Introduction

The *transition zone* in the United States covers 300 to 700 miles north to south between the northern cool, humid region, where cool-season turfgrass species are naturally adapted, and the southern warm, humid region, where warm-season turfgrass species are adapted. Much of the northern edge of this zone is roughly defined east to west by Interstate 70 from Maryland through eastern Kansas. The serpentine southern margin touches parts of North Carolina, Kentucky, and Tennessee. Within this zone neither warm- nor cool-season grass species are completely adapted.

**NEED FOR TURFGRASS MANAGEMENT**

The purpose of this book is to suggest ways to grow turfgrass successfully and efficiently in the transition zone in the United States. To accomplish this goal we provide certain management guidelines once a fundamental understanding of the grass plant and how it grows has been established. We hope that the reader will follow these guidelines, which we believe are key to successful turfgrass management in the transition zone. For example, in many situations, turf growers exceed suggested guidelines and are unsuccessful because they attempt to supply too much fertilizer to grass, to promote unnecessary growth or to enhance the color. That approach, commonly referred to as *overmanagement*, may lead to a succession of problems that weaken the turf and increase its susceptibility to a multitude of environmental stresses. By withholding some of those excess
nutrients, we often end up with a leaner, hardier turf that will endure over a long period of time. On the other hand, we do not want to starve the grass by withholding too much nutrition. That approach is part of undermanagement—either way, guidelines for successful turf management are exceeded, and that can lead to poor turfgrass quality. To establish guidelines, a basic understanding of the turfgrass plant and its environment is essential. Once we have established parameters set by plant and environment, we can make management choices for specific uses of turf as lawns, golf courses, or sports turf in the transition zone.

Consider the restrictive effects that temperature and moisture have on grass plants. Engel (c. 1963) describes these in a condensed variation of the hydrosere, described by Weaver and Clements (1938) as plant species in progression succeeding one another from a wet environment to a “climax” vegetation. Picture grass species adapted to the wet, cool environment of a pond progressing to those in a warmer, drier area some distance away, perhaps on a slope leading from the pond. In the pond we find sloughgrass and wild rice. At the edge of the pond and a short distance up the adjacent slope, bentgrass has adapted to a cool, moist environment, but not the watery environment of the pond, where sloughgrass is domiciled. Kentucky bluegrass may adapt to a somewhat broader environment than bentgrass, perhaps in the cool, moist soil where bentgrass was found but also farther up the slope, where soils are a little drier and temperatures warmer. At the crest of the slope, wheatgrass is growing well in drier soils. In nature these diverse species are rarely found in such close proximity to each other, and plant successions of an actual hydrosere take many, many years to develop to the climax vegetation. But the illustration serves a point, to remind us that plant species may be difficult to grow outside certain natural environments as defined first by temperature and then by moisture.

An example of stretching the environmental parameters of turf culture is the use of ‘Penncross’ creeping bentgrass for golf course putting greens in southern states, including Florida, Georgia, and Alabama, far out of its adapted cool, moist northern environment. Moisture is available to bentgrass through rainfall and irrigation, but the prevailing warm summer temperatures of the southern region are wrong for this species. Add persistent southeastern humidity plus the intensive mowing required for putting greens and this particular bentgrass will struggle to survive, which means that the golf course superintendent will also struggle. Despite the recent development of new and better-adapted cultivars, bentgrass in the
southeast is still a plant growing out of its natural environment as defined by temperature and moisture and therefore a species that is difficult to manage in that southern environment. The best areas of adaptation in the United States for the major turfgrasses are shown in Figure 1-1.

Can we ever control temperature and moisture? Well, consider a few things about Figure 1-1. Bentgrass, although best adapted to cool, moist regions, will also adapt to parts of the southwestern United States if irrigation is provided. As in the southeast, temperatures in the southwest are often very warm, far from optimum for bentgrass. But unlike in the southeast, humidity is usually low in the southwest. Less humidity generally means less disease. So in some geographic areas, bentgrass and other cool-season species may be extended out of their natural environs even though temperatures, not easily controlled, are above optimum.

If temperature and moisture are the two principal environmental factors that define the area of adaptation, a third and very important contributing factor is soil. You may be aware of someone on the fringe of your town who is growing a beautiful Kentucky bluegrass lawn, apparently with little effort. That person’s home is located in a subdivision that was developed on

![Figure 1-1 Regions of best adaptation for turfgrass species.](image-url)
farm pasture, with soil rich in nutrients and organic matter. Instead of stripping and selling the topsoil, the developer left it in place and provided a good environment for new lawns. On the other hand, the developer in your area took the topsoil with him, a common procedure, and left you with the dregs; sticky, “heavy” clay subsoil—and that means a constant struggle for your Kentucky bluegrass lawn.

Consider a second example. The superintendent of your low-budget semiprivate golf course seems unable to maintain first-class turf on a few putting greens in late summer, while the club down the road has excellent greens. Naturally, the members begin to think that their superintendent is incompetent, and some of them may want to hire the guy down the road. But take a close look at the content of those putting greens. Your superintendent is still trying to grow bentgrass mowed at 1/8 inch or less on a few “push-up” greens constructed of clay loam soil hauled in years ago from a farm and shaped into putting greens. Budget restrictions have delayed complete conversion of all greens from soil to the preferred modern high-sand-content greens. The clay loam has been subjected to the compacting forces of thousands of feet plus the weight of machines. It does not drain freely and it resists the movement of roots in its profile. So the bentgrass struggles in a difficult soil environment, which is bad enough considering that these courses happen to be in the St. Louis area, one of the most challenging parts of the transition zone for turfgrass managers. The club down the road constructed putting greens of uniformly graded sand that resists compaction. They drain well and the sand provides ample pore spaces for grass roots to grow with a good supply of oxygen. Their greens look better than yours. Your superintendent has been trying to improve the soil environment in his putting greens with a regular program of machine removal of narrow soil cores (aerification) followed by topdressing with sand, to amend the original soil and improve its structure. But that will take time. The accumulation of 2 to 3 inches of sandy soil above the old clay-loam profile cannot immediately negate the detrimental effects of the underlying soil, which has been in place for many years. So the nature of the soil where grass grows contributes to the success or failure of turfgrass in the temperature- and moisture-defined transition zone.

One final but very important point must be made regarding the influence of the temperature–moisture–soil environment on turfgrass. The turfgrass environment is not static. That is why no sharp lines are drawn in Figure 1-1 to delineate the regions of the country where major turfgrass species are best adapted. The divisions are influenced by topography, such
as the Blue Ridge mountains of North Carolina, which provide cool relief for Kentucky bluegrass in high elevations compared with the coastal plains to the east. Good soils give turfgrass species a thin edge for survival over poor soil environments when temperature and moisture are not favorable. Similar influences may be found in lawns where soil texture and fertility are inconsistent and shade from trees and buildings influences temperature and moisture.

**TURFGRASS PLANT ANATOMY AND MORPHOLOGY**

Before the reader proceeds with subsequent topics in turfgrass management, a baseline of information is needed on grass anatomy and morphology. After all, when uptake of water and nutrients is discussed, the reader should know how these enter the grass plant and make their way through its tissues to areas where they are needed. Begin with the seed: the cells that start the grass plant on its growth cycle are found in the seed. After the seed has germinated, a seedling (Figure 1-2) is formed which eventually develops into a mature grass plant.

The *seminal roots* sustain the plant for a few weeks to a year, depending on the grass species. However, *adventitious roots* that form at nodes on the stem soon become the most important ones for plant nourishment. As the grass plant matures, an examination of cross sections of stems and roots will show cell bundles in tissues containing phloem and xylem cells.

Imagine thousands of xylem cells stacked together, tubing to carry water and nutrients from the soil through the roots and stem to the leaves of the plant. Food in the form of carbohydrates and amino acids is then manufactured in leaves from these raw nutrients and water and distributed throughout the plant in conductive tubing made of phloem cells.

Other cells make up thick-walled *sclerenchyma tissue* to help protect softer tissues and give structural support for sturdy leaves and upright stems. *Chlorenchyma cells* are green and contain chlorophyll, the pigment needed for photosynthesis, a primary source of energy and food produced by the plant.

As the grass seedling matures, the final outward structure, its morphology, is apparent. The mature seedling plants are now ready to give birth to new lateral shoots, called *tillers*. These in turn mature and give rise to their own tillers. So a systematic progression of tillers develops and in this manner the turf thickens and fills in. Species that spread this way are called *bunch grasses* (Figure 1-3).
Some grass species produce horizontal stems that grow laterally underground or creep above ground. The belowground stems are called rhizomes (Figure 1-4) and the aboveground stems are called stolons (Figure 1-5). The cell structure of both rhizomes and stolons in many ways resembles that of upright stems. Species of grass possessing one or the other of these organs are referred to as rhizomatous or stoloniferous. Some species have
Figure 1-3  Tillering bunch grass. (Drawing by William Dierker.)

Figure 1-4  Rhizomatous growth habit. (Drawing by William Dierker.)
both organs. Rooting occurs at nodes along stolons and rhizomes, where new plants may emerge, or in some species, rhizomes may emerge from the soil to form new plants. Then the new plants mature and produce tillers just as the bunch grass did. Species with stolons and/or rhizomes have a large advantage over bunch grasses in their capability to spread vegetatively.

Seedheads, also referred to as inflorescences, are found in many sizes among grass species. A common inflorescence for Poa species is the panicle inflorescence. Its shape may remind readers of the branching of a tree (Figure 1-6). The grass inflorescence is a key morphological tool for identification of species. Hitchcock’s (1950) Manual of the Grasses lists over 1398 grass species, and most descriptions are accompanied by an illustration of the inflorescence as the focal point for identification. But inflorescences of most grass species are produced on a seasonal basis, for example, May–June in the midwestern transition zone for Kentucky bluegrass, and even at that time of year, regular mowing may eliminate most seedheads in turf. Therefore, turfgrass managers must usually rely heavily on vegetative rather than reproductive characteristics for turfgrass identification.
Useful vegetative characters for identification purposes include the presence or absence of rhizomes and stolons and the structure of the leaf blade, the leaf sheath, which wraps around the stem, and a small, white paper or hairy area where stem and leaf join, called the ligule. The nature of the auricles and collar may be helpful on occasion, but identification of the major turfgrasses can usually be made by determining the leaf and ligule structure plus the vernation (budleaf rolled or folded as it emerges) of the species in question.

SELECTED REFERENCES


Engel, R. E. Circa 1963. Personal communication.


