mm. So, the turf has a better chance of survival in the football season.
- Do not remove more the one third of the plants leaf in any one cut.
- So cut the wicket down to 8mm at the start of preparation and cut it each day taking off around one millimeter each time. The final height of the wicket should be around 4 mm long.
- Cutting it much longer than this may give too much assistance to the bowlers as the ball may seam around.
- Cutting the pitch down to 2mm or so will damage the turf sward and mean the pitch will be easily damaged and very slow to recover after the game.

Stripe up the wicket table:

- This means cutting in one direction and returning next to your last cut in the other direction.
- This lays the grass in the two different directions and shows up as light and dark green leaving a visually appealing pattern.
- However the pitch itself can not have any stripes showing as this would be distracting for the batsman and an advantage to the bowler as he/she would have a line to aim at. So you need to cut up the pitch and return on the same line you just cut, effectively double cutting.
- Continue this all the way across the pitch and you will have all the same appearance for the whole pitch.

5) Applying grass clippings:

- Grass clippings play an important role in pitch preparation and presentation.
- They also help keep the shine on the ball.
- If your pitch has a full cover of grass and an even color then you do not need grass clippings rolled into the profile.
- However most pitches need grass clippings especially pitches early on in the season and the second week of a game as wear will damage the turf coverage.
- You simply need to have a supply of grass clippings that you have cut off your pitch during the week.
- This need to be dried and the same color as your pitch. This is easy to achieve if you only have a couple of bare areas on the pitch as you do not need many clippings.
- Get some grass clippings from the wicket table, a nearby bowling club or from the outfield and dry them. Careful they are not too wet and go moldy.
- Spread them out on a concrete area in the sun, turn them regularly and they should dry.

- Wet up the top few millimeters of the profile, up and down the pitch with the hose and fish mouth.
- Allow a few minutes for the water to soak in.
- Then have all your clippings on hand in a bucket, quickly apply them evenly to the bare areas and any other areas you feel need clippings on the pitch.
- You can throw them out or rub the clippings between your hands to distribute them evenly.
- Clippings end up increasing the organic content of the top layer of the soil.
- Roll the pitch immediately after the clippings have been applied.
- You will leave small indentations in the pitch with the edges of the roller.
- Evenly roll the pitch for about five minutes.
- The watering will have wet the clay up and clay is sticky when wet.
- Clippings may stick to the roller and make clumps and these can leave indentations in the pitch.
- If this starts to occur then stop the roller on the end of the pitch and remove these clumps.
- If they haven't stuck one of two things will have probably occurred.
- One is the pitch may have dried out and so the clippings would not stick, or the pitch did not have the bare soil exposed so the clippings did not make direct contact with the clay.
- This is usually due to old clippings not removed or organic matter on the surface.
- If the wicket dried before the clippings were rolled in you can just repeat the process with a little more water this time.
- It is a delicate balance to get just enough water and not too much.
- The other thing this process of rolling in clippings does is gives the pitch a shiny finish.

- So some people lightly wet the pitch and roll it even if they do not need to roll in clippings just to give it the shiny finish.

6) Marking up the creases:

- Allow plenty of time if you are marking up a pitch for the first time.
- Crease markings are an important part of a pitch presentation.
- Nice straight lines that are parallel to the edges of the cut pitch and sharp edges all help with a great finish.
- It is easy to get this wrong, especially when you are first preparing pitches.
- Spilling paint, having wet paint and then rolling the pitch, lines not parallel or simply incorrect measurements are some of the mistakes that can be made.

7) Covering the pitch:

- Most turf competitions now allow covers to be used.
- Covers are used to control the amount of water being applied to the pitch.
- The other big advantage of covers is you will have less games washed out.
- This is a big plus to the players and to the satisfaction of the curator.
- It is very disappointing to have a good pitch all ready for play on Friday and it starts to rain.
- The problem with covers for a curator is they are very heavy especially if it is windy and storage can be an issue.
- Some people do not prefer to use covers as they can sweat depending on weather conditions.
- This sweat has a similar effect to watering the pitch.
- Hessian cloth is usually used under the covers to soak up the sweat.
- Better to use covers than to get an overnight shower on Friday night and the game get washed out.

- Heavy dew can also soften the wicket overnight so covers can reduce this problem. Competitions usually have rules that everyone must put down covers on Friday night

8) Ready for play:

- Presentation and final appearance play a key role in the pitch, if the players like what they see then they will have confidence in the surface prepared.
- So try to achieve a nice even color, a flat pitch, sharp crease markings, and straight lines with your mower and roller on the edges of the pitch.

THE WEEKLY TIME FRAME

- Pitch preparation will vary depending on the standard of the game being played, and the time available to prepare the surface.
- A Test match pitch may take up to two weeks to prepare while a local club playing on Saturday may take as little as five days.
- It is beneficial to start your preparation about 10 days before the match starts.
- This means you will have two pitches being prepared at the same time, the one in use for Saturday's game and the new one you are starting to get ready for next week's game. It is better to take longer to prepare a pitch.
- Below is a rough guide of the time it takes to prepare a pitch and the tasks involved.

Wednesday (11 days before game):

- Select your next pitch
- Mark out the four corners and string line the outside of your pitch
- Cut the pitch to 8 millimeters
- Deep water the pitch
- Ideally the wicket table should be roped off if possible.

Thursday:

- Roll the pitch for 30 to 40 minutes in the afternoon or when you feel the pitch is ready to be rolled.

Friday

- Cut the pitch at 8 mm
- Roll the pitch for 30 to 40 minutes
- Remove the string line and the pegs in the corner of your pitch for Saturday's game
- Place a small white dot of paint where the pegs were to allow you to find the same spot on Monday

Monday:

- Put the pegs and string line out on the pitch
- Now is a good time to repair the pitch used on the weekend.
- Lightly water the pitch to replace some of the evaporation that has occurred in the past few days. The top few millimeters of the soil should be moist.
- Depending on the weather you may be able to roll the pitch, cross roll in the afternoon for 30 minutes

Tuesday:

- Cut the pitch to 6 millimeters. (remember to keep all your clippings as you will need them later in the week)
- Diagonal roll the pitch in the morning for 30 to 40 minutes
- Cut the wicket table at 10 mm.
- Roll the pitch up and down in the afternoon again for 30 to 40 minutes
- Listen and look at the weather forecast and if it is hot give a light water to the pitch last thing for the day

Wednesday:

- Cut the pitch to 5 or 6 millimeters
- Diagonal roll the pitch in the morning for 30 to 40 minutes
- Roll the pitch up and down in the afternoon again for 30 to 40 minutes
- Again check the weather forecast to determine if you need to apply a small amount of water

Thursday:

- Cut the pitch to 4 millimeters (game height)
- Lightly water the pitch and allow a few minutes for the water to soak in
- Spread your dried grass clippings
- Quickly roll grass clipping into the pitch
- Roll the pitch in the late morning for 30 to 40 minutes
- Roll the pitch in the afternoon again for 30 to 40 minutes
- Again check the weather forecast to determine if you need to apply a small amount of water

Friday:

- Cut the pitch to 4 millimeters
- Roll the pitch in the morning for 30 to 40 minutes
- Cut the wicket table at 10 millimeters
- Mark up the pitch. Use pegs to determine the middle stump position at other end.
- Place the marking frame down and paint in your creases.
- Roll the pitch in the afternoon for 40 minutes
- Remove the string line and pegs.

Saturday (game day)

- If you are able to work on the pitch on Saturday morning then a cut and a roll will be beneficial.
- Cut the pitch to 4 millimeters.
- Roll the pitch for 30 to 40 minutes.

AFTER PLAY REPAIR

After play you will be looking at doing one of two things.

- Rest the pitch
- Repair the pitch for next weekend

Rest the pitch:

- Leave the pitch for one or two days to crack open after the game. This allows air into the profile for the roots.
- Monday broom the pitch with a stiff broom. This removes the grass clippings and any other debris off the pitch.
- Place dried clay soil into the bowling and batting holes and then roll the pitch to level these out. Deep water the pitch.
- You may also wish to fertilize the pitch before watering.
- If you have bare areas you may wish to over sow with Ryegrass seed.
- If you have a couch grass pitch you may wish to sprig the bare areas
- Let the grass grow back to 10 mm and continue to cut and water the turf to encourage growth.

Repair the pitch for next weekend:

- On Sunday or Monday broom the pitch with a stiff broom to remove any grass clippings.
- Place dried clay soil into the bowling and batting holes and then roll the pitch to level these out.

- Deep water the pitch.
- After the pitch has taken the water you can then roll the pitch when it is a suitable state.
- The pitch will not take as much work to prepare the second week as the work done in the previous week will have assisted in the preparation.

To measure turf grass stress:

- Look at the turf to see if it is wilting. The leaf will fold over and be limp. It may also look a darker purple color.
- You can purchase a pair of special sun glasses “Stress Detection glasses” that allow you to see the level of stress on the turf.
- We can see turf stress 2-10 days before it is visible to the naked eye.

To measure moisture content:

- Push your thumb into the pitch surface and get a rough gauge.
- Use a soil moisture meter such as the Theta probe.
- Take a small plug from the side or the end of the pitch. Weigh the sample and then weight the same sample once it has been dried in an oven for 24 hours at 110°C.

Wet weight - Dry weight

----- X 100 = Gravimetric Moisture

Content % Dry weight

RENOVATION

1. Roll the wicket table in several directions to get the area as flat as possible:

- After football season there will be undulations in the surface due to football boots running over a wet soft surface.
- These need to be removed through rolling.

- It will be near impossible to get the area dead flat however if the soil is in a pliable state you should be able to take out most of the major undulations and less topdressing will be required.

2. Define the wicket table using paint:

- Marked the four corners of your wicket table with stakes in the ground.
- If not find the corners, run a string line between these and place white paint dots along this to define the area to be renovated.

3. Cut the grass down low:

- If debris is on the surface we need to get down to it to remove it.
- So set your rotary mower down low, as low as you can without hitting the soil.
- This may be as low as a few millimeters.
- Scarifying is also known as vertical mowing.
- Blades cut into the surface and remove grass and debris, leaving groves.
- These groves are important as it gives the topdressing clay a chance to key in, instead of having layering.
- If you do not scarify and just top dress you will get layering.
- This is two layers of clay in the profile and organic matter in between.

4. Aeration: Aeration serves two primary purposes.

1) To release surface and soil compaction

2) To provide a suitable surface hardness- that is safe to play on

- It will be with solid tines, hollow-tines or deep spiking with solid tines.
- Typically aeration will be to 125mm or so.
- Prior to aeration it is desirable to soak the pitch to allow for easier and improved tine penetration.

5. Remove all the debris from the scarifying using a rotary mower or vacuum:

- Each time scarify in a direction you need to remove all the organic matter and loose soil. This is best done with a rotary mower.
- Have it on a low setting and the spinning of the blades creates a vacuum which picks up grass, soil and any debris.
- Use a tractor mounted broom and this can be successful in removing debris.
- Be sure if you are doing this the tractor is not damaging the wicket table by making indentations on the surface.

6. Top dressing with compatible clay soil:

- It is essential to use the same soil or a similar soil.
- There are different types of clay soils available.
- The soil needs to be able to join together when top dressing and if you are not using the identical soil you should get it tested to be sure you will not get layering.

7. Seed the area using fine leaf Perennial Ryegrass:

- Use recommended rates of 6 to 8 kg per 100 square meters.
- Evenly spread the seed over the required area ensuring seed does not land on other areas, like the couch pitches if you have sodded them.
- The seed can be spread with a walk behind spreader or by hand as long as it is distributed evenly.

8. If sodding, the scarifying should have removed all the turf cover and lay the sod directly onto the clean clay soil:

- After scarifying you may need to top dress to regain surface levels.
- Lay the washed sod on the pitch. Ensuring all the joins on the sods are pushed together tightly and there are no gaps.
- Put finely crushed clay on between these gaps, and possibly top dress the newly sodded pitch.
- Place the clay on concrete and use the heavy roller to finely crush it.

9. Sprigging: (For couch grass)

- Cover the sprigs with shade cloth for better growth.

10. Fertilizing:

- Annual soil testing will determine what nutrients required for turf grass.
- A maintenance fertilizer could be applied every month at a rate of 0.1 kilograms of actual nitrogen per 100 square meters.
- The ratio of nitrogen to phosphorous, and potassium is 10:1:8.
- Note the reduced amount of phosphorous as this is only required in smaller quantities on turf once the grass is established.
- Do not apply fertilizer to couch when it is in dormancy as it will not be actively growing so it will not take up the fertilizer, however weeds would benefit from this application.



Cracking pattern test



Core shrinkage



Crushing strength balls test



Five pitches on the wicket table. The white arrows mark the edge of each pitch.



Walk behind roller



Hand roller



Ride on roller



Cylinder mower



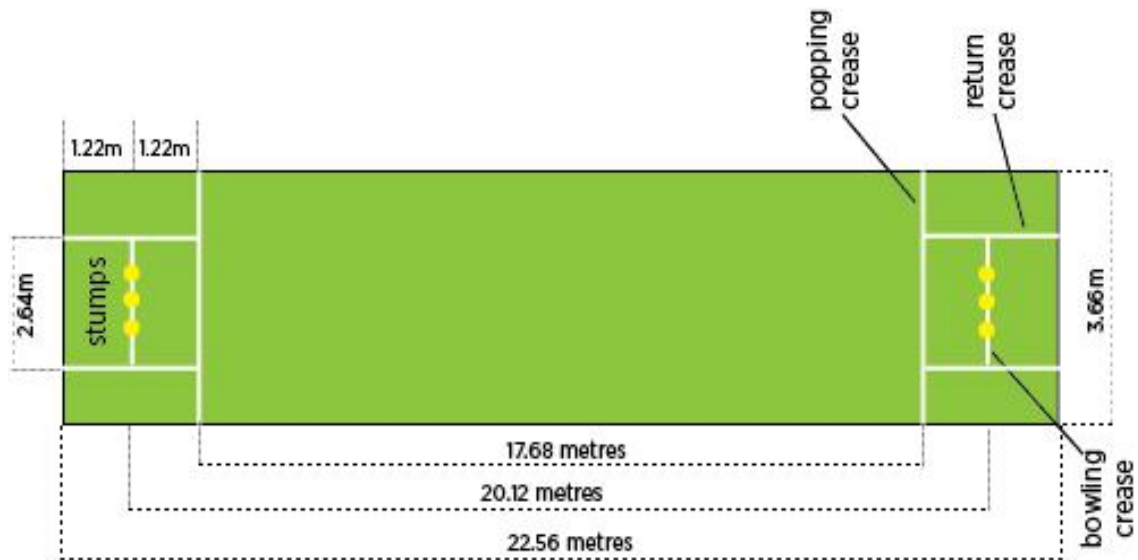
Height bar



Stiff Broom



Note the string lines down the sides of the pitch



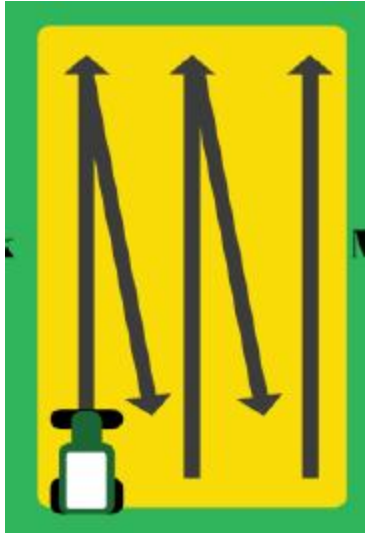
Dimension of the Pitch



Longitudinal (up and down) rolling



Cross rolling



Diagonal rolling



Pitch marking frame



Stump hole setter



Line making Machine



Mobile cricket wicket covers



Stress Detection glass



Theta probe



Scarifying



Aeration



Shade cloth on sprigs1



Newly seeded rye grass pitch



Laying washed sod

20. TURFING FOR HORSE POLO

- Grass height on polo field – 22 to 30 mm.
- Mowing – Ransomes Five gang Hydraulic cylinder.
- Underlying soil structure – Sandy loam Soil on the top of a chalk limestone sub soil structure, which makes it fairly free drainage.
- Irrigation – Briggs irrigator (70 Cubic meter per hour)
- Last watering application is at least 2 days before polo match, allowing a soil to get its optimum good to firm playing condition.
- Aeration – is carried out several times throughout the year using combination of hollow core tines and slitting blades.
- Top dressing: 2500 tonnes of top dressing is applied each year, usually three applications (May, June and July).
- The pitches also harrowed after matches to restore the levels.
- Each polo fields has to cope with over 50 games per season.
- Each game is played over four, five or six periods of seven minutes called Chukka.
- But, generally a game will last for four chukkas making a total of 28 minutes a game.
- Each team has 4 players plus 2 umpires on horse. So, there are 10 horses running, stopping and turning at full speed. Every step a horse takes creates four divots
- The divot operation is probably most unique aspect of polo field maintenance compared with other sports.
- To cover the divots sod is not an option.
- If the horse slips on un-rooted sod and breaks it legs, therefore we must use seed.

Compost needed in divot mix:

- The divot mix is a 80% sand and 20% Compost.
- Use 80% Kentucky blue grass and 20% perennial rye grass blend for the divot mix.

Renovation:

- Cleaning up the surface using brushes.
- Over seeding using direct drill seeders sowing a polo seed mix of grasses.

That includes,

- 20% Aber Elf Perennial Rye grass
- 30% Esquire Perennial Rye grass
- 20% Herald Strong Creeping Red Fescue
- 10% Mentor Hard Fescue
- 20% Wilma Chewing Fescue

Fertilizer: nitrogen 75 Kg /acre during the season

Weed:

- Broad leaved weeds and Clover need to be eradicated. Because, They create a slippery surface which is dangerous for the horse.
- Moles and rabbits are the main pest concerns as their burrowing activities can cause huge problems to the horses foot hold.



Ransomes Five gang Hydraulic cylinder



Briggs irrigator



Divot

21.TURFING FOR ROOF TOP

FACTORS TO CONSIDER IN ROOF TOP GARDEN:

- 1) Protection of roof and structure
- 2) Load bearing capacity
- 3) Drainage
- 4) Planting medium
- 5) Type of plants and depth

1. PROTECTION OF ROOF AND STRUCTURE

- Most important element in roof top garden is protecting the integrity of the roof and the building
- To protect the slab ,water proofing of exceptional quality to be done
- A completely new waterproofing layer to be added to the existing slab
- Different types and different agencies are there to do waterproofing

Water proofing membrane: Protects the roof from leakage.

Ex: Ethylene propylene diene monomer (EPDM) membrane.

Butyl rubber membrane.

Root barrier membrane: Protects the water proofing membrane. Thickness at least 2.5 mm.

Ex: High density polyethylene (HDPE).

High density polypropylene.

Screed: It has also come to describe a thin, top layer of material (traditionally sand and cement), poured and compacted at site on top of the structural concrete or insulation, on top of which other finishing materials can be applied, or it can be left bare to achieve a raw effec

2. LOAD BEARING CAPACITY

- Structural engineer should design columns and beams so as to take the load of the soil
- Bulk density of red soil- 35kg/ Cubic feet
- Bulk density of Coco peat – 20kg/ Cubic feet
- Bulk density of FYM – 20 kg/ Cubic feet

3. DRAINAGE:

- Crucial for roof garden.
- Sub surface drainage with materials such as Drain cell and Geomembrane.
- Drainage layer stores water in green roofs.
- It helps to plants for survive at dry weather.

Ex: Gravel

Dimpled plastic sheets

Ribbed fabric laminators

Geotextile Layer:

- Geotextile fabric layer is used to separate drainage layer and plants growing in soil. It prevents depositing of soil and other fine particles that clogs the drainage system.
- It also counteracts the reduction of water rapidly from the vegetation layer by circulating the moisture.
- Geotextile should be waterproofed and vapour-permeable, Geotextile chemically and biologically resistant and mechanically robust.
- Geotextiles are able to withstand many things, are durable and is able to soften a fall if someone falls down.
- Geotextiles are permeable fabrics which, when used in association with soil, have the ability to separate, filter, reinforce, protect, or drain. Typically made from polypropylene or polyester, geotextile fabrics

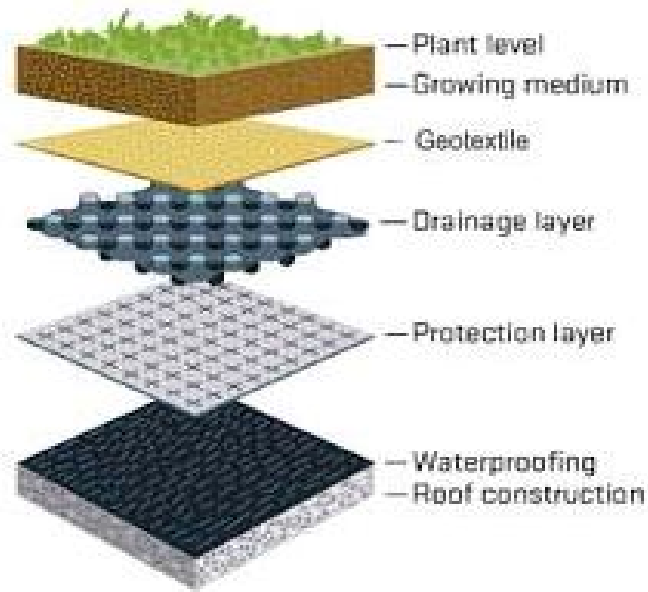
come in three basic forms: woven (resembling mail bag sacking), needle punched (resembling felt), or heat bonded (resembling ironed felt).

4. PLANTING MEDIUM:

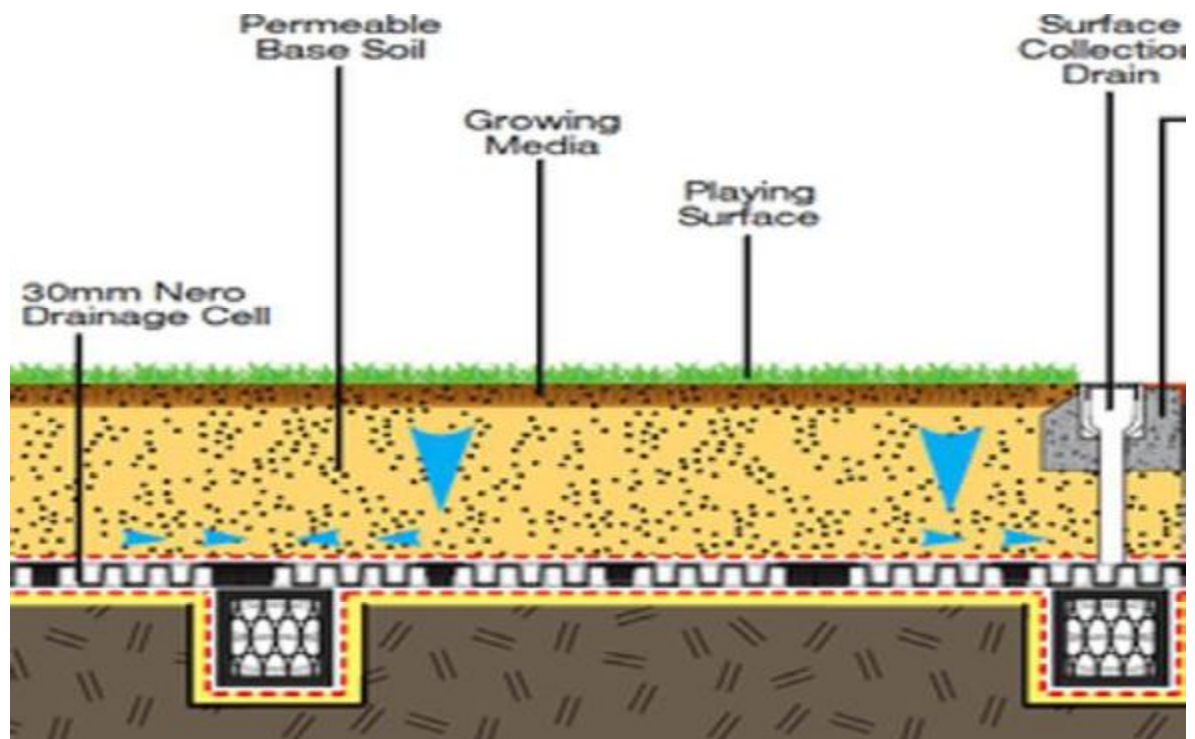
- Red soil
- Coco peat
- Farm yard manure
- Proportion 1:1:1

5. TYPES OF PLANTS AND DEPTH REQUIRED:

- Lawn – 10 inches
- Ground cover – 12 inches
- Shrubs – 18 inches
- Palms and trees –3ft



LAYERS OF ROOF TOP GARDEN





Screed



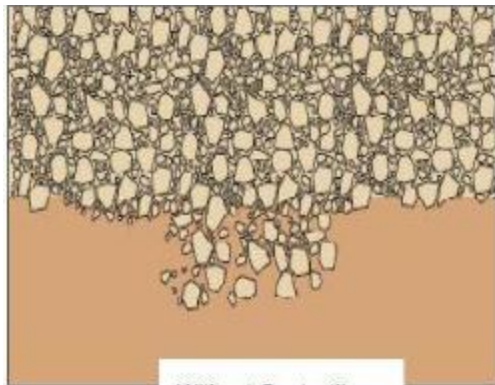
Drain cell



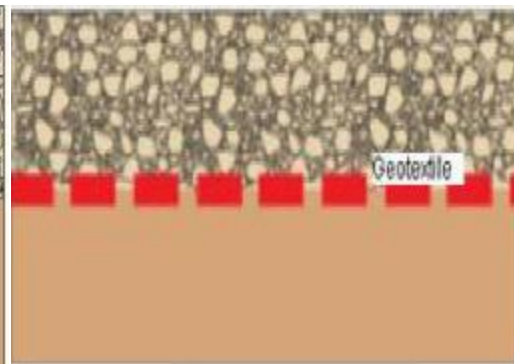
Geotextile



EPDM



Without Geotextiles



With Geotextiles