Chapter 7

Turfgrass Management

Learning Objectives:

From reading and studying this chapter, you should be able to:

- Understand the types of lawn grasses for IN and where they should be used.
- Understand establishment of turf with either seed or sod.
- Understand the importance of maintenance practices like mowing, irrigation, fertilization, aerification, and thatch control.
- Understand the basic concepts of integrated pest management on lawns.

Introduction

The lawn is one of the most important and obvious parts of the landscape. It compliments the ornamental plantings as well as reduces erosion, heat, glare, and noise. Proper establishment, fertilization, mowing, and irrigation are critical for an attractive lawn. Maximizing the positive effects of these processes will minimize the need for pesticides, and will maximize the efficacy of pesticides if they are needed. Understanding this chapter by focusing primarily on cultural practices explained here as well as using the other Purdue Turf Program WWW Publications will help you pass the certification exam.

Turfgrass Selection in Indiana

It is critical to put the right grass in the right place for the long-term success of a lawn. Well-adapted grasses will perform better in the long run with reduced inputs and maintenance costs. In some cases, like shade for instance, it is better not to plant grass, but to use ornamentals instead. It is often best to use a turfgrass mixture of multiple species or a blend of up to four varieties of the same species. Using either blends or mixes will help minimize catastrophic damage from a single environmental stress, disease, or insect.

In Indiana, Kentucky bluegrass is the preferred grass for the vast majority of home lawns. It has a dark green color, spreading growth habit, and good disease, drought, and traffic tolerance. However, it is very slow to germinate taking 14-21 days to germinate and 3 to 4 months to fully establish. Once established, it is by far the best for home lawns in Indiana. The second best turfgrass for lawns in Indiana is turf-type tall fescue. Though slightly coarser bladed than Kentucky bluegrass, turf-type tall fescue is extremely heat, drought and wear tolerant, making it a great turf for non-irrigated areas and or in the southern part of the state. However, avoid Kentucky 31 (K31) tall fescue opting instead for an improved turf-type cultivar. Perennial ryegrass is often used in Indiana, primarily because it germinates and establishes so quickly. However, it is extremely susceptible to a wide range of diseases making it a poor long-term choice for
Indiana lawns and it should only comprise 10% or less of any seed lot for a lawn. Fine fescue performs adequately in the shade and thus is a good choice for dry shade. In southern Indiana, zoysiagrass performs adequately in lawns. However, it is a warm season grass and thus is brown for much of the year.

Table 1. Turfgrass species for Indiana.

<table>
<thead>
<tr>
<th>Sun</th>
<th>Condition</th>
<th>Species</th>
<th>Seed Rate (lbs/1000ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full</td>
<td>Medium-high maintenance</td>
<td>100% Kentucky bluegrass</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(regular mowing, fertilization, and irrigation)</td>
<td>&gt;90% Kentucky bluegrass</td>
<td>3 - 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;10% perennial ryegrass</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>100% turf-type tall fescue</td>
<td>6 - 8</td>
</tr>
<tr>
<td>Full</td>
<td>Low maintenance (limited irrigation, infrequent fertilization, mowing)</td>
<td>100% turf-type tall fescue</td>
<td>5 - 6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100% Kentucky bluegrass</td>
<td>2</td>
</tr>
<tr>
<td>Partial shade</td>
<td>Dry area (limited irrigation, proper drainage)</td>
<td>30-50% shade-tolerant Kentucky bluegrass +50-70% fine fescue</td>
<td>4 - 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100% turf-type tall fescue</td>
<td>6 - 8</td>
</tr>
<tr>
<td>Partial shade</td>
<td>Damp area (irrigation and/or poor drainage)</td>
<td>100% turf-type tall fescue</td>
<td>6 - 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100% shade-tolerant Kentucky bluegrass</td>
<td>2</td>
</tr>
<tr>
<td>Full</td>
<td>Southern IN</td>
<td>100% Zoysia</td>
<td>2, plugged, or sodded</td>
</tr>
</tbody>
</table>

Turf Establishment

Establishment of turfgrass areas is most commonly accomplished with seed, although sod can be used. Sod offers the advantage of an “instant lawn” whereas seed takes much longer to produce a green turf. Establishment with seed is much less expensive and is surprisingly less complicated than with sod. But in no way is establishing a lawn with seed an easy task that should be taken lightly. Following proper establishment procedures can produce a healthy turf that one can be proud of for many years to come.

Date of Seeding

The best time of year to seed a lawn is in the late summer to early fall. Adequate soil moisture, warm soil, and limited weed pressure allow for excellent seedling growth. Between August 15 and September 15 is optimum seeding time in the northern half of Indiana, from September 1 to September 30 is optimum in the southern half of Indiana. It is critical to seed as early as possible within these windows. Even when seeding within
these windows, waiting one week later to seed may mean the stand will take two to four additional weeks to mature. Seeding during the winter would be the next preferred time to seed and this is referred to as “dormant seeding” because the seed will lie dormant until the soil temperatures warm in April or May. Depending on your location in Indiana, dormant seeding can be done as early as Thanksgiving and as late as March. The benefit of dormant seeding is that as the soil heaves and cracks during the winter, crevices are created for the seeds which create ideal germination conditions. Additionally, dormant seeding is easier to schedule than spring seeding, because spring rains often make it difficult to seed after March in Indiana. Dormant seeding should not be attempted on new sites where erosion is a threat. The least desired time to seed is in the spring up until May 15, but this requires extra irrigation and pest control for success.

Preparing the Seedbed

A soil test should be conducted on samples taken from the site. The test will determine fertilizer recommendations for the area. Correct any deficiencies in nutrients or pH by following the recommendations on the soil test report. Use a tiller or other cultivation equipment to work the soil to a depth of 4-6 inches, incorporating the fertilizer or other soil amendments. Do not till wet soil because it will clod. Do not overtill a soil because it will destroy desirable soil structure. The soil should be allowed to settle after tilling. Heavy rains and/or irrigation will hasten settling. Allowing time for the soil to settle now will prevent undulations and difficult mowing in the future. Just prior to seeding, rake the area to the finish grade and to create a good seed bed. After the area is at finish grade, apply a “starter fertilizer” at up to 1.0 lb. P₂O₅/1000 ft² depending on the soil test recommendations. This fertilizer enhances seedling development. If dormant seeding, this fertilizer should be applied as the seed begins to germinate in the spring.

Seeding

Seed should be applied using a drop spreader because rotary spreaders do not disperse the seed uniformly. Seeding rate recommendations are presented in Table 1.

After the starter fertilizer and seed have been applied, the area should receive a light raking followed by a light rolling to insure good seed-soil contact. A roller designed to be filled with water, but left empty, is perfect for this job. It is critical to maximize the seed-soil contact for quick germination and establishment.

Mulching

Mulching the area will prevent erosion and conserve water. Therefore, mulching is most important when it is impossible to adequately irrigate newly seeded areas or in dormant- or spring-seeding. One bale of clean (weed-free) straw per one thousand square feet will give a light covering that will not have to be removed after germination. Apply the straw very lightly so you can still see approximately 50% of the soil through the mulch layer. Hydro-mulch is a paper-based mulch that can be blown onto the site. This is preferred by professionals because of ease of application and the limited weed contamination in the hydro-mulch.

Watering

Seedlings are very susceptible to desiccation, and the seedbed should not be allowed to dry. A newly seeded lawn will need to be irrigated two to four times daily depending on the weather. Enough water should be applied to moisten the top one to two inches of the soil profile, but avoid over-watering and saturating the area. Once the seedlings are two inches high, gradually reduce the frequency of irrigation and water more deeply. After the turf has been mowed two or three times, deep and infrequent irrigation is most effective.

Mowing

Mowing a new lawn will encourage the turf to fill in quickly. Mowing should
begin when the first few seedlings are tall enough to mow. You may only mow 10% of the plants in the first mowing, 20-30% of the plants in the second mowing, and so on. Most wait too long to mow a newly seeded lawn, so mow early and often. Initially mow Kentucky bluegrass, perennial rye, and fine fescue at 1.5 inches and tall fescue at 2.0 inches. After the first three to four mowings, you can adjust your mower to the permanent mowing height which is 2.5 -3.5 inches for Kentucky bluegrass, perennial rye, and fine fescue and 3.0 - 4.0 inches for tall fescue. Always remember, never remove more than 1/3 of the length of the grass blade at any one mowing, and sharpen mower blades often.

Fertility
New seedlings have poorly developed root systems and thus they cannot effectively absorb nutrients from the soil. Therefore, it is important to fertilize frequently after seeding to encourage establishment. Apply 0.75 to 1.0 lb N/1000 ft² four to six weeks after germination and again eight to ten weeks after germination. Assuming seeding in mid-August, these applications would be mid- to late September and again mid- to late October.

Weed Control
There is little weed pressure in the fall so weed control may not be needed when seeding in August or September. Broadleaf weeds may become a problem later in the fall, but these can be easily controlled with a broadleaf herbicide application in October or November, after the third or fourth mowing. Annual grasses such as crabgrass can be easily controlled with preemergence herbicides applied in the spring. In seedings made very late in fall or dormant-seeding when the lawn is not fully established by spring, avoid applying a preemergence herbicide in early spring because it may damage late-developing seedlings. In this case, consider using a postemergence crabgrass herbicide later in summer if crabgrass is a problem.

Sodding

Although most turfgrass areas are established by seeding, sod offers the visual appeal of an "instant lawn." Additional benefits of sod include the ability to use the lawn sooner, reducing the amount of mud and dirt tracked into the house, immediate erosion control, and establishing a lawn during less-than-optimal seeding times. Like seeded lawns, sodded lawns need special attention before and after establishment. Using proper establishment procedures and post-establishment care can help to ensure success in producing a healthy, beautiful lawn.

Site Preparation
Thorough site preparation is sometimes neglected; it is the most important factor determining the success of a sodded lawn. Site preparation for a sodded lawn is identical to that for a seeded lawn. After the area is at finish grade, a starter fertilizer should be applied at up to 1.5 lb. P₂O₅/1000 ft² (Table 2) to encourage root development. Do not use any fertilizer that contains a herbicide, because most herbicides will restrict the root development of new sod.
Table 2. Purdue University’s 2005 phosphorus recommendations for newly planted turf.

<table>
<thead>
<tr>
<th>Soil test values</th>
<th>New sod or seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>range ppm</td>
<td>lbs P/A (lb. P$_2$O$_5$/1000 ft$^2$)</td>
</tr>
<tr>
<td>Low 0-13</td>
<td>0-25 1.5</td>
</tr>
<tr>
<td>Normal to high 13+</td>
<td>26+ 1.0</td>
</tr>
</tbody>
</table>

**Sod Selection and Installation**

Some things to consider when purchasing sod include thickness, soil type, weed content, and freshness. Sod is generally cut to a depth of 0.25 to 0.5 inches, and properly harvested sod should contain surprisingly little soil. Thinner sod is easier to ship and handle and will also root faster. However, thin sod requires more frequent irrigation during establishment. Choose sod that contains soil similar to the soil found on the site. This will help avoid creating layers that could reduce rooting depth and water flow. Weed content is an obvious consideration. If possible, ask to see the area from where the sod will be harvested. This will also give some idea of the health of the sod. Finally, the sod should be fresh when it is delivered to the site and it should be laid within 24 hours after harvesting.

It is very important not to let the sod get too dry. If you cannot lay the sod immediately after delivery, you may need to sprinkle it with water to keep the outer rolls moist. Also, lightly moisten the soil where the sod is to be laid, but avoid over-watering the work area. Begin laying the sod in a brick-like pattern so that the ends are staggered. This will reduce the number of long seams. The edges of the sod should be in contact with each other. Exposed edges can dry quickly and die. It is also important to avoid stretching or overlapping the sod. A piece of sod that has been stretched is likely to shrink, later forming gaps and exposed edges. If there is a slope, start at the bottom and run the sod perpendicular to the slope. A steep slope (10% or more) may require pegging or stapling the sod in place. Wooden pegs can be pulled out after the sod is rooted down, but biodegradable sod staples do not have to be removed.

The final steps in sod installation are to lightly roll and then thoroughly water the sod. Rolling is not meant to remove underlying irregularities in the soil but to insure good sod-soil contact and remove any air pockets without compacting the soil. Thoroughly water the sod immediately after rolling. Keep traffic off the sod until it is well-established.

**Post-Installation Care**

Watering after installation is a priority. During the first two weeks sod requires daily watering. During warm weather, sod may need to be lightly watered during mid- and late afternoon hours when water use and evaporation is greatest. After 7 to 10 days, check for root development by firmly grasping the grass blades with both hands and lifting vertically. When the sod resists being lifted, usually in 10 to 14 days during optimum weather conditions, the frequency of irrigation should be reduced but the amount of water applied during each irrigation cycle should be increased. Schedule irrigation so the lawn becomes firm enough to mow between waterings. Begin mowing the area as topgrowth develops, but keep the traffic level as low as possible. The recommended height for Kentucky bluegrass is 3.0 inches or more.
For best results, mow often enough so that no more than 1/3 of the grass blade is removed at each mowing.

A lawn sodded in the spring or summer will not survive droughty conditions well the first year. It is important to provide proper irrigation until the turfgrass can develop a more extensive root system in the fall when fertilization will boost the root system’s development. In mid-September and at least four weeks after installing the sod, apply 1.0 lb N/1000 ft². An application of 1.0 lb N/1000 ft² should be made in early October and again in mid-November to encourage rooting.

In addition to following sound irrigation and fertilization practices, regular aerification can significantly improve turfgrass rooting. Aerification reduces soil compaction and provides channels for the roots to better penetrate the soil. This practice will also help alleviate problems due to layering caused by differences between the soil on site and the soil on which the sod was grown. Newly laid sod should not be aerified until the sod is firmly rooted into the soil (2-4 months). Aerify in the spring and fall when temperatures are moderate and the grass is growing well. Use the largest diameter tines available and punch 20-40 holes per square foot (this may require 3 to 4 passes across the lawn).

Weeds are usually not a problem in sod, and most herbicides are not labeled for application to sod until it is well established. If annual grasses, such as crabgrass, become problematic shortly after sodding, it is better to tolerate the problem until the following spring when a preemergence herbicide can be used. Dandelion and other broadleaf weeds can be controlled with a broadleaf herbicide application in late October.

**Turf Maintenance**

Creating and maintaining quality turfgrass involves more than irrigation, fertilization, and pesticide applications. A dense, healthy turf demands proper mowing techniques, occasional dethatching, and aerification in addition to fertilization and pest control. Knowing when and how to use these cultural practices will help enable one to have a dense, vigorous turf.

**Mowing**

Improper mowing causes more problems on lawns than any other maintenance practice. Most lawns are mowed too short, not often enough, and/or with a dull mower blade.

Mowing height depends on the grass species. Kentucky bluegrass, or any mix containing Kentucky bluegrass, should be mowed at 2.5 to 3.5 inches; perennial ryegrass and fine fescue should be mowed at 2.5 to 3.5 inches; tall fescue at 3.0 to 4.0 inches; and zoysia at 1.0 inch. Mowing below the optimum height restricts root growth and increases susceptibility to damage from insects, disease, drought, and traffic. Low mowing also favors weed infestations. Shaded areas should be mowed 0.5 to 1.0 inch higher than optimum. Contrary to popular belief, do not reduce the mowing height for the last mowing of the year. Continue to mow well into the fall as long as the grass continues to grow. Not only is this healthier for the grass, it will also help mulch the fallen tree leaves into the turf canopy preventing shading and smothering of the turf over the winter.

Mowing frequency depends on how fast the grass is growing. Some lawns may need mowing twice a week during spring and fall and only once every 2 weeks during summer. Mow frequently enough so as not to remove more than 1/3 of the leaf blade in a single mowing. For instance, if you are mowing at 3 inches, mow when the grass reaches 4 inches. If the grass has grown too tall, raise the mowing height and gradually lower it back to the original height over a few mowings. Avoid mowing during midday when temperatures are above 90°
and the soil is dry because you may damage the turf. If you must mow during a hot and dry period, mow in the early morning or wait until temperatures moderate in late evening.

The mower blades must be sharp and may need sharpening four to six times a year. A sharp blade results in a cleaner and healthier cut, leaving a more attractive lawn. Reel-type mowers often give a better cut, especially at lower heights, but they are more difficult to maintain.

Clipping removal is generally not recommended on most turfgrass areas. Though once thought, clippings do not cause thatch. Furthermore, returning clippings will recycle valuable nutrients to the soil thereby reducing fertilizer requirements. Clippings are not harmful if your mower spreads them evenly and if they are not thick enough to shade the grass below. Mulching mowers are recommended, but research suggests that mulching mowers increase clipping breakdown only slightly faster than conventional side-discharge mowers when used on cool season turfgrasses. Catching clippings is labor and time intensive and should only be done if the clippings are used for mulch or compost. Few, if any, landfills will accept clippings and other yard waste. Additionally, recent research has shown that some herbicides applied to lawn will persist for over a year in clippings and mulch, so it is always best to return clippings to the turf.

**Irrigation**

To maintain a healthy, dense, green, actively growing turf, it is essential to water a lawn during dry periods. While most people think a lack of water will damage the lawn, overwatering may cause more damage. It is easy to overwater a turf area. Some potential consequences of overwatering include increased crabgrass pressure, increased disease incidence, shallow rooting, waste of a valuable resource, and higher water bills. When watering a lawn, it is best to err on the dry side rather than to be guilty of overwatering.

**Frequency of Watering**

The frequency of watering will vary from site to site and should be determined by the appearance of the turf. This can be determined because the first signs of water stress in a turfgrass stand are a bluish-green color, and footprints remain in the turf after walking across it. Ideally, the turf should be watered at this point. Turf grasses can easily withstand this much water stress without a decline in turf quality, and there is no real benefit to watering a turfgrass stand before this point.

As the degree of water stress increases the turf will wilt and have a grayish-green color. Turf that has wilted should be watered without delay. Wilted turf will recover very rapidly following watering. Severe drought stress will cause the turf plants to cease growing, and the leaves will turn brown and possibly die. Watering at this point will help the turfgrass plants survive, but it will take about two weeks until the turf produces new leaves and recovers completely.

Turf should not be watered by a set schedule. A set schedule does not take into account the needs of turfgrass plants and may lead to overwatering. For this reason, homeowners with automatic irrigation systems should not use the same irrigation program for the entire summer. The program should be changed according to the needs of the turfgrass plant. The automatic irrigation system should be set to start for a single irrigation cycle only and then shut off until the turf requires water again.

**Amount of Water to Apply**

Most lawns in Indiana will need from 1 to 1-1/2 inches of water per week depending on weather, soil type, slope, etc. It is best to apply this amount of water in a single thorough soaking, or two equal applications of water three to four days apart rather than in light irrigations every day. The soil should be wetted to the depth of the deepest root. Daily, light irrigations promote
shallow rooting, non-drought hardy turf, and encourage crabgrass.

Hose-end sprinklers usually apply small volumes of water to a turfgrass area. Therefore, most sprinklers should be left in one location for two to three hours to thoroughly wet the turfgrass rootzone. Automatic irrigation systems with spray heads that distribute water in all directions simultaneously are capable of applying a large volume of water in 10 to 15 minutes. Automatic irrigation systems with rotary sprinkler heads that have one stream of water are capable of applying the necessary water in 30 to 40 minutes.

To determine the amount of water being applied by any sprinkler, place shallow, straight-sided containers, such as empty tunafish cans, in a grid pattern around the sprinkler. Turn the sprinkler on for a specified length of time and then measure the water collected in the cans with a ruler. This can be used as a guide in determining the amount of water applied.

**Time of Day to Water**

The ideal time to irrigate a lawn is from 4:00 to 8:00 a.m. At this time water pressure is usually the highest, there is little distortion of the watering pattern by wind, and the amount of water lost to evaporation is negligible. Although the early morning hours are ideal for watering, this is not a convenient time for most people. The second best time to water is from 8:00 to 12:00 p.m. Usually distortion from the wind is not a problem at this time and loss from evaporation is slight. A major problem may be lack of water pressure for those using municipal water systems. A potential problem caused by watering in the early evening hours may be greater incidence of disease. This problem can be reduced by watering only when the turf needs water and by watering infrequently but deeply. Watering an established turf during midday is not very effective. A large amount of water is lost through evaporation, making it difficult to thoroughly wet the soil.

Although not recommended, midday watering does not cause the turf to burn.

**Watering Sloped or Compacted Areas**

Slopes or areas with soil compaction are often difficult to irrigate without the water running off. On these areas it is important not to apply water faster than it can be absorbed. One possible method is to irrigate a slope for a period of time until the water just begins to run off and then stop. Allow the water to infiltrate into the soil and then water the area again until runoff just begins. Repeat this cycle several times until the soil is wet to a depth of six inches.

**Dormancy**

In extended droughts where a lawn is not watered, the lawn will wilt and the leaves will turn brown. These lawns are not dead; the turf is in a dormant condition. Dormancy is a natural survival mechanism of the turf plants. The leaves are dead but the crown (growing point) and the root system remain alive. A turfgrass plant loses water through the leaves. When the leaves are dead, little water is lost which conserves water and allows the crown and root system to remain alive. Turf can survive four to six weeks in a dormant condition without a significant thinning of the turf upon the return of favorable moisture conditions. After four to six weeks of dry conditions, the dormant turf should be irrigated with 1/2 inch of water in one thorough irrigation. This irrigation will not cause the turf to green up, but will provide moisture to help the crown and root system survive. If the dry weather persists, water dormant turf with 1/2 inch of water every four to six weeks. Following the return of favorable moisture conditions, either through rainfall or irrigation, the turf will develop new leaves and begin to grow actively.

**Fertilization**

Lawns need to be fertilized to maintain color, density, and vigor. The healthier and more vigorous a lawn is, the better it can withstand stress from heat, drought, traffic, and pets. We often try to
achieve a dark green lawn, but the darkest green lawn is not always the healthiest lawn. We should try to achieve a healthy lawn that has moderate growth and good density.

The amount of fertilizer applied annually to a lawn depends on a number of factors. Fertilization programs may need to be adjusted to apply slightly more or slightly less nutrients depending on the following factors:

- Desires of the homeowner: A beautiful, dark green, and dense lawn will require more fertilizer than a thin, lighter color lawn. Applying more fertilizer annually also requires more mowing and irrigation.
- Location: Because the growing season is longer in southern Indiana than in northern Indiana, more fertilizer will be needed to maintain the same turf quality in southern Indiana than in northern Indiana.
- Species: Certain species like zoysia, buffalograss, or tall fescue may perform adequately with lower annual fertilizer rates than species such as Kentucky bluegrass or perennial ryegrass.
- Weather: A rainy summer will stimulate growth and will usually necessitate more annual fertilizer than a dry summer. The same holds true for an irrigated lawn versus an unirrigated lawn.
- Soil type: Turf grown on a very sandy or a very heavy clay soil will need more fertilizer than turf grown on a silt loam soil. Sandy soils require frequent applications at reduced N rates to limit the threat of nitrogen loss through leaching. Soil type and pH will have a large effect on the amount of phosphorus and potassium that needs to be applied.
- Age and quality of existing lawn: A new lawn will need more fertilizer for the first few years to enhance density. Improving a neglected or thin lawn may also require more annual fertilizer for the first few years.
- Clippings: Clippings should always be returned to the lawn; removing clippings for composting or mulch will necessitate more annual applications of fertilizer.

**Fertilizers**

All fertilizers will have a series of three numbers displayed prominently on the label. These numbers represent the percentage by weight of nitrogen, phosphorus (as P₂O₅), and potassium (as K₂O). For instance, a 24-4-8 fertilizer will have 24% N, 4% P₂O₅, and 8% K₂O. A 46-0-0 fertilizer will have 46% N, 0% P₂O₅, and 0% K₂O.

Though all three elements are important in maintaining a healthy turf stand, N will cause the greatest response. Because of this, most fertilizer recommendations for lawns are listed as lb. N per 1000 ft². Nitrogen fertilizers come in two basic forms: quick release (soluble) nitrogen and slow release (insoluble) nitrogen. Quick release nitrogen normally causes a response in a week or less, whereas slow release nitrogen will cause a response in three to 10 weeks or more. Quick release nitrogen is inexpensive and may burn leaf blades if applied improperly. The most common forms of quick release N include urea and ammonium nitrate. Slow release forms tend to be more expensive but will rarely burn leaf blades even when applied at temperatures above 85°. Slow release forms used on lawns include organic N, methylene ureas, and sulfur- or polymer-coated urea. Both slow release and fast release N forms can and should be used on lawns. Slow release products are used during warm weather and/or when extended N release is desired. Conversely, fast release N should be used during cool weather and when N is needed immediately by the plant. Both forms of N are often blended in one fertilizer bag. This is advantageous because the quick release N gives a response shortly after
application and the slow release N results in a more gradual and longer response.

Phosphorus and potassium are also important in maintaining a healthy lawn, but most soils in Indiana have adequate P and K. Therefore, P or K should not be applied unless recommended by a soil test (refer to AY-18, Soil Testing for Home Lawns). Table 3 and 4 list Purdue’s current recommendations for P and K fertilization.

Table 3. Purdue University’s 2005 phosphorus recommendations for annual fertilization of established turf.

<table>
<thead>
<tr>
<th>Soil test values</th>
<th>Phosphorus fertilizer recommendations (lb. P₂O₅/1000 ft²/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>ppm</td>
</tr>
<tr>
<td>Low</td>
<td>0-13</td>
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<tr>
<td>Normal</td>
<td>13-25</td>
</tr>
<tr>
<td>High</td>
<td>25+</td>
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Table 4. Purdue University’s 2005 potassium recommendations for annual fertilization of established turf.

<table>
<thead>
<tr>
<th>Soil test values</th>
<th>Potassium fertilizer recommendations (lb. K₂O/1000 ft²/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>ppm</td>
</tr>
<tr>
<td>Very low</td>
<td>0-25</td>
</tr>
<tr>
<td>Low</td>
<td>25-50</td>
</tr>
<tr>
<td>Adequate or above</td>
<td>50+</td>
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</table>

Fertilization Programs

It is best to fertilize lightly in spring and early summer, little to none in summer, and heavy in fall. A heavy fall fertilization program will produce the healthiest turf throughout the year. Applying high rates of N in spring and summer stimulates excess leaf growth at the expense of root growth. Not only does this force you to mow more often, it reduces turf quality during the summer. High rates of spring and summer N can also stimulate disease, weed, and insect activity.

Table 5 lists the Purdue recommendations for lawn fertilization programs. The maximum program is for homeowners who want the greenest lawn, and are also willing to devote considerable time to mowing and irrigation. The minimum program is for those who are satisfied with a less attractive lawn. Keep in mind that the initial seven points in this publication will affect your fertilization program and the rates may need adjusting. The dates listed are for central Indiana, so adjust 10-15 days sooner in spring and later in the fall for southern Indiana, and later in spring and earlier in fall for northern Indiana.
### Table 5. Purdue recommendations for lawn fertilization programs

<table>
<thead>
<tr>
<th>Date</th>
<th>lb. N/1000 ft²</th>
<th>Maximum</th>
<th>Standard</th>
<th>Program Minimum</th>
<th>Nitrogen Release Form</th>
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<tbody>
<tr>
<td>September (fall)</td>
<td>1.0</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Slow/Quick</td>
</tr>
<tr>
<td>November 1-15</td>
<td>1.0</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Quick</td>
</tr>
<tr>
<td>(late fall)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May 15-June 1</td>
<td>1.0</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Slow</td>
</tr>
<tr>
<td>July 15-30</td>
<td>0.75</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In addition to the applications listed in Table 5, an April application of 0.75 lb. N/1000 ft² is recommended where no previous November application was made. Preemergence herbicides applied in April are often combined with nitrogen. If you apply a preemergence herbicide that is combined with fertilizer in April, the May fertilizer application should be skipped. Professional lawn care companies may increase the number of applications while decreasing the rate of nitrogen per application. This can give a more gradual feeding of the grass plants and produce a high quality lawn.

### How Much Fertilizer to Apply?

It is very important to apply the proper amount of fertilizer to the lawn. The following example explains how to calculate the proper amount of fertilizer to apply.

Calculating the pounds of fertilizer to apply

Determining the amount of fertilizer to apply when you are given the fertilizer rate in lbs N/1000 ft²:

\[
\text{Desired rate in lbs N/1000 ft}^2 \div \% \text{ nutrient} = \text{Total fertilizer needed/1000 ft}^2
\]

\[
\text{Total fertilizer needed/1000 ft}^2 \times \text{Area to be treated in ft}^2 = \text{lbs fertilizer needed to treat the area}
\]

For example, how much fertilizer do you need to apply a 16-8-8 fertilizer at 1.25 lbs N/1000 ft² to a 5000 ft² lawn?

\[
1.25 \text{ lbs N/1000 ft}^2 \div .16 = 7.8 \text{ lbs 16-8-8/1000 ft}^2
\]

\[
7.8 \text{ lbs 16-8-8/1000 ft}^2 \times 5000 \text{ ft}^2 = 39 \text{ lbs 16-8-8 to treat a 5000 ft}^2 \text{ lawn at 1.25 lb N/1000 ft}^2
\]

Additionally, the fertilizer bag will often list the proper spreader setting for your spreader. If the setting is not listed, refer to the later section on “Calibrating a Fertilizer Spreader.”

7-11
Spreader.” Even if your settings are listed, you should calibrate your spreader regularly to make sure it is still accurate. As spreaders get older, settings gradually change because of wear and tear. Regular cleaning and lubrication of the spreader will help it last longer.

The Effective Pattern of a Rotary Spreader

A rotary spreader is different than a drop spreader in that the distribution is not uniform across the width of the pattern. More product lands near the spreader and less product lands near the edge of the pattern. To compensate for this, the spreader must be run so the edge of the pattern is just touching the wheel tracks from the previous pattern. The “effective pattern” is the distance from one edge of the spreader pattern to the center of the spreader. All spreaders have a specific effective pattern. All fertilizers have specific particle sizes and weights which impact broadcast patterns.

Fertilizer Application

Apply fertilizer uniformly over the lawn. Overlap wheel tracks for drop-type spreaders. For rotary spreaders, apply the fertilizer so the wheel is at the edge of the pattern from the previous pass. Improper spreading of fertilizer will result in “streaking”, the alternate dark- and light-green stripes in a lawn. Agricultural type fertilizers (10-10-10, 15-15-15, etc.) that have large particle sizes should not be applied with a drop-type spreader; a rotary spreader should be used. Irrigation or rain following fertilization is important to move nitrogen off the leaf blades and into the soil. Some fertilizer/herbicide combination products cannot be watered-in, so be sure to read the label instructions. Avoid applying fertilizer to drought-stressed or dormant turf, or when temperatures are over 80°F.

Fate of Nitrogen

There is some concern about nitrogen leaching into groundwater or running off into surface water. Research shows that when applied correctly and accurately, nitrogen remains where it is applied. A dense turf canopy prevents water run-off and thus prevents nitrogen from moving across a lawn. The thatch and dense rooting of grass plants absorbs nitrogen and prevents it from moving through the root.
zone. Be sure to calibrate your spreader, and follow all label instructions on the fertilizer bag to reduce the risk of nitrogen moving away from the target.

**Thatch Control**

Thatch is a tightly intermingled organic layer of dead and living shoots, stems, and roots that accumulate just above the soil surface. Thatch accumulation is due to over-fertilization, over-watering, and/or soil compaction. A neglected lawn will never accumulate a thatch layer whereas an intensely managed lawn will. A small amount of thatch is desirable because it moderates soil temperature fluctuations and provides a cushion on the soil surface. Too much thatch interferes with water and air movement, reduces fertilizer and pesticide response, and increases disease and insect activity. Eventually, roots may start growing in the thatch, and since thatch does not hold much water, the turf then becomes very susceptible to drought stress.

Dethatching machines are power rakes with blades that cut through the thatch down to the soil surface. As the blades revolve, dead and live organic material is torn loose and brought to the surface. Dethatching machines that cut with knives or blades are preferred for their effectiveness. Avoid machines with flexible rake-type tines and dethatchers that attach to your rotary mower blade. The organic material removed by the dethatcher must be raked, removed, and used as a mulch or in a compost pile.

If the thatch layer is 0.5 inch or more thick, a number of passes in different directions with the dethatcher will be necessary. Several passes will produce large quantities of refuse, and the lawn will look very ragged for some time. Reseeding may be necessary after dethatching lawns with 0.5 inches or more of thatch. Thatch thicker than 1.0 inch is most easily removed with a sod cutter. A sod cutter set at the soil surface removes the sod easily in light and manageable strips. The lawn must then be reestablished. Although reestablishment is hard work, it is better in the long run.

Kentucky bluegrass and fine fescue should be dethatched in the spring (April) or fall (Sept.) when it is actively growing and never in the summer. Zoysiagrass, on the other hand, should be dethatched in the summer when it is actively growing. Tall fescue and perennial ryegrass rarely develop a thatch problem.

**Aerification**

Aerification is the mechanical removal of soil cores. Aerification relieves soil compaction, improving water and air movement into the soil, increasing rooting, and greatly improves turfgrass health. Additionally, aerification will also reduce thatch. Aerification is most beneficial in compacted areas such as sport fields, heavily trafficked areas next to sidewalks, and areas with intense foot or pet traffic.

Aerification is most beneficial when the largest tines or spoons available are used, penetration is 2 to 3 inches deep, and when 20 to 40 holes are punched per square foot. Aerifiers with reciprocating arms are the most effective, whereas the aerifiers that roll behind garden tractors are less effective because they do not penetrate deep enough nor punch enough holes per square foot. Most aerifying machines available at rental agencies may not punch enough holes per square foot, thus multiple passes will be needed to achieve the 20 to 40 holes/ft². The same is often true with aerification services provided by lawn care operators. Practices such as slicing or spiking remove no soil and are not considered aerification.

Aerification of Kentucky bluegrass, perennial ryegrass, fine fescue, and tall fescue should be done in the fall (Sept.) or spring (April) when the turf is actively growing. Zoysiagrass should be aerified in early-to-mid summer.
Rolling

Rolling is not considered a necessary or desirable turf maintenance practice. Heavy rolling of saturated or clay soils in spring will cause soil compaction and increase soil moisture stress the following summer. This is why rolling is generally not recommended by turf specialists. However, rollers do have some usefulness in turf. Light rolling is effective immediately following seeding to insure good seed-soil contact. Rolling can also insure good sod-soil contact after sodding. Rolling may also help in other isolated occurrences such as severe mole damage or frost heaving. Rolling should never be used to correct surface undulations caused by improper grading.

Pest Control

Annual Grassy Weed Control

Crabgrass is the major weed infesting home lawns in Indiana. Crabgrass is an annual weed germinating in April or May, setting seed in August, and dying with the first frost of fall. Crabgrass has tremendous survival reproductive capabilities. Because of this, it is unrealistic to expect no crabgrass plants in your lawn. You cannot eradicate crabgrass, so a few crabgrass plants in your lawn are acceptable. The best method to control crabgrass, or any pest for that matter, is through proper mowing, irrigation, and fertilization to encourage a thick healthy turf. However, cultural control alone will not control crabgrass satisfactorily, and herbicides may be needed. This is especially true in new lawns or lawns that are thin from damage or improper maintenance. When using herbicides and all pesticides, be sure to read, understand, and follow all label recommendations.

Preemergence Herbicides

Preemergence herbicides prevent emergence of crabgrass plants. These products must be applied prior to crabgrass germination which could occur as early as April 1 in southern Indiana and three or more weeks later in northern Indiana. Purdue research has shown that these herbicides can be applied as early as March 1 and still be effective all season. It is essential to apply these products early in spring prior to crabgrass germination.

Often, preemergence herbicides are combined with fertilizers. Since fertilization should be minimized in the spring, purchase products containing minimal nitrogen and with most of the nitrogen in slow release forms such as methylene ureas or sulfur or polymer coated ureas. Avoid products with most of the nitrogen as urea or ammonical nitrogen.

Do not use preemergence herbicides on new seedlings or before seeding an area. To be most effective, these products need to be watered-in after application. Refer to the label for specific instructions of each product.

Postemergence Herbicides

Postemergence herbicides control crabgrass after it has emerged and are most effective on small crabgrass. These products are more difficult to use than preemergence herbicides and it is extremely important to follow label instructions. Keep in mind the following when using these products:

- The area must be well-watered and not under drought stress.
- Do not mow or water for 24 hours following application.
- Apply at temperatures below 85°F. These products are most effective on clear days with low humidity.
- A second application may be needed within seven days for most effective control.
- Refer to the label for use before and after seeding.

Do not attempt to control crabgrass later than about July 15, because crabgrass is too large to control effectively. It is better to simply tolerate the crabgrass until it dies with the first frost.
By maintaining a dense lawn, you can limit the amount of crabgrass. Proper fertility, mowing, and irrigation is essential for crabgrass control; consider herbicidal control only if necessary.

**Perennial Broadleaf Weed Control**

Dandelions and other broadleaf weeds are listed among the most troublesome turf pest problems in lawns. Even though these weeds are fairly easy to control, it is important to understand that you need not eliminate all weeds from your lawn, and a few weeds are acceptable. It is not economically or environmentally practical to eliminate all weeds from your lawn. The best way to minimize weeds in your lawn is through good cultural practices. On the other hand, the best way to encourage weeds in your lawn is by using poor management techniques such as low mowing, no or improperly timed fertilization, and over-watering. Weeds can also infest areas killed by disease or insects. Maintaining a healthy turf will minimize broadleaf weed infestations in home lawns.

The best herbicide choice is a general-purpose mixture made of two to four active ingredients. Products with more than one herbicide component will control a wider spectrum of broadleaf weeds. Read and follow all directions on the herbicide label.

The best time to apply a general-purpose broadleaf herbicide is mid-September to mid-October. The fall represents the best time to control perennial broadleaf weeds such as dandelion, plantain, and clover and also winter annuals like common chickweed. These weeds are storing energy reserves for the winter in their roots. Thus the herbicide will enter the plant and travel to the roots with the food reserves, thereby giving a complete kill of the weed. The second best time is in the late spring or early summer period after the weeds have flowered. If applying in the late-spring, be extremely cautious with these herbicides near ornamentals, trees, flowers, and vegetable gardens because these plants can be damaged by these herbicides through direct application, drift, and/or volatilization. This is one of the reasons why we prefer to apply these herbicides in the fall.

If there are only a few weeds in the area, simply spot-apply a herbicide rather than applying to the entire lawn. Apply just enough to wet the leaf and do not apply to the point that the herbicide is dripping off the leaf.

- Apply to actively growing, preferably young weeds.
- Do not apply broadleaf herbicides when the soil moisture is low. Not only is effectiveness reduced but damage to the turfgrass could result.
- Apply on a calm, clear day when the air temperature is between 50 and 85°F.
- If rain falls within 24 hours, consider reapplying the weed control if no results are obvious after 13 to 21 days.
- Do not apply to new seedlings until after the grass has been mowed at least three times.
- Delay seeding a bare spot caused by the removal of weeds for 3 to 4 weeks and after a good soaking rain or irrigation.
- Delay applying a broadleaf herbicide to newly sodded areas for 4 to 6 weeks.
- Delay mowing the treated area for at least 3 days after the treatment.

**Summer Annual Broadleaf Weed Control**

Summer annual weeds (spurge, knotweed, purslane, etc.) are difficult to control for a number of reasons. Depending on the species, summer annual weeds germinate at different times during the summer and mature in a very short period of time. Thus, a single application of herbicide might only control a single species of weeds because other species have not germinated
yet or have grown too large to be controlled. Plus, summer weeds have a thick, waxy layer on their leaves to prevent water loss which also limits the herbicide from penetrating the leaf. Consider the following strategies for controlling summer annual weeds.

- In April, apply a product containing isoxaben which is a herbicide that controls broadleaf weeds before they germinate. It does not control already germinated weeds so it must be applied with or followed by a postemergence mixture such as decribed above.
- Apply a single application of a broadleaf herbicide in late May, realizing you may not control all of the weeds.
- Use cultural practices mentioned earlier to limit the weeds.

Difficult-to-Control Broadleaf Weeds

Weeds like creeping Charlie (ground ivy), thistles, and wild violets are difficult to control because they spread by underground stems or root stocks. Herbicides often control or burn back the top growth, but generally will not translocate to give a complete kill. Plus, these weeds often get started in the shade or other areas where the desireable grass is compromised. The non-pesticidal approaches are necessary to help minimize these weeds. Multiple applications in the fall followed by another application in the spring after flowering can provide marginally acceptable control, but even then these weeds will likely regrow.

Perennial Grassy Weed Control

Perennial grasses are especially troublesome in turf areas because few herbicides will selectively control them. The weedy grasses often disrupt the uniformity of a turf area with their different colors, textures, or growth habits. Distinguishing perennial grassy weeds from other weeds is very important because control measures differ markedly. When establishing or renovating a turf area, it is essential that perennial weeds are identified to maximize the optimum time for control. Perennial grassy weeds can be grouped into two main categories. Bunch-type grasses, which include tall fescue and orchard grass, can be controlled quite easily. Spreading grasses, such as creeping bentgrass, rough bluegrass, nimblewill, quackgrass, bermudagrass, and zoysia, are more difficult, if not impossible, to control.

When there are few weedy patches, bunch-type grasses can best be cut out with a shovel. Be sure to cut down three to four inches into the soil to get all the stems. The holes should be refilled and seeded or sodded immediately. The seed and soil should be representative of that already in the area. If the area has a large number of plants, chemical control will be more efficient. A nonselective systemic herbicide such as glyphosate (Roundup or Kleenup) or glufosinate (Finale) can be spot-applied. These herbicides will also kill the desired turf species; use care during application. The area should be reseeded 5 to 7 days following application. Stir up the soil by raking or chopping to insure good seed-soil contact.

Control of spreading grasses is usually attempted with a nonselective systemic herbicide like glyphosate. Glufosinate, on the other hand, is not systemic in the plant and will not provide effective control of spreading grasses. Best results are seen when the weedy plants are young, fully green, actively growing, and not under drought stress. The mother plants are easily killed, but often the weed will regrow from the stolons or rhizomes. To overcome this, more than one application is recommended. One must allow the weed to regrow before the next application. At least two applications are recommended, but three or more may be needed. One must realize that the area will be dead and unsightly for a number of weeks or months if optimum control is desired. If there is only a small number of weeds, spot applications can be
made with a wick applicator or a small sprayer. Reseeding can take place five to seven days following final herbicide application. This method can be effective, even though undetected weeds will continue to spread across the area. Once the area has been infested with a large number of weeds, killing the entire area will be most effective. If a herbicide such as glyphosate is used, a number of applications will be necessary. Renovation can begin five to seven days following final glyphosate application.

Weed identification is an important aspect of turf management. Pictures of many common Indiana weeds can be found at http://www.agry.purdue.edu/turf/weeds/weedindex.htm. This page also contains links to other weed identification web pages.

**Insect Control**

Though insects are rarely a problem in Indiana lawns, the most common insect problem is from white grubs. White grubs are the larvae stage of the masked chafer or Japanese beetle. These grubs feed on the roots of turfgrasses in August and September, causing wilting and potentially death of the grasses. Furthermore, even though symptoms may not be visible in an area, raccoons and skunks may start digging for the grubs causing far more damage than the grubs themselves. Control of white grubs must be done prior to the onset of damage because the grubs are too big to control once damage is visible. Some people assume that if a lawn had grub damage one year, it will occur again the following year. Though this is true to a certain extent, we now know that grub populations and potential damage varies widely from year to year, county to county, and even neighborhood to neighborhood. Therefore it is important to scout for white grubs on lawns with a history of the problem. Begin checking for white grubs during the first part of August by digging into the top few inches of soil in numerous places around the turf area. Sift the soil between your fingers looking for small white grubs which may only be 1/4 to 1/2 inch long and 1/8 inch in diameter. As a general rule of thumb, an insecticide treatment is justified when 8 grubs per square foot are found. However, remember that white grubs prune the roots of grass plants and thus primary damage is from water stress. Your tolerance may raise or lower depending on the moisture conditions of the turf. Cool weather, ample precipitation, and/or irrigation will minimize the damage of white grubs, thus raising the treatment threshold.

The newer insecticides like Merit and Mach2 are very effective on white grubs, but they must be applied by early to mid August. After that, the more traditional products such as Sevin should be used. If you attempt grub control much later than early September, Dylox is the product of choice on the larger grubs. All of these products should be watered in immediately after application. Another option, if you decide not to apply an insecticide, is to irrigate more frequently during August and September. Often the turfgrass will outgrow the grub feeding damage if water stress can be avoided.

Though many believe that moles are an indication of grub problems, this is not true. Moles feed primarily on earthworms throughout most of the year. Insecticides applied for white grubs will not affect mole populations, and trapping is the only effective method of controlling moles to date.

**Disease Control**

Diseases can be very damaging in home lawns. The only efficient way to control diseases in home lawns is via cultural methods. Avoiding perennial ryegrass, fertilizing primarily in the fall, mowing at 3.0 inches or higher, and proper irrigation are the best methods to minimize diseases. Fungicides are discouraged on home lawns because it is difficult to identify the disease and thus select the correct fungicide. Furthermore, the disease usually has run its course by the time it is detected making a fungicide application useless.
Review and Study Questions

1. Should the amount of perennial ryegrass be limited in the seed mix for a new lawn? Why or why not.
2. Describe where Kentucky bluegrass can be used. What about tall fescue?
3. What is important for preparing a soil for sodding or seeding?
4. When is the best time to seed cool-season turfgrasses in Indiana?
5. How do you determine mowing frequency on a lawn?
6. Describe the proper timing for fertilizer applications to cool-season turfgrasses in Indiana.
7. How many pounds of 25-10-10 are needed to apply 1.0 lb N/1000 ft² to a 30,000 ft² lawn?
8. How do you determine irrigation frequency on an established lawn?
9. What cultural practices are effective at reducing turfgrass weed problems?
10. What are the options for control of summer annual grassy weeds like crabgrass?
11. What are the options for control of perennial broadleaf weeds like dandelion?
12. The presence of diseases in a lawn usually indicates what?
13. What is the single best application time to control white grubs in IN lawns?
14. Describe the establishment process for a Kentucky bluegrass lawn with seed.
15. Describe a typical N, P, and K fertilization program for an old, neglected lawn on heavy soil.
16. Describe some of the common insect pests of lawns in Indiana and some of the commonly used control techniques for those pests.

For More Information

The following publications can be found on the Purdue University web site at http://www.agry.purdue.edu/turf/. This site also provides links to other universities, and much more information about lawn establishment and management

AGRY-98-03: Maintaining Lawns on Sandy Soils
AGRY-98-04: Control of Yellow Nutsedge in Home lawns
AGRY-99-05: Rejuvenating Turf Areas After the Drought of 1999
AGRY-2000-01: Preparing Your Lawn for a Potential Drought
AY-2: Don't Bag It
AY-3: Establishing Lawn Areas From Seed
AY-6: Zoysiagrass for Indiana
AY-7: Irrigation Practices for Homelawns
AY-8: Mowing, Thatching, Aerifying, and Rolling Turf
AY-9: Control of Broadleaf Weeds in Home lawns
AY-10: Control of Crabgrass in Home lawns
AY-11: Control of Perennial Weedy Grasses in Turf
AY-13: Lawn Improvement Programs
AY-14: Improving Lawns in the Shade
AY-18: Soil Testing for Lawns
AY-20: Seeding a Turf Area in the Spring
AY-22: Fertilizing Established Lawns
AY-25: Purchasing Quality Grass Seed for Your Lawn
AY-26: Should I Hire a Professional Lawn Care Service?
AY-27: Maintenance Calendar for Indiana Lawns
AY-28: Establishing a Lawn from Sod
AY-31: Building and Maintaining Soccer Fields in Indiana
AY-32: 7 Simple Steps to a Better Home Lawn
BP-101-W Turfgrass Disease Profiles: Gray Snow Mold
BP-102-W Turfgrass Disease Profiles: Pink Snow Mold
BP-103-W Turfgrass Disease Profiles: Leaf Spot/Melting Out
BP-104-W Turfgrass Disease Profiles: Red Thread
BP-105-W Turfgrass Disease Profiles: Dollar Spot
BP-106-W Turfgrass Disease Profiles: Brown Patch
BP-107-W Turfgrass Disease Profiles: Gray Leaf Spot
BP-108-W Turfgrass Disease Profiles: Anthracnose
BP-109-W Turfgrass Disease Profiles: Pythium Blight
BP-110-W Turfgrass Disease Profiles: Leaf Rust
BP-111-W Turfgrass Disease Profiles: Powdery Mildew
BP-112-W Turfgrass Disease Profiles: Slime Mold
BP-113-W Turfgrass Disease Profiles: Fairy Ring
BP-114-W Turfgrass Disease Profiles: Take All Patch
BP-115-W Turfgrass Disease Profiles: Summer Patch
BP-116-W Turfgrass Disease Profiles: Necrotic Ring Spot
E-61 Turf Insect Management
ADM-10 Moles