ROOTS: GETTING TO THE BOTTOM OF TURFGRASS

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Roots are the foundation of a turf. They perform functions vital for plant growth. This article will discuss the structure and function of roots, the effects of the environment and cultural practices on root growth, and strategies for increasing rooting. We will look at roots and root systems of both cool season grasses (Kentucky bluegrass, perennial ryegrass, tall fescue and bentgrasses) and warm season grasses (principally Bermudagrass but also zoysiagrass) used for sports field and other natural turf playing surfaces.

ROOT SYSTEMS

Turfgrasses have two different root systems during their lives. The first, known as the primary or seminal root system, develops from the embryo and emerges directly from the germinating seed. The seminal root system provides for water and nutrient uptake for the tiny seedling and functions actively for six to eight weeks.

During this seedling growth phase and shortly after the first leaf emerges, an adventitious root system will begin to form. This root system originates from buds at nodes on the crown. It replaces the seminal root system, becoming the main functioning root system for the plant. Adventitious roots will also form at nodes on the lateral stems: stolons, rhizomes and tillers. These root systems allow the lateral stems to eventually develop into plants functioning to a large degree independently of the main turfgrass plant.

Turfgrass roots are fibrous and multibranched. The tip of each root is covered by a cap, which protects the tender meristem (growing point) as the root bores through soil. The meristem replenishes the root tip and provides for growth of new cells in the root. The new cells behind the meristem eventually stretch and lengthen; this action pushes against the root cap and is what makes the root actually grow longer.

As a root matures the cells become specialized. The cells of the endodermis (the outer layer of the root) behind the area of cell elongation are able to develop the long, slender, almost microscopic extensions called root hairs. These hairs greatly increase the surface area, which can actively absorb water and nutrients. While the roots of cool season grasses can only form root hairs from specialized cells in the epidermis called trichoblasts, warm season grasses have the advantage of being able to develop root hairs from all cells in the epidermis.

A new root is white and slender. As it matures, it turns brown and becomes thinner. Its ability to absorb water and nutrients declines. Eventually the whole root will die and will slough off just below the crown. This cycle of root growth, maturity, aging, death and replacement is a natural and ongoing process. It may be speeded up by environmental or climatic conditions or by cultural practices.

Just as different grasses vary in their leaf texture or color or growth habit, so too do they vary in the size, depth and distribution potential of their root systems. Warm season grass root systems are deeper and more extensive than the finer more shallow systems of cool season grasses. Warm season grass roots tend to be larger in diameter than those of cool season grasses.

Healthy turfgrass roots are well branched. In fact, the ability of a turfgrass plant to effectively compete for water and nutrients is directly related to the extent of branching.

HOW DO TURFGRASS ROOTS GROW?

Cool season grasses. To understand the cycle of cool season grass root growth, consider the cycle of carbohydrate production and use.

In photosynthesis, plants, using the energy of sunlight,

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produce carbohydrates from $C0_2$ and H_20. These carbohydrates, when broken down through the process of respiration, provide energy to the plant. Roots do not contain chlorophyll and so cannot photosynthesize. They depend on the leaves for carbohydrates for their energy needs. The absorption of nutrients and the movement of water and nutrients from cell to cell within the root requires energy.

Carbohydrates produced at the time that shoots are actively growing will be used in the areas of most rapid growth (leaves) before they are sent to the roots for respiration and energy production.

When temperatures are too cool for rapid shoot growth, carbohydrates will be available to the roots. When temperatures are warmer, and when shoot growth is stimulated during very warm weather, carbohydrates will be used by the leaves before any are translocated to the roots.

The roots of cool season grasses grow and function most vigorously when soil temperatures are cool. The most intense period of root initiation and growth is in the spring. A slightly less active period occurs in the fall. The temperatures for maximum root growth are slightly lower than those for maximum shoot growth, and so roots will be growing rapidly before shoot growth begins in the spring and after shoot growth stops in the fall. When temperatures drop in the fall and the shoots stop growing, roots are still actively growing. Carbohydrates are moved into stems and to a lesser extent into roots at this point, providing for slow but continued growth in cold (not frozen) soils until active growth resumes in spring.

Tall fescue tends to slow and stop growth at warmer soil temperatures than other cool season grasses.

Turf grown in reduced light situations will lose even more roots. Turf which has been stimulated by high levels of nitrogen for rapid shoot growth during warm weather may lose large amounts of roots even while shoots remain active

When air temperatures rise in summer, the efficiency of photosynthesis in cool season grasses is reduced. The leaves produce fewer carbohydrates for translocation to the roots. Energy available for root growth and work is reduced and as a result root growth slows. As root growth slows, the root system becomes limited in its ability to absorb water and nutrients from the soil and transmit them to the other parts of the plant.

As air temperatures rise, soil temperatures will follow. As soils warm, root respiration increases. As respiration increases, more and more carbohydrates are used up. So, when temperatures warm, the use of carbohydrates increases while the supply decreases. Eventually this can lead to root starvation and death. There will be a net loss of roots to sustain the rest of the turfgrass plant. Roots will not be replaced until cool weather resumes. Creeping bentgrass roots, for instance, stop new root initiation at soil temperatures greater then 75F.

Warm season grasses. Photosynthesis is more efficient in warm season grasses than it is in cool season grasses. As temperature and light increase, so too do shoot and root growth. Root initiation and activity peaks in late spring and summer. When temperatures cool down, root as well as shoot growth slows. When the plant enters dormancy, root growth ceases. The peak loss of roots for warm season grasses is in late winter.

WHAT DO TURFGRASS ROOTS DO?

Roots absorb water. They are the principal entryway for this essential compound. Water is needed to maintain turgor and for photosynthesis and many other processes in the plant. Water is needed to replace that lost through transpiration

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as well as through mown leaf ends.

Roots absorb nutrients. While carbon, hydrogen and oxygen, the main building blocks of organic compounds, are derived from the atmosphere and from water, the remaining thirteen essential mineral nutrients are principally absorbed from the soil by the roots. Nutrients do not just "seep into" or passively move into roots. The process of nutrient absorption requires energy. This energy comes from respiration: the breakdown of carbohydrates in the presence of oxygen with a subsequent release of the energy captured by the plant in the process of photosynthesis. When carbohydrate reserves are low or not available, roots will not have the energy needed to absorb nutrients.

Deep, extensive root systems are able to access more nutrients as well as water, from a larger volume of soil than can weaker, shallower root systems.

Roots anchor plants. Plants with deep and extensive root systems are less likely to rip out from divoting. Plants with deep and extensive roots contribute to a stable playing surface.

HOW CAN YOU ENHANCE ROOT GROWTH?

Pay attention. Make regular inspection of the root system a habit. Note its depth and distribution. How does its condition relate to time of year, climate and your management?

Maintain a well-aerated rootzone. Depth and extent of roots as well as root branching increase when the rootzone is kept well aerated. When the soil is not compacted, roots expend less energy as they bore through the soil. Good drainage, both surface and subsurface, management of thatch, relief of compaction and appropriate topdressing in conjunction with aeration will ensure a well-aerated soil.

Roots in a poorly aerated soil tend to be thicker in diameter and less branched than roots growing in well-aerated soil. These roots are inefficient at water and nutrient uptake.

Irrigate intelligently. Irrigation events should be spaced as far apart as possible without sacrificing turf quality. Turf watered deeply and infrequently has been shown to have a deeper, more extensive root system with a higher level of carbohydrate reserves than turf watered frequently and shallowly.

Fertilize judiciously. Provide adequate nutrients at the proper time for balanced turfgrass shoot and root growth.

Time nitrogen applications so as to maximize root growth. Strive to maintain a healthy balance between root and shoot growth. Apply potassium before expected stresses of heat, cold and possible drought are likely to occur. Take care not to overly stimulate shoot growth during periods environmentally unsuitable for root growth (i.e. in the summer for cool season grasses).

The timing of nitrogen applications influences rooting of cool season grasses. Applications made in late summer and late fall will result in an increase in rooting. Applications made in spring and especially in summer will result in an increase in shoot growth with a corresponding reduction in rooting.

The balance between shoot growth and root growth in warm season grasses is less affected by timing of nitrogen applications.

Cool season grass roots have the ability to store some nitrogen applied in the late fall for use when growth resumes vigorously in the spring.

Maintain soil pH at 6.0 - 7.0. Turfgrass roots grow very poorly at reduced pH, especially at pH < 5.0.

Mow appropriately. Mow cool season grasses as high and as infrequently as possible given the use of the

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Welcome New STMA Members

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Robert Trevino
Denton, TX

Turf Equip. & Supply Co., Inc.
Lance Ernst
Jessup, MD

Danny Turner
Clearwater Landscaping Co., Inc.
Sun Valley, ID

Roger Weinbrenner
University of St. Thomas
St. Paul, MN

Tony Wilcenski
Monroe Township
Monroe Township, NJ

Curt Williams
Town of Castle Rock
Castle Rock, CO

Scott Wilson
City of Fairhope
Fairhope, AL

MU builds new baseball 'field of dreams'

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by an electronic eye on a tractor. That controls the valves for a blade on the tractor.

"We don't touch the controls," said Mike Munie, MJM Services owner. "When we did the two MU football practice fields, we laid a Number Two pencil on the far end and you could lay down and see the pencil from 300 feet away. We were within a hundredth of a foot."

A playing surface must be firm and playable yet workable so that cleats can dig in for traction. "Safety and playability are the main things we look for on skinned infield areas," Fresenburg said.

While the infield diamond will be "Baby" Bermuda grass, the aprons will be planted in a turf-type tall fescue, he said. Bermuda grass holds up better and can be mowed to five-eighths of an inch for a better playing surface.

MU is considering replacement of the bluegrass on its diamond at the infield of Simmons Field, home of the baseball Tigers, with "Baby" Bermuda grass.

In addition to installing the infield diamond, MU researchers plan to add research plots nearby to test different soil blends. Mixtures will include combinations of round and sharp sand, silt and clay from native soils and calcined clays. "It's possible that the MU baseball team may come over and use the field," Fresenburg said. "That's been discussed. It would relieve their game field from excessive wear and allow us to look at wear patterns to teach field maintenance."

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turf. This is especially important during times of environmental stress. Low mowing can dramatically reduce the depth and extent of roots of cool season grasses, though bentgrass is not as severely affected as the others.

Warm season grasses are less dramatically affected by low mowing. Bermudagrass especially will tolerate low mowing without significant reduction in rooting.

Constant defoliation by frequent mowing reduces the photosynthetic potential of the turf. The result is depleted carbohydrate supplies available for root growth. Cool season grasses are especially sensitive to this cultural stress.

Take care with herbicide applications. Avoid using herbicides when turf is under stress or when root growth is restricted.

Bensulide, benefin, oxadiazon, oryzalin, pendimethalin, prodiamine, siduron, DCPA and other herbicides may inhibit root growth. Healthy turf may be able to recover from this quickly. A turf stressed by drought, heat, traffic or with a root system already limited may be more seriously damaged and take a longer time to recover.

CONCLUSION

Roots are the foundation of a turf. Attention to the growth, development and health of the root system by the turf manager can ensure a deep and extensive root system able to sustain a vigorous, properly performing playing surface.

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