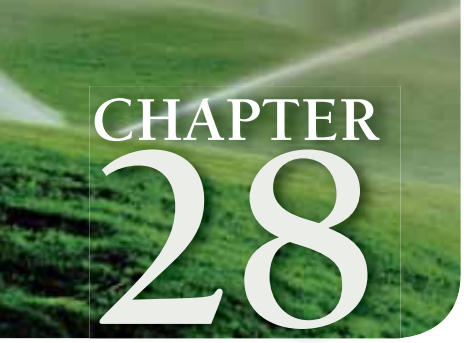

CHAPTER 28 Turfgrass Management

Chapter Outcomes

After studying this chapter, you will be able to:

- Describe the turfgrass industry and turf applications.
- Describe turf morphology and types of turf.
- Discuss methods of lawn establishment.
- Explain how turf is maintained.
- List methods of turfgrass renovation.
- List careers related to turfgrass management.

Words to Know

auricle
blade
collar
herbicide
lawn
ligule
moisture stress
overseeding
plugging device
reel mower
rhizomatous
rotary mower
seed blend
seed spreader
seedhead
slit seeder
sports turf
spot seeding
stoloniferous
thatch
tiller
transition zone
turf
turfgrass breeding
turfgrass industry
utility turf
vernation
verticutting
volatilization

Before You Read

Arrange a study session to read the chapter aloud with a classmate. Take turns reading each section. Stop at the end of each section to discuss what you think its main points are. Take notes of your study session to share with the class.




While studying this chapter, look for the activity icon to:

- **Practice** vocabulary terms with Words to Know activities.
- **Expand** learning with identification activities.
- **Reinforce** what you learn by completing Know and Understand questions.

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Owners of English estates began to establish ***lawns*** (an expanse of turfgrass used for recreation or beauty) during the seventeenth and eighteenth century. Only the very wealthy could afford to install and maintain lawns, **Figure 28-1**. American settlers' lawns, in contrast, consisted of dirt, cottage gardens, or some crops growing outside their doorways. Wealthy travelers to Europe saw the beautiful lawns in those countries and wanted to replicate them in the United States.

Growing turfgrass in the United States at the turn of the twentieth century was difficult. Grass seed was not commercially available as it is today. At that time, lawns consisted of native grasses that were untidy and weed-like. These were the only grasses that could thrive in the soil and environmental conditions present in the United States.

"There is not a sprig of grass that shoots uninteresting to me."
—Thomas Jefferson

In 1915, the United States Department of Agriculture (USDA) and the United States Golf Association combined efforts to find a grass variety that would thrive here. Researchers tested bermuda grass from Africa, bluegrass from Europe, and a mixture of fescues and bentgrass. They were looking for an attractive, durable, and easy-to-grow grass suited for the United States. Almost two decades later, the USDA found suitable grasses for lawn cultivation. Many other lawn-growing challenges emerged, including pest problems, irrigation, fertilization, and mowing.

The home lawn revolution began in the middle of the twentieth century when many homeowners gained easy access to lawn care equipment. Garden clubs pushed the home lawn movement by promoting lawn care as a form of gardening. Clubs sponsored competitions to convince homeowners that a green, weed-free lawn was the ideal environment to surround a home or business.

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Figure 28-1. London's Hyde Park opened to the public in 1637. It is well known for its beautiful lawns, trees, and plantings.

History Connection

Sheep on the White House Lawn

Before the lawn mower, livestock or scythes were used to cut grass. A flock of sheep grazed on the White House lawn during World War I to show Americans a way to trim their lawns, feed their flock, and provide wool (which was scarce) while soldiers fought overseas.

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The lawn, once a symbol of wealth, is now more easily attained by average Americans. Multimillion-dollar turfgrass companies manage lawns across the country. The competitive nature of some homeowners makes the home lawn a wonderful canvas for contests of many forms. Families use this space for countless activities from throwing a ball to roasting hot dogs.

Turfgrass Industry

Turf is grass and the surface layer of soil held together by the grass roots. This agricultural crop is cultivated the same as vegetables and flowers. The total area of the United States covered in turf is more than 50,000 square miles, making this the largest crop grown. Turf is beneficial to the environment and to people, **Figure 28-2**.

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Figure 28-2. Turfgrass is enjoyed all over the world, especially for sports-related purposes.

Turf Industry

The ***turfgrass industry*** consists of businesses that grow seeds, sods, and grasses for recreational areas, homes, and commercial, utility, and sports uses. The turfgrass industry contributes nearly $40 billion annually to the US economy. Approximately 65% of total turf areas in the United States are lawn. The other 35% of turf area is utility turf, golf courses, and athletic fields. ***Utility turf*** is grass that is used for spaces such as roads, airports, and parks. About 50 million American homes include a lawn in their landscape. Nearly 50 million more lawns are located at schools, churches, parks, cemeteries, businesses, and hospitals.

A huge component of the turfgrass industry is turf for athletic uses. ***Sports turf*** is grass that is used for recreation and competitive sport purposes. Golf course turf is one type of sports turf. More than 50% of the total golf courses in the world are in the United States. An estimated 20,000 sports fields in the United States are grown with turf.

Corner Question

Which early US presidents had home lawns?

Corner Question

What size lawn is needed to release enough oxygen to sustain a family of four people?

The turfgrass industry has nearly 600,000 full- and part-time employees. Nearly 100 universities and colleges offer turfgrass programs that provide formal training in science and management. Numerous industry professional organizations, publications, and other resources on a national and international level deliver research information to a diverse audience of turf enthusiasts and specialists.

The turfgrass industry is a top agricultural business in many states. Continued attention to sustainable practices and future research ensures that there is no slowing of this industry's growth.

Benefits

Turf provides many benefits to people and the environment. Turf does the following:

- Reduces noise pollution.
- Decreases allergens related to pollen.
- Stabilizes dust particles and reduces mud.
- Provides safety in vehicle operations and contact sports.
- Lowers fire hazards.
- Moderates temperature fluctuations and reduces the urban heat island effect via *evapotranspiration*.
- Functions in *carbon sequestration* (a process in which carbon dioxide is removed from the atmosphere and held in solid or liquid form).
- Improves soil through healthy root system and microorganism activity.
- Prevents erosion and runoff while aiding in flood control.
- Boosts ground water recharge, helping to absorb up to six times more rainwater than other crops.

The environmental impacts of turfgrass management can be destructive, however, if growers use poor growing practices. Turf sustainability is discussed in the next section.

Turf Sustainability

Some environmental enthusiasts believe that turf cultivation should be avoided because of issues related to irrigation, pesticides, and fertilizer. Conservationists may think that this crop is the cause of too many environmental problems. However, poor management practices result in negative outcomes for the environment.

Did You Know?

Combining the front lawns of eight average-sized homes provides the same cooling effect as about 70 tons of air conditioning.

Turf growers should use sustainable practices just as horticultural growers do. Excessive use of water, fertilizer, and pesticides is harmful to the environment regardless of the crop being produced. Because there is so much turf that blankets the United States and so many people who are trying to manage this crop, using sustainable practices is especially important. Business owners, landscapers, and homeowners must consider sustainable practices to ensure that the environmental benefits of turf outweigh any negative impacts associated with mismanagement.

Turf Applications

The four main applications or uses of turf are lawns, golf courses, utility turf, and sports turf. In addition, sod and seed production are part of this industry. Several industries that support or are associated with the turf industry include pesticide, fertilizer, irrigation, equipment, and information technology companies.

Lawns

Many Americans value a beautiful lawn whether it is in a park, business, garden, or yard. An individual ***blade*** (the flat, leaf part) of grass on a lawn lives an average of 40 days. Lawns provide opportunities to connect with nature and breathe in fresh air. They also provide a clean space for a picnic. Can you imagine your favorite park without green grass and only pavement or concrete?

Golf Courses

The type of golf played today can be traced back to Scotland in the fifteenth century. Today, this sport is popular around the globe and is played by many types of people. Golf can be played on a 9-hole or 18-hole course with varying levels of difficulty. Golf courses often change the locations of the holes to provide variety for players. A golf course is composed of many different components and each is managed to impact the game in some manner.

Corner Question

Which mowing pattern is better: spiral or rows?

Career Connection

Andy Smith

Erosion Control, Eco Turf

Andy Smith, a former high-school FFA member and tobacco farmer, did not know that he would end up owning an erosion control company in Raleigh, North Carolina. After college, Smith worked for a hotel and then sold real estate. After Hurricane Fran, Smith went to work on a golf course repairing storm damage. He found that he loved working on the golf course. He quickly merged his agricultural roots, understanding of land development, and new love for turf management into a job with a company that installed golf courses around the country.

In 2007, golf course installation nearly stopped. Smith began working for an erosion control company and used his knowledge, experience, and network contacts to sell erosion control materials to golf courses around the country. He is now the owner of Eco Turf, a company that sells erosion control materials.

Jodi Riedel/Goodheart-Willcox Publisher

Smith's tenacity for hard work, his ability to learn quickly, and his enthusiasm for working with other people helped him get where he is today. He urges students interested in the turfgrass industry to further their education in a two- or four-year program and to participate in internships in the industry. "You have to love what you do," says Andy. "So many hours of the day are spent working; it is important to enjoy your job." Andy Smith did not know where his career path would lead him, but he has enjoyed the journey so far.

Corner Question

Which professional football stadiums have real turfgrass?

Sports Turf

Sports turf provides a recreational space for physical activity while protecting the soil. Sports turf provides space to play soccer, lacrosse, football, and baseball, or just to run or walk and enjoy being outdoors. These activities can help increase physical and mental health. Turfgrass areas help decrease sports injuries (compared to playing on hard surfaces) and increase community participation and pride.

ziher/Shutterstock.com

Figure 28-3. This airstrip is covered in utility turf. Can you explain why the soil on this airstrip needs to stay in place?

Utility Turf

Utility turf serves a purpose in the landscape. Utility turf is found in places where soil must be conserved or stay in place. Utility turf prevents erosion and helps to increase water penetration in an area. Places where utility turf is used include airport runways, closed landfills, and alongside roads, **Figure 28-3**.

Sod Production

Sod producers grow a solid platform of turfgrass. The harvested grass along with roots and a thin layer of topsoil is known as sod.

Career Connection

Todd Lawrence

Golf Course Superintendent

Todd Lawrence works in the turfgrass industry as the golf course superintendent for a tournament course for professional golfers. Lawrence and his staff use best management practices combined with a National Audubon certification. The Audubon golf course certification program helps golf courses protect the environment while preserving the natural heritage of the game.

Lawrence did not begin his career track with the goal of golf course management in mind. While managing test fields on a research farm as an intern, a researcher encouraged Lawrence to consider a career in the turfgrass industry. Lawrence decided to take a turfgrass course while studying agronomy at North Carolina State University. He began working on a golf course while in college and realized he could not only grow turfgrass, but also enjoy a unique work environment that focused on recreation. Lawrence saw his future in managing golf courses.

Jodi Riedel/Goodheart-Willcox Publisher

Lawrence's educational background, hard work, and ability to work well with others earned him jobs with increased responsibility. He eventually was hired as the superintendent of the newly built tournament course. Lawrence is extremely proud of the course and appreciates his crew's work and their commitment to excellence for both golfers and the surrounding community.

Many sod producers also transport and install the sod. Once harvested, sod is placed onto prepared soil and immediately provides the look of an established lawn, **Figure 28-4**.

Sutichak Yachiangkham/ Shutterstock.com

Figure 28-4. Sod installation creates a complete lawn in a short time.

Seed Production

Since the Dust Bowl of the 1930s, people in the United States have realized the importance of protecting soil. The most economical and common method of establishing turf is to use turfgrass seed. Growers, mostly located in the Pacific Northwest, grow various cool-season turf varieties through flowering and fruiting. The turf crop is harvested and the seed is then cleaned, analyzed, bagged, and distributed.

Supporting Industries

Various industries help the turfgrass industry to function more efficiently. Turfgrass growers use integrated pest management (IPM) and sustainable growing practices to cultivate the highest quality turf crop. Growers use pesticides, fertilizers, irrigation, equipment, and information technology to promote plant growth. These industries include key businesses that produce the following:

- Chemicals—fertilizer, insecticide, fungicide, rodenticide, and molluscicide.
- Irrigation—hoses, valves, timers, couplings, heads, and rain sensors.
- Equipment—tractors, mowers, rollers, golf carts, painting devices, aerators, sod cutters, utility vehicles, spray applicators, dethatchers, and seeders.
- Information technology—computer software, global positioning systems (GPS), and bar coding.

Thinking Green

Freshkills Park

Freshkills Park, a 2200-acre site in New York City, was once a landfill. It is now scheduled to become a park. Areas inside the park will be covered in utility turf. The park will be three times the size of Central Park in New York City.

Turfgrass Morphology and Types

Turfgrass belongs to the grass family known as Poaceae. Turfgrass has unique characteristics that distinguish it from other plants. These characteristics include:

- Grass leaves have linear-shaped leaves that are elongated. Leaves have parallel veins.
- Roots are fibrous systems.
- Flowers and ***seedheads*** (a cluster of seeds within a plant's inflorescence) are not easily visible when the turf is mowed.
- Grass stems are located at the base of the leaves called the crown.

As with all plants, some identifying characteristics help to differentiate one turf from another.

Turf Morphology

Morphology is a branch of biology dealing with the study of the form and structure of organisms and their specific structural features. Grasses have unique morphological structures that include:

- Leaf blade.
- Sheath.
- Vernation.
- Ligule.
- Auricle.
- Collar type.
- Rhizome.
- Stolon.
- Tiller.
- Inflorescence and seedhead.

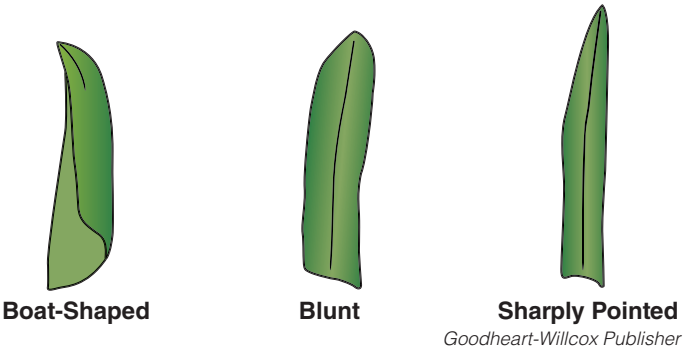

Figure 28-5. Leaf blade tip shapes.

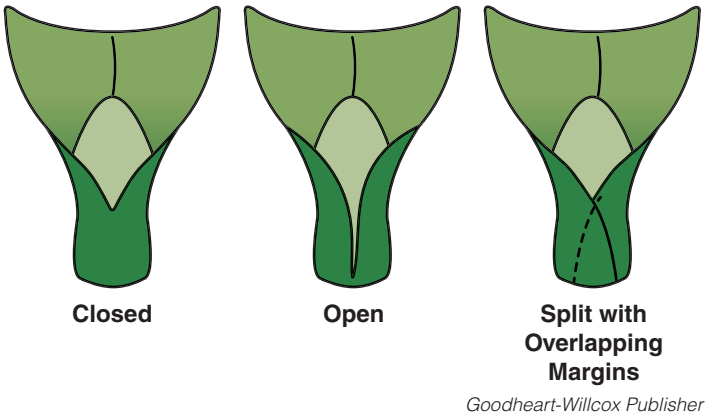

Figure 28-6. Turfgrass leaf sheath margins.

Leaf Blade

The turf's leaf blade is also known as the broad portion of the leaf. Blades can be distinguished based upon shape, size, and color. All leaf blades have parallel veins. However, the width and lengths of mature blades vary. Blade tips can be boat shaped, blunt, or sharply pointed, **Figure 28-5**. Boat-shaped blade tips are cupped and curved upward. Blunt blade tips are rounded and end abruptly. Sharply pointed blade tips are long with a sharp point.

Sheath

The basal portion of the grass that surrounds the stem is known as the sheath. Sheath types can be round and flattened. A round sheath is cylinder-shaped, circular in cross-section, and rolls easily between your fingers. A flattened sheath is compacted, elliptical in cross-section, and tends to flip from side to side rather than roll between your fingers.

Sheath margins (edges) are one of three types. In *closed margins*, an overlapping portion of the sheath cannot be seen. The *open sheath margin* forms a small V-shape. In the *split with overlapping margins*, grass blades are not closed (fused) together, but are overlapping, **Figure 28-6**.

Vernation

The arrangement of the leaves within the bud (youngest leaf) and the surrounding sheath is known as the ***vernation***. Vernation usually is described as rolled or folded, but some plants have both features. To determine the type of vernation, place the leaves, surrounded by the sheath, between your thumb and index finger, and roll the plant back and forth. If it moves as a pencil would, and has a bumpy path, it is folded. *Folded vernation* leaves fold lengthwise in a V-shape, with the margins meeting but not overlapping.

If it moves like a straw it is rolled. *Rolled vernation* margins overlap due to curled leaves, **Figure 28-7**.

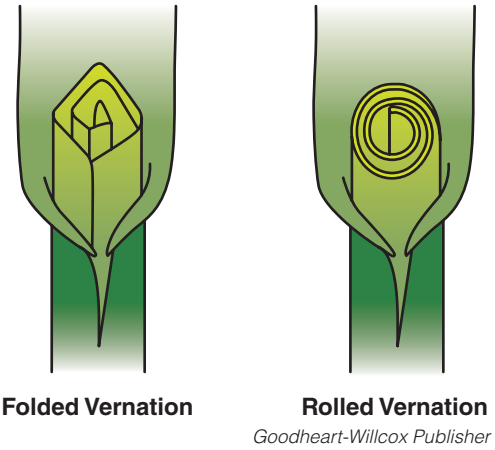

Figure 28-7. The vernation of turf varies and can be rolled or folded.

Collar Type

The ***collar*** is a band at the backside of a leaf where the leaf blade and sheath meet. Collars are usually a lighter color than the rest of the grass blade. Collars are either divided by the midrib or continuous.

Auricles

A small, claw-like appendage that projects from a grass blade is known as an ***auricle***, **Figure 28-8A**. Auricles can be absent, claw-like, or rudimentary. On claw-like auricles pointy appendages edge the grass stem. Rudimentary auricles have partial appendages that do not enclose the grass stem.

Ligules

A thin structure that clasps the top of the leaf sheath (where the blade and sheath join) is the ***ligule***. The ligule structure starts from the auricle. It can be seen when the blade is bent backwards, **Figure 28-8B**. Ligules can be absent, hairy, or membranous. Membranous ligules are transparent, flexible, and can vary in height.

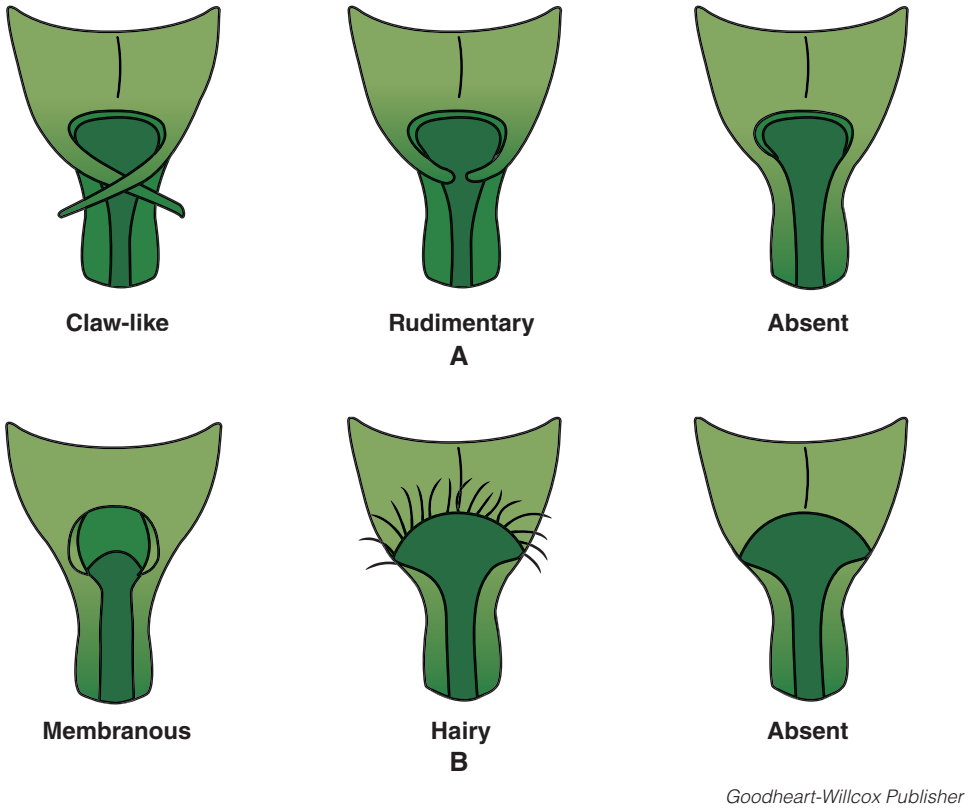

Figure 28-8. A—Auricles are appendages that project from each side of the collar. B—Ligules are located near the back of the collar.

Did You Know?

Some rhizomes are edible. Ginger and turmeric are both rhizomes that make flavorful additions to many dishes.

Rhizomes and Stolons

A rhizome is a modified stem structure that grows horizontally at or near the soil's surface. It produces roots on the bottom and shoots on the top. These structures can begin at the main stem. Rhizomes allow grass plants to spread horizontally.

Stolons are lateral stems at or just below the surface of the soil that produce new plants from buds, or nodes. Stolons allow a grass plant to spread laterally. Stolons often root at the nodes, producing new plants. A turfgrass plant can have both rhizomes and stolons.

Tillers

A ***tiller*** is a stem that develops from the crown of the parent plant and grows upward within the enclosing leaf sheath of the parent plant, **Figure 28-9**. Multiple tillers can grow from an initial seedling, forming dense tufts of grass.

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Figure 28-9. Tillers are smaller plants that form as an offshoot from the central plant.

Inflorescence and Seedheads

The flowering and reproductive parts of a grass plant are known as the inflorescence. The fruiting structure is known as the seedhead. This morphological structure makes identification of turf much easier. However, when turf is mowed, seedheads may be lost for identification purposes. Inflorescence and seedhead shapes include panicle, raceme, and spike, **Figure 28-10**.

- Panicle—flowers are less densely clustered than in raceme or spike types of seedheads. Panicles often have a triangular shape. The seedhead is branched with multiple seeding branches clustered around the stem.
- Raceme—several slender spikes re attached along the end of a stem. Individual spikes can be attached at one point or along the top of the stem in an alternating fashion.
- Spike—an unbranched seedhead is located at the end of a stem.

Types of Turf

The types of turf that a grower selects for an athletic field, lawn, or golf course depend on how that space will be used. Growth habit, zone of growth, and specific characteristics of the turf all contribute to the final selection of the grass.

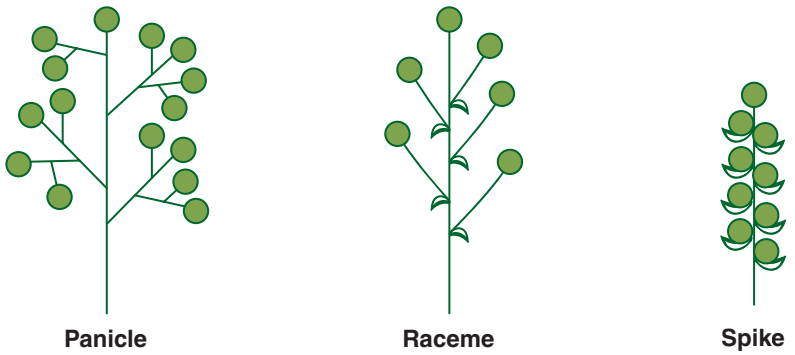

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Figure 28-10. Inflorescence and seedhead shapes help to identify types of turfgrass.

Growth Habit

Depending upon the growing conditions, a turf with a specific growth habit can be useful in a specific site. The growth habit of a grass can also help identify turf. Types of turfgrass growth habits are rhizomatous, stoloniferous, or bunch type.

- ***Rhizomatous*** plants produce rhizomes, or underground lateral stems. Rhizomatous grass quickly recovers from heavy traffic.
- ***Stoloniferous*** plants produce stolons (aboveground lateral stems).
- Bunch-type grasses produce only tillers and take more time to recover from injury. They are not well suited for athletic fields or heavily trafficked areas.

Corner Question

What is indicated by a blue tag on a seed container?

Zones of Growth

The zone of growth refers to a site's location and the climatic conditions the location. Temperature, humidity, and available moisture all factor into zones of growth in the United States, **Figure 28-11**. The United States can be divided into three zones: warm season, cool season, and ***transition zone*** (a growing area that can grow both warm- and cool-season grasses).

Warm-Season Grasses

Warm-season grasses are best suited for the warmer southern regions of the United States. These plants are propagated using the vegetative parts of the plant and are planted in late spring or early summer.

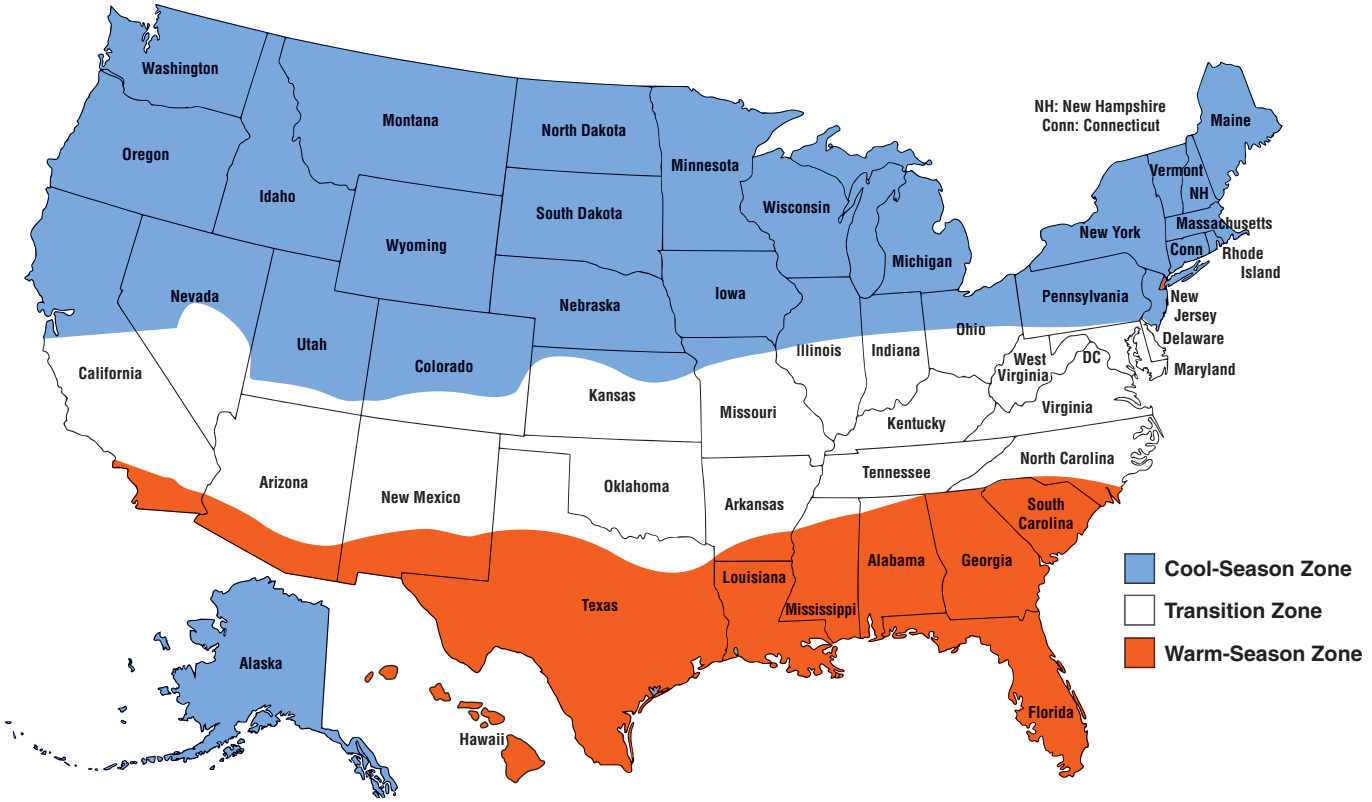

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Figure 28-11. The United States is divided into three zones: warm season, cool season, and transition.

Corner Question

How many seeds of bermuda grass are in one pound?

The turf goes dormant when the air temperature is below freezing during the winter season, usually after the first frost. These turf types can tolerate very high temperatures. However, they can be damaged by cold temperatures, leading to winterkill. Generally, these grasses have low shade tolerance but good drought tolerance. Examples of warm-season grasses include:

- Bahia grass (*Paspalum notatum*)—well adapted to mild coastal climates, coarse textured, best for low-quality and maintenance turf.
- Bermuda grass (*Cynodon* spp.)—popular warm-season turfgrass, used for all quality levels.
- Centipede grass (*Eremochloa ophiuroides*)—light green, medium-textured, low maintenance, tolerates shade, lacks tolerance for high traffic.
- St. Augustine grass (*Stenotaphrum secundatum*)—coarse-textured grass, tolerant of traffic, shade, and salt, rarely available as seed.
- Zoysia grass (*Zoysia japonica*)—hardy turf, tolerates high heat and humidity, withstands cold temperatures, long dormant period, slow growing, low maintenance.

"A warm smile is the universal language of kindness."
—William Arthur Ward

Cool-Season Grasses

Cool-season turfgrasses thrive in temperatures between 60°F and 80°F (15.6°C and 26.6°C). These grasses are well suited for the northern United States. These grasses do not show signs of dormancy during the winter season but grow very gradually. Cool-season turfgrasses are propagated by seed and planted in the fall. They show signs of stress in heat and humidity. The United States produces the largest quantity of cool-season grass seed and many other areas of the world rely on this production. Examples of cool-season grasses include:

- Kentucky bluegrass (*Poa pratensis*)—rhizomatous, medium- to fine-textured grass, deep green color, goes dormant during summer months, recovers well from most droughts.
- Tall fescue (*Festuca arundiacea*)—bunch-type grass, coarse texture, breeding efforts have improved drought tolerance and pest resistance.
- Perennial ryegrass (*Lolium perenne*)—bunch-type grass, medium texture, tolerates partial shade, excellent wear tolerance.
- Fine fescues (*Festuca* spp.)—shade and drought tolerant, fine texture, often mixed with other cool-season grass seeds.

Transitional Turf

A transition zone is an area where warm- and cool-season grasses can be adapted to survive the climate. Fewer cool- and warm-season grasses thrive in transition zones. Winterkill and summer heat and drought stress are disadvantages associated with this zone.

Cold-tolerant warm-season turfgrasses and heat-tolerant cool-season grasses are well suited for lawns in the transition zone. Zoysia grass and bermuda grass are the two most popular warm-season lawn turfs for the transition zone. Tall fescue is the most popular cool-season lawn turf for the transition zone.

Management strategies to help grasses thrive in this zone include changing fertilization programs, increasing mowing heights, and avoiding shady conditions for warm-season grasses. Cool-season grasses are adapted by reducing nitrogen use, watering deeply and infrequently during mornings, increasing mowing height, and following integrated pest management (IPM) strategies during summer heat. The best turfgrasses for the transition zone include Kentucky bluegrass, bermuda grass, tall fescue, and fine fescue.

Lawn Establishment

To achieve a lush lawn, several steps must be followed. The appropriate turf must be selected, the site prepared, the soil conditioned, the turf planted, irrigation operated, fertilizer applied, and pest management employed.

Did You Know?

Turfgrasses can be cultivated in all US states and territories.

Turf Selection and Timing

When choosing a site for turfgrass, consider the appropriate type of turf and the time of year to cultivate.

Warm-Season Grasses

Growers have better success establishing warm-season grasses during the warmer months of the year. Most warm-season grass seeds germinate and thrive from spring to midsummer. Warm-season sod will not produce roots unless soil temperatures exceed 55°F (12.78°C) for several weeks. Sprigs or plugs, however, do well in the same conditions.

Cool-Season Grasses

Cool-season grasses do best when installed during the cooler months of the year. Seeding is usually done from August to September in most of the United States, **Figure 28-12**. Later seeding usually fails due to winter injury or winterkill. Sowing seeds in late winter or spring does not give the turf enough time to grow the deep roots needed to help plants survive the heat (and possible drought) of summers. Cool-season sods do best when the growing season is cool but the ground is not frozen.

LianeM/Shutterstock.com

Figure 28-12. Planting seeds is an economical way to establish turfgrass.

Site Preparation

Site preparation is important in order to establish quality turf. To properly prepare a site, pay particular attention to details. Follow these steps to prepare a site for turf planting:

1. Remove any trash, debris, or rocks that are larger than a quarter.
2. Grade the site, if possible, to no more than a 15%–20% grade. Avoid planting turf on steep grades or heavily shaded areas. If grading is required, remove and store the topsoil. Replace the topsoil when grading is completed. A 2%–3% slope around buildings will ensure that water drains properly away from structures.

3. Install a drainage system for sites with poor drainage.
4. Remove weeds.
5. Water the area and look for areas of uneven settling. Note any areas with standing water. Reshape where needed.
6. Mix one to two cubic yards of compost per 1000 ft^2 into the top 8″ (20.3 cm) of soil.
7. Follow the soil preparation steps.

Soil Preparation

Proper soil preparation ensures healthier turfgrass and is worth the investment of time, and resources. Without the results of a soil test, there is no guide to adjusting pH or adding nutrients. Growers can only add nutrients based on a guess. This is not a logical way to establish turf, and is not a good practice for the environment. Growers should always test the soil and amend it according to test results.

Take soil samples from the area where turf will be established. If there is more than one area that will be planted, take soil samples from those areas. Follow proper soil sampling protocol. Based on the results of the soil test:

1. Adjust the pH of the soil using lime or sulfur. Add fertilizer according to the suggestions. Incorporate into the top 8″ (20.3 cm) of topsoil using a disc or rototiller.
2. Rake the site. Soil particles should be no larger than a quarter; pea-size is best. Hand raking is the best method to break up soil pieces and level the soil.
3. Irrigate the soil to allow settling. A well-timed rain shower will also work as irrigation.
4. Roll the soil before using your chosen planting method.

Hands-On Horticulture

Turf Soil Testing Protocol

Contact your local cooperative extension service agent for specifics regarding soil testing in your state, the materials needed to submit an application, and any costs associated with this service. In general, follow these procedures in taking a soil sample for analysis:

1. Gather a clean trowel, a ruler, and a clean plastic bucket.
2. Sample your site in 15 to 20 spots. Avoid any spots that look as if they do not represent the sample as a whole (where there is standing water or no vegetation, for example).
3. Take one-half cup of soil from a depth of about 4″ (10.1 cm) from each sample spot.
4. Combine all the samples together and mix thoroughly.

sharon kingston/Shutterstock.com

5. Send approximately one pint of the soil mixture in for soil testing. Often, your cooperative extension service agent will supply a specific bag or box for the sample, along with a sample information sheet.

Fertilization

A soil test will help determine exactly how much fertilizer to add to a site for turf establishment. General recommendations for fertilizer applications before planting can be used, but they are not nearly as accurate and can lead to cultural problems in turf establishment. If no soil test was done, follow these guidelines:

- Add limestone or sulfur according to the suggested rate per 1000 ft^2.
- Apply a starter fertilizer (higher in phosphorus). The second number of the fertilizer NPK (nitrogen, phosphorus, potassium) analysis denotes the percentage of phosphorus.

Nitrogen promotes green growth and color, phosphorus promotes rooting, and potassium enhances vigor and overall hardiness.

Examples of common starter fertilizer percentages are 5-10-10, 10-20-20, or 18-24-6.

Planting Methods

Determining which method to use to establish a lawn or turf site requires thought and planning. Once you have chosen a turf that is well suited for your site, you can then select a planting method based on the availability of that turf species.

Seeding

Purchase top-quality seed to avoid future problems with turf establishment. Select a seed or ***seed blend*** (a mixture of various cultivars of grass seed) based on the information on the seed bag. Be sure the grass seed is free of noxious weeds, contains low percentages of other grass seed, and is a certified seed (indicated with a blue tag). The blue certified tag indicates that the seeds meet established industry standards and have been analyzed to ensure seed purity.

To successfully sow grass in a seed bed (a site prepared for starting turf), follow these steps:

1. Determine the amount of seed that is required for the area.
2. Use a seed spreader to apply one-half of the grass seed, working in one direction. A ***seed spreader*** is a tool that distributes seeds on a prepared area, **Figure 28-13**. The spreader uniformly distributes seeds or other granular materials.
3. Apply the remaining grass seed perpendicular to the first pass.
4. Lightly cover the seed by gently raking or dragging the soil with a mat or chain-link fence panel.
5. Roll the soil to ensure contact between soil particles and the seed.
6. Mulch the seed with straw. Use one bale per 1000 ft^2 for warm-season grasses and one bale per 2000 ft^2 square for cool-season grasses. This helps to retain moisture, insulate the seeds, and prevent erosion.
7. Roll the mulch.
8. Irrigate gently. Ensure that the soil remains moist at all times through germination and until maintenance begins.

pryzmat/Shutterstock.com

Figure 28-13. Seeds can be planted using a seed spreader.

Corner Question

What is straw?

Sodding

Sodding is using strips of turf grown at another site and transplanting that grass to the current site. This produces an instant lawn. Purchase sod that is certified and grown by reputable grower. Install sod on the site as soon as possible after harvesting. Follow these steps for sod installation:

1. Thoroughly moisten the area where the sod will be laid.
2. If the sod cannot be installed within 24 hours of receiving it, it should be unstacked, unrolled, placed in the shade, and watered.
3. Start sodding along a straight edge (sidewalk or driveway) and stagger the strips in a brick-like pattern, **Figure 28-14**.
4. Use a knife to trim pieces to fit. Lay sod lengthwise across slopes.
5. Roll the lawn after all pieces are transplanted to ensure soil contact.
6. Irrigate gently and keep evenly moist until the sod is well established and the sod cannot be pulled up.

Vadim Nikolaevitch/Shutterstock.com

Figure 28-14. Sod is installed by placing strips in a brick-like pattern.

Plugging and Sprigging

Some species of warm-season grasses do not produce viable (live) seed or are sterile. In such cases, plants must be used to establish turf. Laying sod is expensive. Less costly alternatives are plugging and sprigging. In plugging, mature pieces, or plugs, of sod are planted in the soil. Pieces are normally about 2″ (50.8 cm) or larger and planted on 6″–12″ (15.2 cm–30.4 cm) centers.

Sprigging involves broadcasting pieces of grass (cut stems) over an entire area. The sprigs are then pressed into the soil 1″ (2.5 cm) deep by hand or roller. Three to five bushels of sprigs are required for every 1000 ft^2 for minimal coverage, or 5–10 bushels per 1000 ft^2 for rapid establishment.

Irrigation

One of the most important factors when establishing plant material of any type is irrigation. The top 2″ (50.8 cm) of soil must remain constantly when establishing turf. To ensure this, lightly water the area two to three times a day for the first month.

As the turf establishes itself and plants develop roots, they require less frequent, but deeper watering. After the third mowing, water to a depth of 8″ (20.3 cm) about once a week or when the turf shows signs of water stress (change in color). Most turf needs an average of 1″ (2.5 cm) of rain a week or supplemental irrigation to equal that amount, **Figure 28-15.**

topseller/Shutterstock.com

Figure 28-15. Most turf requires at least 1″ (2.5 cm) of rain or irrigation per week to maintain active growth.

This general rule depends on the water-holding capacity of the soil and surrounding environmental conditions. Determine when, how much, and whether to water depending on the established turf's needs.

Corner Question

How much water does one leaky hose spigot waste each year?

Mowing

Once grass height is 50% higher than the preferred height, begin mowing. For example, when Kentucky bluegrass reaches 3″ (7.6 cm) in height, it is mowed to a height of 2″ (5 cm). The amount of mowing needed depends on the quantity of turf growth. Growth depends on temperature, moisture, fertility, the rate of growth for a species, and time. In general, however, turf should be mowed when the leaf surface is 50% higher than the suggested mowing height.

Mowing safety is a serious concern. Follow a few simple rules to maintain your safety.

- Use a well-maintained mower and check all safety features before operating.
- Use a lawn mower with a sharp, balanced blade.
- Mow when grass is dry to prevent slipping or spreading turf disease.
- If clippings are heavy enough to shade grass, bag the clippings or rake and remove them from the lawn. Otherwise, leave grass clippings on the turf to decompose and release vital nutrients needed for soil and plant health, **Figure 28-16**.

danyimages/Shutterstock.com

Figure 28-16. Mow turf safely by following safety protocols.

Thinking Green

Lawn Mowers

Every sunny weekend that turf is growing, approximately 54 million people in the United States mow their lawns. The EPA estimates that a gas-powered lawn mower emits as much pollution as eleven new cars being driven for one hour each. What can be done to keep grass manicured without polluting the air?

Electric lawn mowers use electricity as their fuel source, creating less pollution during operation than gas mowers. Electric mowers are quiet, and do not need oil changes or tune-ups. Remember, however, that the electricity needed is generated by burning fossil fuels or natural resources, which creates air pollution.

Ints Vikmanis/Shutterstock.com

A reasonable environmental solution for mowing is a manual lawn mower. This mower allows you to be the engine and the power behind the machine, unlike gas or electric mowers. Only your energy is expended, and no air pollution is created.

Integrated Pest Management for Lawns

Establishing new turf will require some pest management. Before planting turf, weeds must be removed and any pests that live in the soil, such as voles and moles, must be removed. Prevention is always easier than treatment. Proper pest identification is essential to management. Follow these strategies for integrated pest management (IPM):

- Scout for weeds and pests. Look in the soil and surrounding area for perennial and annual weeds. Determine if there are animals dwelling in the soil that might cause problems. Check for grubs in the soil that will later emerge as beetles.
- Use cultural mechanisms to prevent problems. Use weed-free seed or vegetative sources. Clean the soil. Remove any areas where pests can breed or live.
- Create mechanisms to trap pests. Use traps for insects, animals, and other pests that can impact developing turfgrass.
- Use natural barriers. Find or establish trees that could screen your site from others that could contaminate the location.
- Use biological controls to combat pests such as voles and moles, **Figure 28-17.**
- Use chemicals only when necessary. Whether you are considering a fungicide, herbicide, insecticide, or other chemical, use it only as a last resort. Try to use organic chemicals first and then apply other chemicals when all other methods of IPM have been exhausted. Follow all chemical labels when applying any pesticide.

Jeanie333/Shutterstock.com

Figure 28-17. Dirt mounds indicate a mole infestation in this lawn.

Thinking Green

Organic Weed Control

Weeds are best controlled through prevention before they grow. Pre-emergent herbicides contain chemicals that prevent weed seeds (or any seed) from germinating. One organic product that has been used with some success on smaller lawns is corn gluten meal, an organic herbicide. This material not only inhibits weed growth, it also acts as a soil amendment. Application timing is critical. Corn gluten must be applied just before seedlings emerge. While it is a pre-emergent, it works to actually prevent the seedling (just after it emerges from the seed coat) from being able to grow by dehydrating the roots. To achieve good results, this product must be applied at a rate of 20 pounds per 1000 ft^2.

Nika Novak/Shutterstock.com

That is a lot of corn gluten meal for an acre (43,560 ft^2). How much corn gluten meal would be required for one football field?

AgEd Connection

Equipment and Supplies Identification

As part of a career development event, students must identify materials and equipment used in the industry. The tools and materials may be presented physically or as photographs. Use the e-flashcards on your textbook's student companion website at www.g-wlearning.com/agriculture to help you study.

Turf Maintenance

A lawn enters the maintenance lifecycle when it has been mowed at least three times. At this point, the lawn is considered established, and it enters a new phase of its life. During the maintenance phase, irrigation, fertilization, mowing, aeration, thatch control, and pest management are important for healthy turf.

Irrigation

Many growers need turf that is drought tolerant. Ordinances and legislation often do not permit unlimited use of water. Growers of turfgrass must be water wise and conserve this resource. Turfgrass should not be watered haphazardly. Indiscriminate watering leads to problems with fungus, fertilization, and other cultivation issues.

When to Irrigate

Turfgrass should not be irrigated on a set schedule. A stand of grass should only be watered when a significant portion of the lawn exhibits signs of moisture stress, **Figure 28-18**. ***Moisture stress*** is a condition caused by lack of water. Signs of the condition include changing leaf blade color; wilted, folded, or curled leaf tips; or depression marks that remain in the turf from foot traffic.

komkrit Preechachanwate/Shutterstock.com

Figure 28-18. Moisture stress can lead to permanent injury to turf.

To properly irrigate turfgrass, follow these guidelines:

- Water in the early morning. This will reduce the amount of time that water will stand on the grass and can reduce disease risk. Water will not be wasted to immediate evaporation (as it would be during a hot afternoon).
- Use overhead irrigation with oscillating or rotating sprinkler heads for best delivery.
- Monitor the site to ensure that sprinkler heads are only irrigating turf and not any other surfaces. Be sure that heads are not unevenly watering the site.

Darryl Brooks/Shutterstock.com

Figure 28-19. Place a rain gauge near a sprinkler head to measure the amount of water being applied.

How Much to Irrigate

Turf requires about an inch of water per week. It is best not to apply that amount all at once, however. Follow these guidelines for irrigation:

- Measure the amount of water being delivered to an area. Deliver 0.5″ (1.27 cm) of water every four days in most cases. Use a rain gauge to measure water, **Figure 28-19**. Most soils cannot absorb more than 0.5″ (1.2 cm) of water per hour.
- Water turf to a depth of 8″ to encourage deep root growth.
- If watering cool-season grasses in summer, slowly reduce water to coax the turf into dormancy. Allow drought symptoms to appear between infrequent irrigation cycles. During dormancy, reduce fertilization and mowing as well.
- Water a dormant cool-season lawn about 0.25″ (0.6 cm) every three weeks to keep it alive during summer months. When cool temperatures return in the fall, irrigate or allow rain to irrigate the site to help promote new growth.

Fertilization

Following soil test recommendations prevents unnecessary fertilizer application. Responsible turfgrass growers realize the importance of using fertilizers in a sustainable and sensible manner. No single fertilizer application program is suited for all forms of turfgrass cultivation.

Conduct soil tests at least every other year to determine the amount of nitrogen, phosphorus, potassium and lime or sulfur to add. If a soil test is not done, use a complete fertilizer with ratios such as 4:1:2, but this is a weak alternative. An example of a complete fertilizer is one with a nutrient analysis of 16-4-8.

Nitrogen in Turfgrass

Nitrogen comes in several forms. It is important to recognize how quickly the nitrogen is released into the soil and under what conditions. Improper application of a nitrogen fertilizer can be detrimental to turf and the environment. In some cases, improper applications can be irreparable, requiring installation of new turf as a replacement.

Thinking Green

Subsurface Drip

Subsurface irrigation conserves water and produces healthy turf. A newly introduced system contains a drip pipe with patented copper material inside that prevents roots from growing into the drip lines. The drip pipe is installed 6″–12″ (15.2 cm–30.4 cm) apart in the lines. The drip lines are then fed into a feeder line that supplies the water. The drip lines water the roots below the surface. This reduces runoff, evaporation, and water consumption. This irrigation is initially expensive and labor intensive, but it produces healthy turf that requires much less water.

Quick-release sources of nitrogen are also called fast acting, soluble, or quickly or readily available. These fertilizers concentrations of nitrogen range from 11% to 46%. They are less expensive than slow-release fertilizers, react readily with water, and produce rapid turf greening. Frequent applications at low concentrations will prevent the grass from burning. Water the fertilizer in immediately after application to prevent volatilization of nitrogen into ammonia. ***Volatilization*** is a process in which fertilizer components change from a solid to a vapor and are released into the atmosphere. The forms of this fertilizer include urea, nitrate, and ammonium.

Slow-release sources of nitrogen are called controlled release, slowly available, or insoluble. They provide a longer, slower release of nitrogen and are less likely to burn grass. They are also less likely to leach into groundwater. Slow-release nutrient sources are expensive and less effective than other types. They include organic sources, polymer, and sulfur-coated fertilizer.

"Failure is the fertilizer for success."
—Dennis Waitley

Phosphorus in Turfgrass

Phosphorus helps promote a healthy root system and seed production. Recently, there has been an effort to limit phosphorus because there is concern that this nutrient impairs water health. Avoid applying this nutrient near water sources or where runoff can occur.

When a plant is phosphorus deficient, leaf blades usually appear purple. Phosphorus is very immobile in soils and can take months to move just a couple of inches. Phosphorus sources include superphosphate (treating rock phosphate with acids) and bone meal (harvested from animal bones).

Did You Know?

Nitrogen is the fifth most abundant element in the universe.

Potassium in Turfgrass

Potassium is responsible for several physiological processes in plants, which contributes to plant hardiness and vigor. Potassium deficient plants are sensitive to drought, cold temperatures, and disease.

Introduce potassium to turf using inorganic or natural organic fertilizers. The potassium in fertilizer comes mostly from inorganic sources including muriate of potash (potassium chloride) and sulfate of potash (potassium sulfate). These fertilizers are water-soluble. Unlike phosphorus, potassium is not considered to be a major contributor to water pollution.

Fertilizer Formulations and Programs

No single fertilizer formulation or program is ideal for all settings. Lawns, athletic fields, and golf courses all have their own specific objectives for turf growth, **Figure 28-20**. In addition, fertilizer needs and applications depend on the type of grass that is grown, soil conditions, time of year fertilizer is applied, and location in the United States. Turfgrass species differ in the amount of fertilizer, especially nitrogen fertilizer, that is required for optimum performance. This makes creating a general plan for a fertilizer program nearly impossible. Check with your cooperative extension agency or state land-grant university for specific information for the types of grass and soils in your region.

Bochkarev Photography/Shutterstock.com

Figure 28-20. Fertilizer formulations and programs vary. Check with your local cooperative extension service to find specific information regarding fertilizer application for your region.

Kitch Bain/Shutterstock.com

Figure 28-21. A reel mower uses scissor-like action to mow grass.

Mowing

Most mowing is done using rotary (centrifugal) or reel (cylinder) mowers. A ***rotary mower*** is a piece of equipment that uses a blade that cuts grass by sucking and tearing the grass blade. Think of a helicopter blade. That is the same action used to cut turfgrass with a rotary mower. A ***reel mower*** is a piece of equipment that uses scissor-like action to cut grass blades, **Figure 28-21**. These mowers are best suited for grasses that will be cut to less than 1″ (2.5 cm).

Follow these simple mowing operation tips for a better cutting experience and healthy turf:

- Never mow wet grass.
- Mow only when needed. Mow when the grass is 50% taller than the desired height (usually weekly or biweekly during peak season).
- If the lawn is too high, meaning you will remove more than 50% of the leaf blades, cut off one-fourth to one-half of the present growth. Mow again to the proper height in one or two days.
- Mow across slopes, never up and down slopes.
- Do not mow slopes greater than 15% using a push mower or 20% using a riding lawn mower.
- Mow in one direction and then mow perpendicular to that direction the next time you mow. This prevents compaction and makes the turf appear more even.

Safety Note

Mower Safety and Maintenance

Mower safety and maintenance work hand in hand. Paying close attention to both will ensure easier mower operation.

- Read the owner's manual before operating.
- Always shut off the lawn mower when not actively mowing.
- Wear the proper personal protective equipment (PPE): goggles, sun protection, insect repellent, tightly laced (close-toed) shoes, and appropriate, fitted clothing.
- Watch for obstacles.
- Disconnect spark plug before servicing the lawn mower.
- Keep mower blades sharp.
- Balance the blades. Dull and unbalanced blades will reduce the quality of the cut and can lead to jagged ends. Damaged grass blades create sites for disease to enter the turf.
- Mow away from the cord when using an electric lawn mower.
- Do not operate blades while going over gravel or pavement.
- Do not spray cold water on a hot engine.
- Never leave a mower unattended when the engine is running.

Corner Question

What is the largest mower on the planet?

- Leave short grass clippings on the lawn to decompose. These clippings place valuable nutrients back into the soil, **Figure 28-22**.
- If grass clippings are long and will shade the grass beneath, remove the clippings.

Collected grass clippings can be placed in gardens, around trees, or added to compost piles. Yard waste accounts for 20% of the waste in the landfills. Composting your yard waste rather than putting it out for trash collection will keep it out of landfills. Contact your cooperative extension service agent for other ideas about how to use yard waste.

Tony Campbell/Shutterstock.com

Figure 28-22. Leaving grass clippings on turf puts nitrogen back into the soil, increases microbial activity, and amends the soil structure.

Aeration

Compaction-prone soils and high-traffic turf areas should be aerated. The process of aeration (also referred to as plugging or coring) is done using a machine that pulls out cores or plugs of soil. The holes left in the soil allow air to penetrate into the root zone of the turf.

Aeration is done during active growth when turf can quickly recover from the process. Aerate cool-season grasses in fall or early spring. Aerate warm-season grasses in late spring or early summer. Rent an aerating machine to do the work yourself or hire a landscaping or turf maintenance company to do the job for you.

Thatch Control

Thatch is a layer of dead grass and organic material that forms a mat beneath leaf blades and above the root zone. Some thatch is beneficial; it can help retain moisture and add nutrients to the soil. Too much thatch can prevent water penetration and proper air exchange with roots. Excess thatch can also be a breeding site for pests.

Verticutting is a method of thatch control done by a machine that slices into thatch layers to create space for water penetration and air exchange. This process is also called power raking. Some grasses produce a great deal of thatch, which is desirable on athletic fields. Thatch can help prevent injury when athletes fall to the ground.

Thinking Green

Keep Mower Blades Sharp

Sharp mower blades are beneficial for the mowing equipment, the operator, and the environment. Sharpened blades reduce vibration and noise and lengthen the mower's life. This makes operation easier for the person mowing the grass. In addition, keeping blades sharp can reduce fuel consumption by as much as 22%.

Corner Question

How many times per year is a putting green aerated on newly installed sod?

Need credit line from author

Figure 28-23. A verticutter slices into the thatch and helps to prevent thatch buildup.

Thatch that exceeds 0.75″ (1.9 cm) should be power raked or cored. Verticut warm-season grasses during the spring. Specialized equipment can be rented for this job, **Figure 28-23**, or you can hire a landscaping company to do the work.

Other methods to help prevent and control thatch include:

- Reduce fertilizer applications.
- Monitor and adjust the pH with lime or sulfur applications.
- Mow only when needed.
- Make sure clippings are decomposing. If thatch is building up, collect clippings and compost elsewhere (other than on the turf site).

Integrated Pest Management for Turf

Practices used during turf establishment for integrated pest management (IPM) should be continued once the turf is established. The IPM program should include these activities:

- Scout for pests, such as insects, diseases (fungus, bacteria, virus, and parasites), weeds, and living organisms (moles, voles, woodchucks, gophers, and slugs).
- Correctly identify pests.
- Determine your threshold for the pest.
- Choose a method of control.
- Evaluate the results.

Prevention is always better than treating a pest in the IPM process. To help prevent pest problems, properly cultivate the site, select turf appropriate for the site, apply but do not overuse fertilizers, apply appropriate pH adjustments, prevent excessive thatch buildup, use best mowing techniques, and use precision irrigation.

Thinking Green

Herbicides

Weeds can become an issue in any garden or turfgrass site. Trying to prevent weeds is a good practice but weed control will most likely become necessary. An ***herbicide*** is a chemical that will kill a plant. A post-emergent herbicide is applied after weeds have emerged. Non-selective herbicides kill all plant material. Selective herbicides target and kill specific plants.

One selective herbicide is the chemical 2, 4-D. This chemical kills broadleaf plants (those with intersecting veins) but will not harm grasses. 2, 4-D can be used on fescue, zoysia, or bluegrass turf. Plants such as dandelions will be killed, but the grass will not be harmed.

Carefully research, select, and apply herbicides according to label directions. The label of a pesticide contains important warnings and use instructions that should not be overlooked. The person who applies a pesticide is responsible for any harmful effects caused by the application.

Turf Renovation

There are times when turf renovation is necessary. A newly planted lawn may not work out as planned, **Figure 28-24**. Maybe the school football field has become uneven and dangerous for players. These situations will require turfgrass renovation.

komkrit Preechachanwate/Shutterstock.com

Figure 28-24. Conduct a thorough inspection and analysis of failed turf to determine the cause before spending additional time or resources on renovation.

Turf Failure

There are several common mistakes or problems that create turf problems. Before the turf can be renovated, the underlying cause of the failure must be identified. Possible causes for turf failure include:

- The wrong species or variety of turf was selected for the site. For example, a nondurable species was planted in a high-traffic area.
- Poor establishment procedures were used.
- Improper mowing, fertilization, irrigation, or other management techniques were used.
- Excessive thatch buildup occurred.
- The turf was infested with pests, such as weeds, insects, or diseases.

After identifying the underlying cause of the turf failure, create and enact a plan to deal with the issues.

"I have not failed. I have just found 10,000 ways that will not work."
—Thomas Edison

When to Renovate

Renovation timing depends on the type of turfgrass that is grown. Cool-season grasses should be renovated in the late summer to early fall. Warm-season grasses should be renovated between late spring and early summer. Trying to renovate at times that are not suited for the turf can make repair difficult.

Pests and Turf Renovation

Pests are a leading causes of turf failure. Pests must be controlled before a lawn can be renovated. Common pests include weeds, insects, or diseases.

Weeds

Weeds (unwanted plants growing in a space) steal nutrients, space, water, and light from turfgrass. Methods for controlling weeds include:

- Hand pulling.
- Using pre-emergent herbicides (applied before the weeds emerge) to prevent new weeds.
- Using selective or nonselective post-emergent herbicides to kill existing weeds.
- Using organic methods such as flaming, solar sterilization (using clear plastic to heat the site), or the use of goats or sheep for grazing.

Most often, a site that will be renovated will be seeded. In this case, pre-emergent herbicides cannot be used as this will prevent the turf seed from germinating.

Corner Question

What percentage of all plants is considered weeds?

Post-emergent herbicides can control annual and perennial weeds. Most herbicides should be applied four to six weeks before using additional renovation techniques. Some sites are so weed infested that the entire area should be sprayed with a nonselective herbicide to kill everything on the site, including turf. More than one application of herbicide may be needed to kill stubborn weeds. Wait at least seven days or as directed by the herbicide label to observe results before respraying. Young weeds are always easier to control than mature weeds (with flowers or seeds). Carefully read all label information before applying herbicides for the best results. Always follow labeled safety directions to comply with legal use of the product.

Insects

Insects can completely destroy turfgrass. White grubs attack roots, and caterpillars eat the leaf blades, **Figure 28-25**. Depending on the insect, IPM can be used to control the pest. Biological controls, such as a bacteria known as Bacillus thuringiensis, work well against caterpillars and grubs. Organic and synthetic chemicals can be applied to targeted pests with good results when used correctly. Growers should apply chemicals when pests are most susceptible, select the least dangerous chemical, and follow the chemical label.

Stephen Farhall/Shutterstock.com

Figure 28-25. Grubs are larvae of various beetles. They live below the turf and eat the roots.

Diseases

Diseases, often fungi, plague many turf sites, **Figure 28-26**. Brown patch, dollar spot, and pythium can stress turf and lead to death. Proper cultivation techniques, such as reducing nitrogen applications, can help prevent disease infestations. Fungicides applications may also help. Apply them according to chemical label instructions. Pay attention to environmental conditions and spray rates before and during application.

Damian Herde/Shutterstock.com

Figure 28-26. Various fungi can grow on turf and cause significant growth problems.

Seeding

Prepare the site properly before planting turf seed. Follow these steps:

1. Remove weeds in and around the turf site. An easy method for removal is to mow on the lowest setting and collect all clippings.
2. Remove thatch so that the soil is exposed. Use rakes, hoes, or power equipment such as a dethatcher. This reduces competition and allows good light penetration to emerging seeds.
3. Prepare the soil, including proper lime, sulfur, and fertilizer application. Apply nutrients and lime or sulfur based on soil test results. Apply evenly over turf site.
4. Loosen 4″–6″ (10.1 cm to 15.2 cm) of soil with a rake, hoe, or cultivator. Fill in low areas with existing soil or a topsoil blend. Smooth out soil and ensure that the soil aggregates are no larger than a marble. On large sites, use an aerator to bring cores to the surface. Allow the cores to dry, pulverize them with a mower, and then rake flat.

STEM Connection Overseeding

In some regions, such as the warm-season grass zones, turf growers may choose to overseed during the dormant season. ***Overseeding*** is sowing grass seed over the thatch of dormant grass. The overseeded grass grows up through the brown, dormant grass, providing color in the cooler months. When the temperatures begin to climb in the spring, the overseeded grass begins to die back and the dormant, warm-season grass replaces it.

Small bare spots less than 6″ (15.2 cm) in diameter do not need to be replanted. Instead, repair these spots using proper cultivation techniques, including fertilizer application, irrigation, and pest management.

Reseed bare spots larger than 6″ (15.2 cm). This is known as ***spot seeding***. To renovate large barren areas, follow the same procedures used for establishing turf from seed.

If you do not want to do the project by hand, use a power rake or vertical slicer. These devices slice into the ground and allow air and water to penetrate the soil. A slit seeder can also be used to ensure soil to seed contact. A ***slit seeder*** is a device that creates a slit in the thatch and root zone while also planting seed.

Plugging

A turf with rhizomatous or stoloniferous growth habits can be renovated using plugs that contain turf and some soil with roots. Place the plugs on 6″ or 12″ (15.2 or 30.4 cm) centers. Collect plugs from healthy areas and place in bare areas using a shovel or a ***plugging device*** (equipment that pulls pieces of leaf, stem, and root material from the turf).

Sprigging

Areas greater than 15,000 ft^2 that already have rhizomatous or stoloniferous grass in place can be sprigged to fill in bare areas. Spread sprigs (containing the rhizome or stolon for the selected turf) over the surface of a well-prepared site. The sprig should be inserted into the soil at least 0.5″–1″ (1.2 cm —2.5 cm) deep. Roll the site until to ensure good contact between the rhizome or stolon and the soil.

After Care

After turf has been renovated, the principles of good plant management must take place. These management activities involve irrigation, fertilization, and mowing.

Irrigation

Lightly water renovated turf several times a day. As the turf grows, reduce irrigation frequency but increase irrigation time. The goal is to create deep and vigorous root systems. Keep soil constantly moist through the third mowing. After the third mowing, irrigate two to three times a week until the soil is saturated to at least 6″ (15.2 cm) in depth.

"The grass may look greener on the other side of the fence, but when you get there it is usually artificial turf."
—Author Unknown

Did You Know?

Turf used for the forty-ninth Super Bowl® in Phoenix, Arizona, was grown in Alabama and then shipped to the University of Phoenix Stadium. The turf was shipped on 33 refrigerated trucks for three days, and then crews from 30 stadiums joined efforts to install the turf.

Thinking Green

Hydromulch

The USDA's Agricultural Research Service (ARS) constantly works to improve techniques and practices to improve soil conservation. One soil conservation method is growing grass in bare areas. Hydromulch is a material that is a mixture of seed, mulch, water, binding ingredients, and other materials. This slurry mixture is sprayed over the bare soil, and grass begins to grow. The ARS tests materials that can help make this method less expensive and more successful.

USDA Agricultural Research Service (ARS)

Fertilization

Warm-season and cool-season grasses require fertilizer of different quantities at different times of the year. The type of grass also determines how much fertilizer is applied. Contact your local cooperative extension service agent or land-grant university for guidelines on fertilizer applications. These organizations have done extensive research about proper and sustainable fertilizer applications for optimum plant growth.

Mowing

Follow the safety operation and maintenance guidelines given earlier in the chapter. Continue to mow existing turf on the renovated site. For newly planted seed or vegetative structures, mow when leaf blade height is 50% more than ideal height.

Careers

Many careers in the turfgrass industry include turf maintenance or equipment operation, but other careers are available in the turfgrass industry. Some of these careers include sod sales associate, sports turf manager, and turfgrass breeder.

Sod Sales Associate

Sod sales associates work for sod growers. They help customers choose products. A sales associate for a sod company must be well informed about the product and all its characteristics. Customers depend on the sales associate to know about the product, from where it can be grown to price and installation information. Sod sales associates must be able to work with both expert and novice horticulturists. In addition, the associate must be friendly and organized.

Sod sales associates need a high school diploma or associate degree, but a four-year degree in an agriculture-related field is preferred. An emphasis in turfgrass education also is beneficial.

Sports Turf Manager

Turf is the centerpiece for many sports. It must be installed, established, and maintained according to specifications. Sports turf can be found everywhere in the United States.

Sports turf managers work with their crews to ensure that turf is irrigated, fertilized, aerated, and mowed. Paint is also sometimes applied to fields based on rules and for team logos and branding requirements, **Figure 28-27**. Sports turf managers must have experience in athletic field management. They must pay attention to detail, work well with others, and be willing to work at various days and times of the years.

Sports turf management positions require a college degree in an agriculture-related field, typically turfgrass management. In addition to the educational requirements, many sports turf managers have work experience gained through internships. Internship opportunities provide job seekers with a competitive edge over other applicants.

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Figure 28-27. A sports turf manager's duties can include painting the turf before an athletic

Career Connection

Dr. Melodee Fraser

Turfgrass Breeder

Dr. Melodee Fraser was raised in a family of turf lovers. Her father was a superintendent of a golf course in Indiana, and all of his children are currently employed in the turfgrass industry. Dr. Fraser went to Mississippi State University (MSU) and was the first woman to graduate with a turfgrass management degree. Originally, Dr. Fraser wanted to work as a golf course superintendent like her father, but her passion for science and analysis changed her focus to scientific inquiry. She continued her studies at Rutgers University where her research focused on turfgrass breeding. ***Turfgrass breeding*** involves selecting plants with desirable traits and combining them to develop improved cultivars.

Dr. Fraser was hired by Pure Seed Testing of Oregon to open a southeastern research station in Rolesville, North Carolina. She breeds grasses to resist brown patch disease. Once she and her team select improved varieties, the company licenses the new varieties to other seed companies that then grow, harvest, and sell the licensed seeds.

Jodi Riedel/Goodheart-Willcox Publisher

Her focus is to breed turfgrass that requires the least maintenance. The ideal turfgrass requires fewer fertilizer, irrigation, and pesticide applications, making it more sustainable. Water scarcity, water salinity (of irrigation or at coastal sites), and legislative limitations on chemical availability provide challenges for turf breeders at Pure Seed Testing.

Dr. Fraser feels rewarded by her work breeding turfgrass. Technological advances, such as computer software that analyses digital images of turf, increases the objectivity of trial evaluations and keeps her work fresh. She enjoys new and ongoing experiments involving turfgrass. She also has the opportunity to travel the world, working with a wonderful group of turfgrass professionals.

CHAPTER 28

Review and Assessment

Chapter Summary

- The turfgrass industry consists of businesses that grow seeds, sods, and grasses for homes, commercial spaces, utility uses, and sports uses. The use of turfgrass provides benefits that are helpful to people and the environment, such as reduced noise pollution and soil erosion.
- Turf growers should use sustainable practices. Excessive use of water, fertilizer, and pesticides is harmful to the environment.
- There are four main applications or uses for turf: lawns, golf courses, utility turf, and sports turf. Sod and seed production are also part of this industry. Companies that provide pesticide, fertilizer, irrigation, equipment, and information technology are associated with the turfgrass industry.
- Turfgrass has unique, identifying characteristics. These characteristics include specific traits regarding the leaf, roots, stem, flower, seedhead, and growth habit.
- Warm-season grasses and cool-season grasses are best suited for specific growing zones.
- To establish a lawn, the appropriate turf must be selected, the site must be prepared, the soil conditioned, the turf planted, irrigation operated, fertilizer applied, and pest management employed. Proper mowing is also important.
- The method for establishing turf depends on the grass selected and the site. A lawn can be established using seeding, sodding, or plugging. Follow soil test results to determine the amount fertilizer to add to a site for turf establishment.
- Turfgrass must be maintained. During the maintenance phase, irrigation, fertilization, mowing, aeration, thatch control, and pest management are important for healthy turf.
- Turfgrass managers can choose a number of methods to renovate a lawn. These methods include clearing all plant material from the site or reestablishing turf in bare patches. The first step is to identify the reason for the turf's distress and then act accordingly to replant or replace turf to the site.
- The turfgrass industry offers careers in installation, maintenance, sales, and planning. Three careers related to the turfgrass industry are turfgrass breeder, sod sales associate, and sports turf manager.

Words to Know

Match the key terms from the chapter to the correct definition.

A. auricle	H. plugging device	O. sports turf	V. turfgrass industry
B. blade	I. reel mower	P. spot seeding	W. utility turf
C. collar	J. rotary mower	Q. thatch	X. vernation
D. lawn	K. seed blend	R. tiller	Y. verticutting
E. ligule	L. seed spreader	S. transition zone	Z. volatilization
F. moisture stress	M. seedhead	T. turfgrass	
G. overseeding	N. slit seeder	U. turf breeding	

1. A method of thatch control done by a machine that slices into thatch layers to create space for water penetration and air exchange.
2. Selecting plants with desirable traits and combining them to develop improved cultivars.
3. Businesses that grow seeds, sods, and grasses for recreational areas, homes, and commercial, utility, and sports uses.
4. A layer of dead grass and organic matter that forms a mat beneath leaf blades and above the root zone.
5. A condition in turfgrass caused by lack of water.
6. Sowing grass seed over the thatch of dormant grass.
7. A small, claw-like appendage that projects from the collar of a grass blade.
8. The flat, leaf part of the grass.
9. A piece of equipment that uses a blade that cuts grass by sucking and tearing the grass blades.
10. A device that creates a slit in the thatch and root zone while also planting seed.
11. A stem that develops from the crown of the parent plant and grows upward within the enclosing leaf sheath.
12. A process in which fertilizer components change from a solid to a vapor and are released into the atmosphere.
13. Grass that is used for spaces such as roads, airports, and parks.
14. The arrangement of leaves within the bud.
15. A piece of equipment that uses scissor-like action to cut grass blades.
16. Equipment that pulls pieces of leaf, stem, and root material from the turf.
17. An expanse of turfgrass that is used for recreation or beauty.
18. The band at the backside of a leaf where the leaf blade and sheath meet.
19. A tool that places seeds in an area.
20. A mixture of various cultivars of grass seed.
21. A thin structure that clasps the top of the leaf sheath.
22. Grass that is used for recreation and competitive sports purposes.
23. The cluster of seeds within a plant's inflorescence.
24. Reseeding bare spots larger than 6″ (15.2 cm).
25. Grass and the surface layer of soil held together by the grass roots.
26. A growing area that can grow both warm-season and cool-season grasses.

Know and Understand

Answer the following questions using the information provided in this chapter.

1. What do businesses in the turfgrass industry produce and how much does this industry contribute to the US economy?
2. What percent of the turf area in the United States is for lawns and what are the other uses of turf?
3. What are some benefits of turf for people and for the environment?
4. What are some unique characteristics of turfgrass that separate it from other plants?
5. List the unique morphological structures of grasses that can be used to identify them.
6. Describe the three shapes that a grass leaf blade may have.
7. Describe the three growth habits of turfgrasses.
8. How are warm-season grasses affected if they are grown in an area where temperatures are too cold?
9. Name four grasses suitable for the transition zone.
10. When is the best time of year to establish a lawn with cool-season grasses and what are two methods used?
11. Why should a grower use certified seed for establishing a lawn?
12. Describe how to establish a lawn using sod.
13. What steps must be taken to prepare a site for turf planting?
14. Why should growers do a soil test before installing turf?
15. What procedures should be followed in taking a soil sample for analysis?
16. What is the general rule for watering established turf?
17. What are some integrated pest management strategies used to benefit turf growth?
18. What activities are important for turfgrass sites during the maintenance phase?
19. Why is there no single fertilizer formulation program that is suitable for all settings?
20. What personal protective equipment should be worn when operating a lawn mower?
21. What are some common pests that may be a problem in managing turfgrass sites?
22. What are some possible causes of turf failure that may make renovation necessary?

Thinking Critically

1. You are driving through your neighborhood and see someone applying a chemical to a lawn while it is raining. What would you do?
2. It is not a good idea to leave gas in small-engine equipment, such as mowers, for more than 30 days. What should you do at the end of a season if your mower still has gas in the tank?

STEM and Academic Activities

1. **Math.** Your school wants to apply a pre-emergent herbicide to prevent weeds from growing, and they have heard that corn gluten meal is an organic option. Corn gluten meal requires an application of 20 pounds per 1000 ft^2. How much will need to be applied to a football field that is nearly one acre with the end zones? How much will this cost if corn gluten meal is $12 for 5 pounds?

2. **Math.** You recently received the soil test results from your cooperative extension service agent. The results indicate that your lawn is lacking nitrogen. The suggested application rate is 1 lb of nitrogen per acre. Your yard is one-half acre. How much nitrogen must you apply? If you have a 50-pound bag of 12-4-8 fertilizer, how many pounds of this fertilizer will you need to apply to your entire lawn?
3. **Engineering.** Design an irrigation system that could be used on a football field.
4. **Social Science** Contact a local golf course or sports turf site and schedule a visit. Create a video of your visit. Ask employees at the site how they practice sustainability and integrated pest management. Create your own list of questions to ask as well.
5. **Language Arts.** Write a one-page response to someone who believes that turfgrass is responsible for your area's water pollution. Be sure to support your response with facts.

Communicating about Horticulture

1. **Speaking and Listening.** Divide into groups of four or five students. Each group should choose one the following topics: seeding, sodding, plugging and sprigging, fertilizer, or irrigation. Using your textbook as a starting point, research your topic and prepare a report on how it impacts turfgrass management. As a group, deliver your reports to the rest of the class. Take notes while other students give their reports. Ask questions about any details that you would like clarified.
2. **Writing.** Identify insect pests that may be a problem in your area or state and prepare one-page information sheets about those pests. What do the pests look like? Which turfgrass species do they attack? At what time of year are these insect pests most likely to be seen? What can be done to control or eliminate the pest? To make your information sheets engaging and informative, use images from the Internet. Ask permission to post these information sheets in your school, in public libraries, or on your school's website.

SAE Opportunities

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1. **Exploratory.** Job shadow a turfgrass employee.
2. **Experimental.** Grow a plot of turf and apply different fertilizer concentrations to specific parts of the plot. Analyze the differences in growth. Record your results.
3. **Exploratory**. Interview people in your community regarding their perception of the turfgrass industry. After completing the interviews, create an educational brochure that will help participants understand the many environmental and social benefits of turfgrass.
4. **Entrepreneurship.** Develop a lawn mowing service.
5. **Placement.** Get a job working at a sports field or golf course.