ROLE OF NUTRITION IN THE STRESS TOLERANCE OF TURFGRASS

By Dr. Wayne R. Kussow
Professor of Soil Science, University of Wisconsin-Madison

A prolonged period of high temperatures and relative humidity placed turfgrass in southern Wisconsin under tremendous stress this past summer. How well the turfgrass came through this period depended very much on three things: (1) the condition of the turfgrass at the onset of the stress period; (2) management practices employed during the period of stress; and (3) the recuperative capacity of the turfgrass once temperatures and humidity subsided. Nutrition played an important role in all three of these aspects of tolerance to heat stress.

TURFGRASS HEAT STRESS

Knowledge of the role of nutrition in the tolerance of turfgrass toward heat and humidity begins with an understanding of the influence of high temperatures on the turfgrass plant. Our cool-season turfgrasses grow most rapidly when air temperatures are around 70°F. *When temperatures exceed 85*°F for several days in succession, growth slows perceptibly. The reason is an imbalance between photosynthesis and respiration. Because of this imbalance, the supply of photosynthate for plant growth is reduced and, what little photosynthate there is available for growth, is preferentially consumed in the turfgrass shoots. This not only halts root growth, but leads to die-back of root systems. It is not unusual during prolonged periods of heat stress to have a 60 percent or more reduction in the size and/or depth of turfgrass roots and rooting.

High air temperatures also elevate turfgrass transpiration rates. Water loss rates from turfgrass in Wisconsin go as high as ¼-inch per day when air temperatures climb into the 90°F range and a breeze is blowing. Extraction of this quantity of water by a reduced root system growing in a relatively small volume of soil becomes problematic. Early afternoon wilting of turfgrass is common, particularly when growing in sandy or compacted soils. With wilting comes greater susceptibility to damage from foot and vehicular traffic and added stress on the turfgrass plant.

High daytime air temperatures also lead to high soil temperatures. During nighttime hours, the grass blades cool much more rapidly than the warm soil. Warm, moisture-laden air rising from the soil surface contacts the cooler leaves causing water to condense on the leaves. The leaves then become ideal environments for the growth of disease-causing organisms, particularly if bruising of the leaves has occurred earlier in the day. Bruising releases plant cell substances that are energy-rich foods for disease organisms and provides places for the organisms to enter the turfgrass plants.

ROLE OF NITROGEN

Turfgrass growing in the presence of favorable temperature and adequate moisture is extremely sensitive to the amount of N supplied. Insufficient amounts of N result in poor color, reduced photosynthesis, slow shoot growth rates and restricted root, tiller, rhizome and stolon development. Hence, stand density is low. Weeds readily invade the turf and compete for water, light and nutrients. The turfgrass is susceptible to certain diseases such as red thread and dollar spot and is very slow to recover from any type of damage.

At the other extreme, supplying turfgrass with large amounts of N during periods of favorable temperature and moisture leads to rapid shoot growth at the expense of root growth. The turf has excellent color and, because of its lush growth, appears to be of excellent quality. When N-induced surges in topgrowth are followed by high temperatures, respiration consumes much of the carbohydrates produced during photosynthesis and reserve carbohydrates are rapidly depleted as the plant strives to maintain high shoot growth rates. Evapotranspiration rates are high and, should moisture supplies become limiting, previously depleted root systems are unable to provide shoots with adequate amounts of water. At this point the turfgrass becomes highly susceptible to physical damage and to diseases such as pythium and anthracnose. Because carbohydrate reserves have previously been exhausted and root systems curtailed, the ability of the turfgrass to recover from physical, insect or disease damage is very low.

From this discussion, it is apparent that all aspects of turfgrass stress tolerance very much relate to the N fertilization program being followed. The key factor is how much N gets into the turfgrass plant at different times during the season. This, in turn, depends on when the N is applied, at what rate and in what form.

A sound N management strategy for turfgrass emphasizes a late fall application of N that promotes root, tiller and underground stem growth at a time when air temperatures limit shoot growth response to the N. Because some of this late fall N is not utilized until the following spring, N application the following year can be delayed to such time that air temperatures suppress shoot growth response. This greatly reduces the chances of adversely affecting root growth. Under these circumstances, the turf is in the best condition possible to cope with summertime heat and moisture stress.

When prolonged periods of heat and moisture stress occur, there are two things that can be done to minimize stress-related injury. The first is to suspend N fertilizer applications normally scheduled for that period of time. Application of N does not offset turfgrass color decline resulting from heat stress and has the risk of over-stimulating shoot growth once temperatures subside. Should the latter response occur, evapotransition rates will increase and accentuate moisture stresses. The second action that helps ease turfgrass through periods of heat and moisture stress is to decrease the mowing height and to increase the frequency of mowing. This is not always possible, but when done will reduce the turfgrass demand for water.

ROLE OF PHOSPHORUS

Research has demonstrated that application of phosphate can promote root development in turfgrass. This is the basis for fertilizer sales campaigns that promote use of high phosphate fertilizers on turf in fall and is the link between phosphorus and turfgrass stress tolerance. However, applying phosphate to turfgrass growing in soils well supplied with P *will not* result in greater root growth.

In certain situations, the potential for significantly enhancing turfgrass stress tolerance through phosphate fertilization is substantial. A prime example is golf putting greens where soil P levels are deliberately kept low to discourage growth of *Poa annua* and N rates are kept low in the interest of maintaining fast greens. This combination of management practices has led to P deficiency in bentgrass during periods of prolonged heat stress. What these temporary P deficiencies mean in terms of turfgrass heat or moisture stress tolerance is unknown at this time. It is, however, logical to assume that the condition delays bentgrass recovery from heat and moisture stress.

ROLE OF POTASSIUM

Potassium ranks second only to N in terms of its influences on the stress tolerance of turfgrass. Low levels of potassium in plants have long been associated with high disease susceptibility. Thus, when high temperatures and humidity favor growth of disease-causing organisms, potassium becomes an important factor in the stress tolerance of turfgrass.

Potassium also influences the response of turfgrass to moisture stress. High annual rates of K markedly reduce the wilting tendency of turfgrass and can offset the adverse effects of high N rates on moisture stress tolerance.

The mechanisms whereby K increases the stress tolerance of turfgrass are largely unknown at this time. They may be related to the fact that soluble carbohydrates accumulate in K-deficient plants and such plants are not fully turgid and bruise readily. Whatever the mechanisms, the fact remains that turfgrass that is well supplied with K is best able to tolerate stress. This is why recommendations for annual rates of K application on golf greens now are the same as for N.