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Roots—A Key Plant Health Indicator

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One can interpret more about past cultural practices and potential future turf problems by examining the underground turfgrass root characteristics and root environment than by any other approach. A root examination is much more comprehensive if a 4 inch (100 mm) diameter root core is removed, examined, and then carefully broken up in progressive sections starting from the bottom, with each section also examined. Be sure to note the coloration of the roots, with white being healthy and actively growing, light-brown being functional, and thin/brown-to-black being very restricted to nonfunctional in terms of water and nutrient uptake. It behooves the turf manager to take the time to periodically examine the root profile and trends in growth and dieback at regular intervals throughout the year. It is amazing how many consultants conduct site visitations without ever examining the underground rooting aspects.

To properly conduct a root examination, **it is important to know the rooting characteristics of each turfgrass species involved, as well as how these root system characteristics vary seasonally throughout the year and finally how they are affected by various turfgrass cultural practices.** Thus, the following discussion will be oriented around these three crucial dimensions.

ROOT CHARACTERISTICS

The root systems of C_3 cool-season turfgrasses are characterized as fine, fibrous, and multibranching. Typically, the roots extend to depths no greater than 12 to 18 inches (300–450 mm), and under severe summer heat stress on closely mowed greens the roots may be less than 2 inches (50 mm) in depth. The closer the mowing height, the shorter the root system.

Rooting depth is a key dimension that is strongly affected by the cutting height and nitrogen nutritional level. **Higher mowing heights or moderate to low nitrogen levels have a positive effect on the root depth of C_3, cool-season turfgrasses.** The greater the rooting depth the greater the capability to take up moisture from a larger portion of the soil profile and thus the better the drought stress avoidance characteristics. The root density also is a significant characteristic which has a response pattern that is affected by environmental and soil factors similar to those of rooting depth.

TEMPERATURE EFFECTS

Seasonal variations in temperature have a strong effect on root growth, especially on the cool-season turfgrasses. **The soil temperatures for optimum root growth of most cool-season turfgrasses are in the range of 50 to 65°F (10–18°C).** Root growth gradually declines in terms of root initiation and growth extension rate as soil temperatures are increased or decreased from the optimum range. At soil

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temperatures above 80°F (27°C) there is a drastic decline in root growth caused by enhanced maturation or aging of the existing roots and a cessation of new root initiation.

In contrast to the temperature optimum for root growth being in the range of 50 to 65°F (10–18°C), **the temperatures for optimum shoot growth of most cool-season turfgrasses are in the range of 60 to 75°F (16–24°C).** A very distinct difference. Also, the maximum and minimum temperatures for root growth are lower than those for shoot growth, with cell division in the root tips of Kentucky bluegrass (*Poa pratensis*) having been observed at temperatures just above 32°F (0°C). In contrast, creeping bentgrass (*Agrostis stolonifera*) produces very little root growth at suboptimal temperatures, which results in most of the root replacement from summer heat stress loss occurring during the following spring.

Mowing and Fertilization. The proper mowing frequency and a moderate to low nitrogen fertility level are particularly important for cool-season turfgrasses during the optimum root and shoot growth temperatures of the spring period. It is critical to maintain a mowing frequency that removes no more than one-third of the leaf area at any one time. Allowing the grass to grow excessively tall and then removing a major portion of the leaf that approaches a scalping effect, can result in a dieback of the root system. This is caused by a sink-source relationship in which the carbohydrates are mobilized to support the needed leaf growth recovery, thereby causing the dieback of the root system due to a carbohydrate deficiency. Similarly in the case of cool-season turfgrasses, a nitrogen application rate exceeding 0.8 pound per 1,000 ft^2 (0.4 kg/100 m^2) per application of a water soluble nitrogen carrier causes excessive leaf growth that can not be supported by normal photosynthetic rates. As a result, carbohydrate partitioning causes the shoots to have priority for the available carbohydrates, with no carbohydrates allocated for root growth which thereby may result in root dieback.

Thus, the proper mowing frequency and moderate to low nitrogen fertilization are very critical during this peak spring shoot growth period, just prior to entering the summer high-temperature stress period. To do otherwise would cause a loss of the root system which could not be adequately replaced before summer heat stress develops. Because root replacement is minimal during the summer heat stress period, the amount of roots needed to survive the heat stress period is seriously reduced. Thus, **it is important to maximize the amount of root density and depth as summer heat stress approaches in order to enhance the potential for summer heat stress survival.**

SUMMER ROOT LOSS

Root growth of cool-season turfgrasses is severely restricted during summer heat stress. **This occurs at soil temperatures above 80°F (27°C) when the new root initiation ceases and the maturation or aging of the existing root system is greatly accelerated, especially on creeping bentgrass (*Agrostis stolonifera*) and annual bluegrass (*Poa annua*) putting green turfs.** It is not uncommon for the root system to be shortened to a depth of 1 to 2 inches (25–50 mm), with a sparse root density. It is temperature that is the major factor affecting this root decline. While other biological stresses such as disease may be contributing factors, no amount of pesticide is going to prevent significant root loss from occurring at soil temperatures above 80°F (27°C). It should be noted that cool-season turfgrasses can survive air temperatures well above 80°F (27°C), as long as the soil temperature remains well below 80°F (27°C). This occurs in environments where the air temperatures may be very high during the daylight hours, but there is a substantial radiation cooling of nocturnal temperatures, as occurs in desert environments.

AUTUMN ROOT RECOVERY

As temperatures cool during the late summer-autumn period, some turfgrasses exhibit significant root depth and density recovery from the summer decline, such as is the case with Kentucky bluegrass (*Poa pratensis*), whereas other species may not show significant root replacement until the next spring, such as is the case with creeping bentgrass (*Agrostis stolonifera*), especially on putting greens.

ANNUAL VERSUS PERENNIAL ROOT SYSTEMS

Root death and replacement is a continuing process in certain turfgrasses which can be termed as having a perennial-type root system. Examples include Kentucky bluegrass (*Poa pratensis*) and crested wheatgrass (*Agropyron cristatum*). In contrast, there are perennial turfgrasses which have an annual-type root system. In this case **the root system is fully replaced each year, with a period of significantly deficient root depth and density existing at some time during the growing season.** Examples include creeping bentgrass (*Agrostis stolonifera*), colonial bentgrass (*Agrostis capillaris*), perennial ryegrass (*Lolium perenne*), and rough bluegrass (*Poa trivialis*).

SEEDHEAD DEVELOPMENT EFFECT

Certain grass species have a strong floral development stage during the May period, that also may have a striking effect on rooting. Again, this is related to carbohydrate partitioning. **When the plant is hormonally induced to switch from a vegetative to a developmental stage, then the carbohydrates are allocated to formation of the culm, inflorescence, and eventually grass seeds.** During this period of partitioning to seed development, the root system is deprived of needed carbohydrates and typically dies back.