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Bulletin

Best Management Practices for Irrigating Golf Course Turf

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Many factors influence the water requirements to grow turfgrass. A healthy, high-quality turf may need up to 1¾ inches of water per week to keep it growing vigorously under hot, dry, windy summer conditions. This total water requirement includes both rainfall and irrigation. Turfgrass will require much less water when the weather is cool or cloudy. Turfs that produce a deep root system will require less frequent irrigation than a shallower rooted turf. In many cases, rooting is limited by poor soil conditions and subsequently such turfs require more frequent irrigation to produce healthy vigorous growth and an acceptable playing surface for the game of golf.

Shaded areas protected from wind generally require less water over the growing season than more exposed turf sites. The roots of trees and shrubs, however, also need water. Thus, you may need to water turf in mature landscapes frequently because of the competition for water from the roots of many plants. A regular root-pruning program for trees that surround high priority playing areas will likely reduce the need for irrigation in those areas. Healthy turf, encouraged by proper mowing, fertilizing, cultivation, and other management practices uses water more efficiently and is more drought resistant.

Species Selection

A number of turfgrass species are used for the various turfed areas on a golf course. Bentgrasses (*Agrostis* spp.), perennial ryegrass (*Lolium perenne*), Kentucky bluegrass (*Poa pratensis*), and annual bluegrass (*Poa annua*) are commonly grown species on the primary playing surfaces of golf courses in New Jersey. These species, as well as fine fescues (*Festuca* spp.) and tall fescue (*Festuca arundinacea*), can be found growing in the rough and utility areas of golf courses.

Some variation in drought tolerance does exist among creeping, velvet, and colonial bentgrasses; however, the differences among these species are not well understood. Other performance issues (e.g., playability and disease susceptibility) are likely more important criteria to use for the purpose of selection than drought tolerance at this time. Moreover, the close mowing of the playing areas on a golf course will likely have a greater impact on water use efficiency than the differences among the bentgrass species. Specific recommendations on bentgrass species selection relative to drought tolerance (irrigation management) will not become available until further research is done in this area.

Annual bluegrass is a common weedy grass that has infested many golf course turfs in New Jersey. This species is inferior to bentgrasses and other commonly used grasses for drought tolerance. It is also very susceptible to diseases and heat stress.

Turf-type tall fescue grown in rough and utility areas will require less frequent irrigation than Kentucky bluegrass, if it can grow a deep root system. In many cases, however, tall fescue rooting is limited by poor soil conditions and, subsequently, such turfs often require as much watering as Kentucky bluegrass to look good and maintain healthy vigorous growth. Perennial ryegrass will typically have poorer drought tolerance than tall fescue and Kentucky bluegrass. Fine fescues are an excellent choice for turf areas receiving limited traffic and little to no irrigation. Fine fescues, however, are less tolerant of traffic under drought stress than Kentucky bluegrass, tall fescue, and perennial ryegrass.

Zoysiagrass can remain green for weeks without watering, even during hot dry summers. This species is sometimes used for dry, difficult to maintain areas on the golf course such as bunker faces. Zoysiagrass, however, is a warm-season grass that looses color quickly in October and remains brown until late spring. For more information on Kentucky bluegrass, perennial ryegrass, tall fescue, fine fescues, and zoysiagrass, see Rutgers Cooperative Extension fact sheets FS738, FS989, FS990, FS688 and FS521, respectively. These fact sheets can be downloaded from the Rutgers Cooperative Extension website at http://www.rce.rutgers.edu/pubs/pdfs/fs738.pdf, http://www.rce.rutgers. edu/pubs/pdfs/fs989.pdf, http://www.rce. rutgers.edu/pubs/pdfs/fs990.pdf, http://www.rce.rutgers.edu/pubs/pdfs/fs688.pdf and http://www.rce.rutgers.edu/pubs/pdfs/fs521.pdf, respectively.

EFFECTIVE IRRIGATION

Turf, or any plant, should be irrigated in a manner that applies enough water to moisten as much of the root zone as possible without loss to drainage or runoff. A soil probe can be used to determine the average rooting depth in a turfed area. If the roots grow down to 6 inches deep, irrigate to moisten the soil to that depth to provide maximum water availability for the longest period possible (water use efficiency).

In addition to rooting (soil) depth, the quantity of water to apply is also a function of the soil's texture, organic matter content, structure, and bulk density. Examples of the effect of soil texture on soil water availability are provided in Table 1. From Table 1, it is evident that the amount of irrigation water applied in a single event should be predicated on the soil's ability to hold water. Sands typically can only be irrigated with a ¼ to ½ inch of water at a time, whereas a silt loam can have 1½ inch or more of water applied in a single irrigation event (provided that the water is not applied too intensely, resulting in runoff).

Incorporating organic matter (e.g., peat, compost) into soil will increase the water holding capacity of soil. Organic matter is commonly used to improve plant water availability in sand-based root zones used for turf.

Unfortunately, the structure of a soil is often destroyed during earthmoving operations which typically creates a very high soil bulk density. High bulk density soils not only suffer from poor water infiltration but also have low soil water availability to plants. Thus, turf grown on soil damaged by compaction will be extremely prone to drought stress because the soil dries out very quickly and does not re-wet readily. Investing the time and expense to loosen (cultivate) soil that was compacted during earthmoving operations will substantially improve your ability to conserve water. Cultivation with an agricultural subsoiler, chisel plow, and disking equipment before establishing a turf will greatly improve the capacity of the soil to absorb and store water, and thus reduce drought problems and intensive irrigation management (high frequency of irrigation) after establishment.

Table 1. Plant available soil water for various soils.

Soil Texture	*Available Soil Water*
	inches per foot of depth
Sands	0.5
Loamy Sands	1.0
Sandy Loams	1.5
Loams	2.0
Silt and Clay Loams	2.5
Clays	2.0

Carrying Capacity

Evapotranspiration (ET) is the term used to describe the loss of water through evaporation from the soil surface and transpiration of water through plants. The rate of evapotranspiration (amount of water lost per day) is one of several factors that determine the required frequency of irrigation for a given soil and plant system.

Plants grow best when the soil is managed to hold 50 to 80% of the plant-available water for that soil. Plants develop severe symptoms of drought stress when the soil has dried to within 20% of its plant-available water. Because of the variation in the amount of plant-available water among soil types, each soil has a different capacity to supply water to turfgrass plants. Additionally, the depth of rooting determines the total quantity of available water in the root zone. The term, *carrying capacity of a soil*, is used to describe the time required by a crop (turf) to deplete 50% of the plant-available soil water. It is affected by the rate of evapotranspiration, effective rooting depth of the turf and water holding capacity of the soil. It can be calculated by the equation:

$$\frac{\text{available water (inches/foot) x effective rooting depth (ft) x 50\%}}{\text{evapotranspiration (inches/day)}}$$

Some calculated values based on the carrying capacity of various soils and rooting depths are presented in Table 2. Turfs that have a shallower rooting depth have a shorter carrying capacity than more deeply rooted turf. Soils with greater available water have a longer carrying capacity, however, an increase in evapotranspiration shortens the carrying capacity of a soil.

Table 2. Carrying capacity of a soil for several turfgrass rooting depths and evapotranspiration rates.[1]

Soil Type	Evapotrans-piration	Effective rooting depth (inches) 2	4	8	12
	Inches/day	*Time (days) to Deplete 50% of Available Water*			
Sands	0.1	0.4	0.8	1.7	2.5
	0.2	0.2	0.4	0.8	1.3
	0.3	0.1	0.3	0.6	0.8
Loamy sands	0.1	0.8	1.7	3.3	5.0
	0.2	0.4	0.8	1.7	2.5
	0.3	0.3	0.6	1.1	1.7
Sandy loams	0.1	1.3	2.5	5.0	7.5
	0.2	0.6	1.2	2.5	3.8
	0.3	0.4	0.8	1.7	2.5
Loams and clays	0.1	1.7	3.3	6.7	10.0
	0.2	0.8	1.7	3.3	5.0
	0.3	0.6	1.1	2.2	3.3
Silt and clay loams	0.1	2.1	4.2	8.3	12.5
	0.2	1.0	2.1	4.2	6.3
	0.3	0.7	1.4	2.8	4.2

[1] Based on depletion of 50% of the available water.

The carrying capacity should be used in the design and scheduling of irrigation. There is less flexibility in irrigation design and management for shallow rooted turfs. Soils with a longer carrying capacity provide greater flexibility in irrigation, and more reliance can be placed on rainfall to extend the carrying capacity.

Frequency of Watering

It is evident, from the discussion above, that turf grown on sandy soil must be irrigated differently than the same turfgrass grown on clay or loam soils (Table 2). Even after thorough irrigation, sandy soils hold less plant-available water and require more frequent irrigation with a smaller amount of water. Improvement of the poor water holding capacity of sands is one reason why gravel blankets, highly compacted impermeable subgrades, or plastic liners are installed under high sand content root zones. These styles of root zone construction (often referred to as the USGA and California methods) will increase water content of the root zones, reduce the frequency of irrigation, and are strongly recommended when water conservation is a critical issue for the golf course. Conversely, turf growing on loam soils can be irrigated less frequently with larger quantities of water. Watering more often than the carrying capacity of the soil results in less efficient use of water because of greater loss to evaporation and possibly leaching and runoff. Excess watering will also increase the amount of weeds that appear in a turf and enhance the severity of certain turf diseases.

Irrigation frequency will also vary with environmental or climatic factors. Less frequent irrigation is needed in the spring when the roots of turf are deep and temperatures are low. More frequent irrigation is needed when roots are shallow and temperatures are high (summer), particularly for cool season grasses.

Do not apply water too quickly, otherwise water may run off from sloped sites, thatchy turf, or turf growing on highly compacted soils. In these situations, it is more effective to apply only a portion of the total water needed and to move the sprinkler or switch to another station (on automatically controlled systems) to irrigate other areas of the golf course. After the water has infiltrated and percolated into the soil, apply another portion of the water and repeat the cycle until all the water is applied. This method of irrigating is referred to as multiple cycling. Simultaneous irrigation from sprinklers that do not overlap will effectively reduce the precipitation rate around the sprinkler. Thus, adjusting or zoning sprinklers so that adjacent (overlapping) sprinklers are not running at that same time will reduce the tendency to produce run off. These irrigation techniques will allow the applied water to soak into the soil rather than runoff because of too high of a precipitation rate. See the cultural practices section below for a discussion of cultivation and wetting agents to improve water infiltration.

A healthy durable turf that withstands minor drought is achieved by irrigating thoroughly but as infrequently as possible (based on carrying capacity). A sure sign that turf will benefit from irrigation is a wilted appearance. One initial symptom of wilting is “footprinting,” where footprints on the turf will not disappear within one hour. This symptom is soon followed by actual wilt, where the leaves of the turf lose an upright erect appearance and take on a grayish or purple-to-blue cast. Usually, only a few areas will appear wilted in the same general location of the turf; these areas serve as good indicator spots when assessing the need to water. You can delay watering the entire turf area for another day or so by irrigating only the wilted areas. If the weather provides rain in that time frame, you will have maintained turf quality while saving water.

Allowing some subtle wilt stress to develop in a turf will not destroy the turf. Allowing the soil to dry to 50% of its available water between irrigation events promotes deep rooting and helps plants to survive subsequent drought or heat stress. As drought stress becomes more severe, however, turf becomes more susceptible to traffic, insect, and disease damage as well as weed invasion, especially at lower mowing heights. Thus, wilt stress should be minimized for playing surfaces that are mowed at very low heights (i.e., putting greens) or receive high amounts of traffic form play or vehicles.

Devices for Measuring Soil Water Content

Over the last decade, a number of relatively accurate and precise devices to measure soil water content have been commercially developed. Although these devices have been used successfully in agricultural research and crop production systems, non-destructive soil water content meters have not been widely adopted in the turfgrass industry. These devices are portable and relatively inexpensive, and can provide a turf manager the ability to rapidly assess the soil water content of the turf. Routine measurement of soil water content is a good practice that can be used to develop an association between turf performance and a certain range in soil water content. For example, measuring soil water content when turf is wilting identifies the lower limit of water content for that soil/site. Subsequent measurements after rain or irrigation can identify how close the soil is to the wilt stress point. Over time and repeated sampling, a manager can become more familiar and confident in anticipating how long a turf can go without rain or irrigation. Table 3 lists some companies that supply relatively accurate, precise, and non-destructive tools which can rapidly measure the soil water content under turf.

Time of Day

The most efficient time of day to water is late evening through early morning (between 10 p.m. and 8 a.m.). Nighttime is generally less windy, cooler and more humid, resulting in less evaporation and a more efficient application of water. Water pressure is also usually better at night resulting in a more uniform application of water through sprinklers. Contrary to popular belief, irrigating during this period does not stimulate disease development.

Some turf, soil and environmental conditions (Table 2) may result in the need for more than one irrigation event per 24-hour period; accordingly these sites will need some irrigation during daylight hours. The tendency to water "heavily and infrequently" on these sites will result in an inefficient use of water since these sites typically have rapid drainage. Thus, excess water is readily lost through drainage.

Table 3. Name, address, and website of companies that supply handheld portable devices to measure soil water content under turf.

Company	Address	Website	Telephone
Campbell Scientific, Inc.	815 West 1800 North Logan, Utah 84321-1784	www.campbellsci.com	435-753-2342
MESA Systems Co.	6 West Mill St., Unit 3, Medfield, MA 02052	www.mesasystemsco.com	508-359-5322
Soil Moisture Equipment Corp.	801 S. Kellogg Ave., Goleta, CA 93117	www.soilmoisture.com	888-964-0040
Dynamax Inc.	10808 Fallstone Suite 350 Houston, TX 77099	www.dynamax.com	281-564-5100
Eijkelkamp Agrisearch 631941	P.O. Box 4 Equipment	www.eijkelkamp.com NL-6987 ZG Giesbeek Nijverheldsstraat 30 NL-6987 EM Giesbeek, The Netherlands	31-313-

Note: This is not intended to be a complete list of companies that supply reliable soil water measurement devices; there are likely a number of other companies that can provide similar tools. No endorsement, warranty, or guarantee is intended by mention of a company name.

Moreover, site specific watering (e.g., hand watering and syringing) is performed during daylight hours because of the need to visually identify areas where the water should be applied. Employees responsible for hand watering and syringing should be thoroughly trained regarding the most effective and efficient techniques for applying water during the day.

Seasonal Need for Watering

Based on historical records of rainfall, established turfs in New Jersey typically need irrigation to maintain vigorous healthy growth during the months of June, July, and August (Figure 1). In occasional years, some irrigation during the months of April, May, September, and October may be needed to compensate for minor drought. Even under drought conditions, irrigation frequency in the spring or fall will be considerably less than irrigation in summertime because evapotranspiration is rather low in the spring and fall.

Cultural Inputs Related to Watering

Sound cultural practices, often referred to as best management practices, are needed if a turf is to have good drought resistance or survive dormancy. Mowing, fertilization, and cultivation (aeration) are important cultural practices, in addition to irrigation, that affects the health of a turf and its ability to survive drought.

Mowing

Two important aspects of mowing are height and frequency. Mowing heights for the playing surfaces of a golf course typically range from 0.1 to 1.0 inch, depending on the demands for playing quality and available management resources. Mowing height for rough and utility areas varies depending on function, but will generally not be less than 1½ inches. Mowing rough and utility areas less than 2

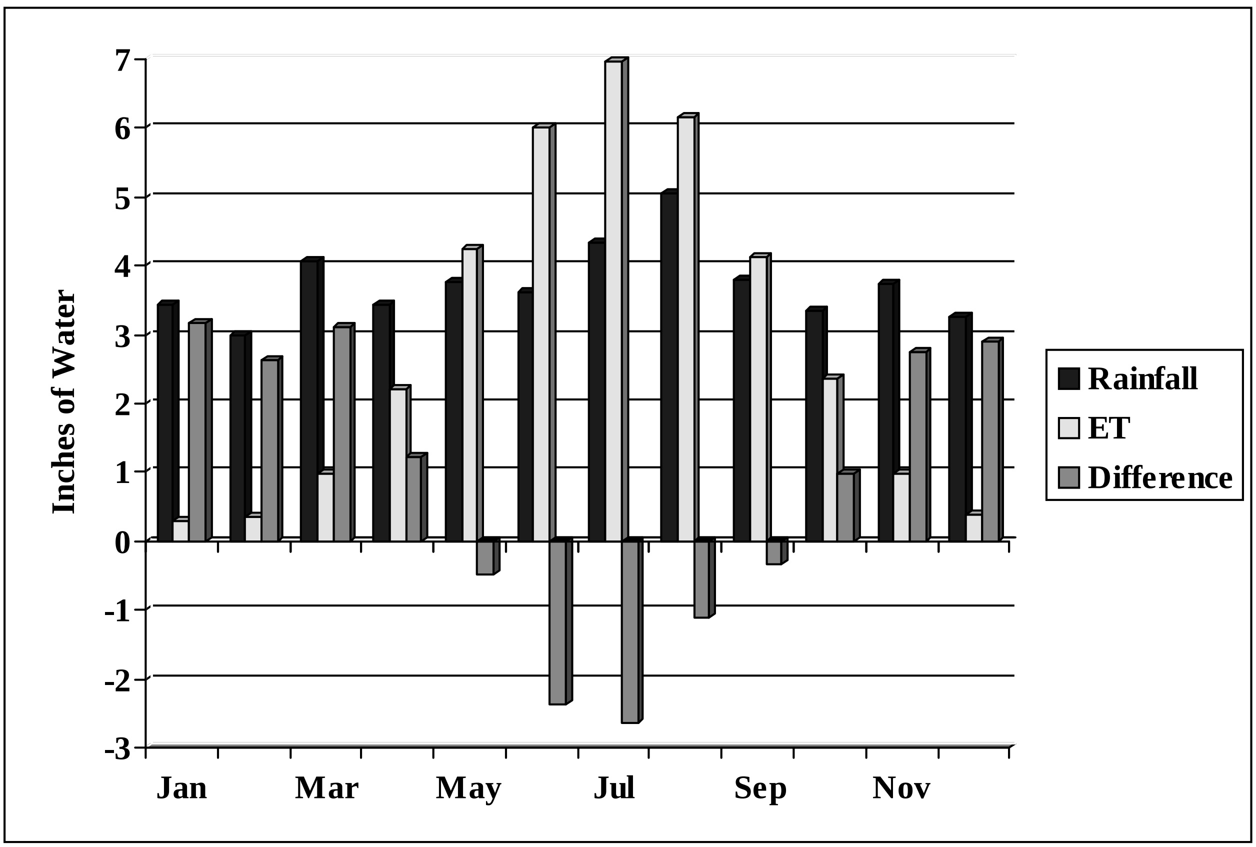

Figure 1. Rainfall and evapotranspiration (ET) data for Trenton, New Jersey based on a 30-year average (1930-1961). Modified Blaney-Criddle formula used to calculate ET. Difference represents + or – difference between rainfall and ET. Data adapted from Rainfall – Evapotranspiration Data published by The Toro Company (1966).

inches decreases drought and heat resistance of the turf and may increase the severity of insect and disease damage, and weed invasion.

Naturalized grassy areas require very infrequent mowing (annually to semi-annually); mowing heights for these should be as high feasible (4 inches or more) to avoid damaging the crowns of the grass plants that may become elevated in these infrequently mowed areas. Presumably, under good soil conditions (i.e., low bulk density, adequate soil fertility), naturalized grassy areas should develop sufficient root systems such that the need for irrigation will be minimal, if at all. If soil conditions are not adequate, however, the performance of naturalized grassy areas may be poor without irrigation.

Mowing frequencies that result in no more than 1/3 of the leaf blade being removed in a single mowing will help to maintain good vigor in a turf. Mowing (removing) too much of the leaf tissue at one time will substantially increase the physiological stress of the turf and reduce its vigor. The low mowing heights used for playing surfaces on the golf course require more frequent mowing than the higher cut roughs and utility areas. Recently fertilized turf will also need more frequent mowing, especially in the spring. Turf growth slowed by heat, cold, drought or limited fertilization will require less frequent mowing. Generally, fine fescue turfs require less frequent mowing than turfs comprised of perennial ryegrass, tall fescue, or Kentucky bluegrass. Perennial ryegrass and annual bluegrass turfs will typically have high mowing frequencies in the spring and fall because of the vigorous growth rates of these species during cool weather.

If wet weather or other factors prevent mowing at the proper frequency and the turf grows too high, raise the height of the mower temporarily to avoid cutting more than 1/3 of the leaf blade. Lower the height of cut according to the height of the turf with each successive mowing. Increasing the mowing frequency as mowing height is lowered will allow you to return to the desired mowing height more quickly.

Mowing at the appropriate frequency on areas of the golf course where clippings do not have to be removed will allow you to let the clippings fall back into the turf without detriment to the turf. Grass clippings decompose quickly and provide a source of recycled nutrients and organic matter to the soil, which can enhance the vigor of the turf. Grass clippings do not contribute to thatch accumulation. Mulching and side-discharge rotary mowers do this easily in rough and utility areas if the turf is mowed at the proper frequency.

Fertilization

Fertilizers must be used correctly; otherwise the practice will be ineffective or wasteful. For nutrients other than nitrogen, soil testing must be used to develop effective fertilizer programs; tissue testing can also be an effective tool for evaluating fertilizer requirements.

Nitrogen is typically the most important nutrient for promoting good turf growth, cover, and color. Excess nitrogen fertilization, however, will cause excessive shoot growth and limit root growth. Over-fertilization can also contribute to disease, thatch buildup and the need for more frequent mowing. Fertilization during July and August is often important on golf courses to sustain adequate vigor necessary to help turf recover from wear; however, nitrogen should be applied frequently at this time and at very low rates. Under-fertilization results in weak grass plants that cannot develop an adequate root system or compete with invasive weeds. Thus, improper fertilization reduces the drought resistance of turf.

Although nitrogen fertilization programs are best developed based on the specific needs of the turf, Table 4 provides some general guidelines on which to develop a sound nitrogen fertility program for drought resistant turf. Fertilizing late in the season (September through November) of the previous year reduces or eliminates the need for fertilizer in the spring, reduces the frequency of mowing, and improves drought resistance.

Table 4. Guidelines to develop a nitrogen fertilization schedule for golf course turfs.

		Timing of Application				
Type of Turf	**Annual N[1]**	**Mid-Mar. to Apr.[2]**	**May to mid-Jun.[3]**	**Late Jun. to early Aug.**	**Mid-Aug. to mid-Sep.**	**Early Oct.to early Dec.[4]**
			pounds of N per 1000 ft^2			
Putting Green	1½ to 4	0 to 1	¼ to 1¼	¼ to 1	¼ to 1	½ to 2
Tee	2 to 6	0 to 1	½ to 1½	½ to 1	½ to 1½	½ to 1
Fairway	1½ to 3	0 to 1	½ to 1½	0 to ¾	½ to 1	½ to 2
Roughs	1 to 3	0 to 1			1 to 2	0 to 2
Utility	0 to 2	0 to ½			0 to 2	

1 Use lower rates for older (mature) healthy turfs that have been properly managed for many years and receive low to modest amounts of traffic (play).

2 The March-April nitrogen application may not be needed if you fertilize late in the season (September to early December) the previous year. When spring green-up and growth is satisfactory, delay fertilization until May or June, or possibly later.

3 To avoid excessive growth approaching the stressful summer months, use a slowly available source of nitrogen (sulfur-coated urea, polymer-coated urea, IBDU, methylene urea, or natural organic-based fertilizers) for amounts of greater than ½ pound of nitrogen applied per 1000 square feet of turf.

4 Apply only when grass is still green. Do not apply if grass is dormant (brown). Use higher nitrogen applications where greater turf cover (quality) is desired or turf requires recovery from extensive play (wear). Nitrogen applications above 1 pound per 1000 square feet should contain slowly available sources of nitrogen; 30% or more of slowly available nitrogen is suggested.

- On very sandy soils, do not fertilize turf at more than ¾ pound of N per 1000 ft^2 using water soluble nitrogen sources in a single application after early October to avoid nitrogen leaching. Use slowly available nitrogen fertilizers at N rates above ¾ pound per 1000 ft^2 on sandy soils to reduce the potential for leaching losses.
- Fertilizer should not be applied near water bodies or impervious surfaces where rain can wash fertilizer nutrients into water bodies. Excess nutrients entering streams, ponds, and lakes will lower water quality.

Newly seeded or sodded turfs have a higher fertilizer requirement to establish than mature, established turf. Turfs that do not respond to nitrogen may be deficient in other nutrients or require liming. Get the soil tested to determine the specific needs for fertilizer and lime.

Do not misapply fertilizers near water bodies (streams, ponds, etc.) because excess nutrients in water will harm water quality. Do not misapply fertilizer to streets, sidewalks, driveways, parking lots, or other impervious surfaces because the nutrients may runoff into nearby water bodies with subsequent rains.

Cultivation

Core cultivation (aeration) can resolve some water infiltration problems by reducing soil compaction, managing thatch, and creating openings in the turf surface that aid in water infiltration. A reduction in soil bulk density of severely compacted soil will enhance water retention (storage) and encourage deeper rooting, thus increasing the carrying capacity of the soil.

Wetting agents may also be beneficial, but these should not be considered to be a cure-all solution. Wetting agents are surfactants which when added to water or applied to the turf can enhance water infiltration. Wetting agents can be helpful on difficult to wet soils and sloped areas where rain and irrigation are prone to run off. Drench applications of wetting agents are sometimes more effective than low volume spray applications. Combining core cultivation with wetting agent applications has been proven to be highly effective in many of these situations.

Thatch is a tight, brown, organic layer of both living and dead grass crowns, roots and stems that accumulate above the soil surface. Thatch can accumulate rapidly on some Kentucky bluegrass, fine fescue, bentgrass, and zoysiagrass turfs. Thatch is generally not a problem in tall fescue and perennial ryegrass turfs. Compacted soil is another factor that contributes to thatch buildup.

As a thatch layer thickens, it becomes the primary rooting medium of the lawn. Improperly managed thatch predisposes the turf to drought stress and increases the possibility of damage due to insects and disease. Fertilizers and pesticides applied to thatchy turf may also work less effectively. Management of an accumulating thatch layer in a turf via cultivation and topdressing practices is important for improved tolerance to drought, disease and insects.

Verti-cutting (dethatching), topdressing, and core cultivation are beneficial in managing thatch accumulation when done appropriately. Dethatching and core cultivating are best done in the spring or fall when cool-season turfgrasses (not zoysiagrass) grow vigorously and can recover from the damage caused by these practices. Zoysiagrass, a warm-season grass, should be dethatched/cultivated in July /August. Topdressing is best done throughout the year based on the growth rate of the turf; turfs that aggressively develop thatch should be topdressed more frequently.

Growth Regulators

Growth regulators reduce the need for mowing and may be useful in reducing the need for irrigation. Greenhouse research has shown that some growth regulators (i.e., melfluidide, ethephon, and trinexapacethyl) lower evapotranspiration, which potentially would extend the carrying capacity of the soil presuming adverse effects on root growth do not occur with use of a growth regulator. Research has shown that growth regulators, other than melfluidide, can reduce rooting.

Growth regulators may also improve the carbohydrate reserves of the turf plants thus improving plant stress tolerance. Growth regulation will reduce the need for mowing, enabling turf to develop better carbohydrate reserves. The effect of growth regulation on the ability of turf to survive dormancy is not well understood, thus recommendations relative to dormancy are not available at this time. Although abscisic acid (a plant hormone) can also lower water use, it has not been used in field trials and currently is not commercially available.

Dry Soil Conditions – Severe Drought

Dormancy of Turf

Turfs maintained at low mowing heights do not survive drought through dormancy as well as turf mowed at higher heights. The low mowing heights used for putting greens, tees and possibly fairways do not allow the plants to develop sufficient carbohydrate reserves necessary to survive drought-induced dormancy. Moreover, the greens, tees and fairways of many golf courses have been infested with large populations, in many cases nearly 100%, of a weak, perennial, weedy grass called annual bluegrass. Annual bluegrass has a very limited capacity to survive drought through dormancy; if allowed to wilt and turn brown, most of the annual bluegrass plants will not survive when rain or irrigation returns. Substantial losses of turf cover should be expected if annual bluegrass comprises a significant proportion of the turf stand and irrigation is not allowed during a prolonged drought. Recovery from drought damage and dormancy varies with species. For example, Kentucky bluegrass resumes growth faster than tall fescue after re-watering.

Many higher cut turfs can survive drought quite well by going dormant (leaves turn brown), if the turf is healthy and damage from insects, diseases, or foot traffic are minimal. Drought-induced dormancy of turfs in New Jersey is rarely long enough to cause failure of higher cut turf, as long as it is healthy. Allowing an unhealthy turf to go dormant on poor quality soil will result in severe thinning (loss) of turf.

Thinning of the turf or significant stand loss enables weeds to invade when rain re-wets the soil, thus increasing the need for herbicides. In severe cases, loss of turf will result in erosion of exposed soil during rainstorms and thus the likelihood of impacting water quality through sedimentation. Therefore, maintaining a healthy turf cover enhances both drought resistance and environmental quality.

Mowing

If the decision is made to stop irrigating during a severe drought, and rainfall is not sufficient to sustain growth and vigor of the turf, decrease mowing frequency and gradually raise the mowing height as the soil dries and growth of the grass slows. Mowing during the coolest part of the day (early morning) will minimize the added stress caused by mowing. Ultimately mowing should be stopped when the soil dries to the point that the turf is wilted. Mowing wilted turf will cause damage to the lower leaf sheaths and crowns. Damage to crowns increases the likelihood of turf loss. The severity of damage from mowing will be greater as the level of drought stress or traffic intensity increases. All turfs go through a severely wilted condition before dormancy is reached.

Growth Regulation

Use of growth regulators before severe wilt stress develops will aid in maintaining quality of the playing surface as mowing frequency or height are adjusted in response to very dry soil conditions (limited soil water availability). It is not understood how the growth regulation of turf going into dormancy will influence survival of dormancy. Further research is needed to address this question.

Fertilization

Established turfs should not be fertilized immediately before or during the time a turf is experiencing drought stress or developing dormancy. Fertilizer stimulates growth of the grass and increases the need for water and mowing. Thus, fertilization during very low soil water availability (drought) increases the risk of turf failure.

Late season (September through early December) fertilization will prepare a turf for drought in the next growing season better than spring fertilization (see Table 4). Late season fertilization encourages a deep root system and minimizes surges in shoot growth in the spring that would more rapidly deplete soil water during green-up.

A healthy turf cover will re-develop more rapidly after a severe drought if moderate fertilization is resumed after rainfall has returned. Recovery will be enhanced with an application of nitrogen fertilizer at ½ to 1 pound per 1000 square feet of turf area. Rapid return of turf cover also minimizes weed invasion.

Pesticide Use

Properly targeted and timed applications of pesticides before a drought may improve survival of the turf as it enters drought stress and eventually becomes dormant. However, once the decision is made to stop irrigating during severe drought and rainfall is not sufficient to sustain growth and vigor of the turf, applications of pesticides should be suspended until rain and re-growth of the grass returns.

Some examples of sound pesticide usage during restricted water use would include a preemergence herbicide in the spring (presuming rainfall or irrigation is available to activate the herbicide) to minimizes grassy weed invasion of drought damaged turf; an insecticide to control a population of a root or crown feeding insect that is actively feeding on the turf as the turf approaches drought stress (restricted water use) and dormancy; or a fungicide to control a root-infecting disease before the turf is damaged by drought stress and dormancy. These pest problems must be identified BEFORE severe drought conditions develop. Attempts to treat the problem after significant pest damage has occurred and severe drought conditions have developed will not be successful, and may actually damage turf and reduce its ability to recover once rains return.

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