Photo credit: University of Idaho

Managing Kentucky blue against summer stress

By Dr. Bingru Huang

Kentucky bluegrass is a widely used cool-season grass on sports fields in the north central and northeastern regions, although it is found throughout the United States. This species grows most actively at temperatures between 65 and 75°F and require as much as 2-3 inches of water per week during summer months.

Kentucky bluegrass forms attractive turf when supplied with adequate water and when temperature is cool in spring and fall. However, turf performance of Kentucky bluegrass often declines during summer when temperature exceeds 75°F and/or under drought stress conditions. Kentucky bluegrass generally undergoes dormancy during severe summer stress that increases the chance of turf survival, but substantially lowers turf quality. The lack of heat tolerance restricts its use in cool climatic regions.

In addition, water supply is often inadequate to maintain high quality turf due to lack of rainfall or limited water availability for irrigation in many areas. Maintaining Kentucky bluegrass in situations requiring high quality or playable turf such as sports fields can be challenging in areas with limited rainfall or irrigation during summer months.

Management strategies for **KENTUCKY BLUEGRASS**

Sufficient irrigation is an effective means to prevent or alleviate summer decline in turf quality due to drought and heat stress. Several other cultural practices could be utilized to prevent or alleviate summer stress injury in Kentucky bluegrass:

1. Using **stress tolerant cultivars** is the primary means for improving turf performance of Kentucky bluegrass in hot and dry environments.

2. Keeping **mowing heights at highest level** allowed to promote plant tolerance to both drought and heat.

3. Using **growth inhibitors and anti-transpirants** for water conservation and delaying drought stress injury in water-limiting environments. However, anti-transpirants may not be used in the situations with high temperature.

4. Maintaining **adequate fertility could alleviate stress injury**. Proper use of nitrogen may delayed or suppress leaf senescence during extended period of high temperatures. Increasing potassium may enhance plant tolerance to both drought and heat stress.

–Dr. Bingru Huang

Drought and high temperature are two major summer stresses limiting the growth of cool-season turfgrasses during summer months. It is not uncommon that drought and heat stress may occur simultaneously during summer months, which can severely reduce turf quality and field playability.

Drought stress and growth

Leaf wilting or desiccation and reduction in cell enlargement and growth due to water deficit characterize drought injury in turfgrass, although many physiological and morphological changes are induced. Under drought stress, water loss from stomatal pores on leaf surface (transpiration) increases while root growth and water uptake from the soil is limited. Leaf wilting or rolling is a typical symptom of drought stress. Turf experiencing drought stress initially becomes bluish, dull green color and then turns to brown color as chlorophyll content decreases with stress progression.

Kentucky bluegrass is relatively more tolerant to drought stress compared to other cool-season grasses. This species produces rhizomes (underground stems) that give rise to new plantlets. Rhizome formation enables bluegrass to recuperate from injury and fill in thin areas. Kentucky bluegrass may go dormancy resulting in loss turf quality, but can survive several months without significant rainfall or irrigation. Then, after rainfall or significant irrigation the grass will quickly regenerate new shoots and roots and recover.

For perennial turfgrasses, one of the most important drought-tolerant strategies is the ability to survive and recover rapidly from the stress after rainfall or irrigation. Our study found that the recuperative ability of Kentucky bluegrass from drought stress varied with the duration of exposure to drought stress, the duration of rewatering, and growth or physiological parameters. Turf quality could not recover completely (100% of the pre-stress level) after 6 days of rewatering when turf quality declined below 5.0 (quality of 1 = dead turf and 9 = completely turgid and green turf) due to drought stress.

Short-term drought brought reversible effects on Kentucky bluegrass growth, but prolonged soil drying was detrimental to the whole-plant performance for Kentucky bluegrass. How long to let plants go drying before recovery upon irrigation depends on the severity of drought stress. The critical physiological status or injury level may be used to determine when rewatering or irrigation is needed following a period of drought stress. Optimum leaf relative water content (RWC) is about 85 to 95% for most plant species when water uptake by roots equals leaf transpirational water loss; the critical RWC is approximately 50% (varies among species and tissue types), below which tissue physiological injuries and death occurs. Our study found turf quality of Kentucky bluegrass could recover completely following rewatering as long as leaf RWC was maintained at or above 25%.

Kentucky bluegrass has high environmental plasticity. The recuperative response may represent an important adaptive strategy that permits a rapid regrowth following a rainfall event or irrigation. The critical values for physiological parameters could be used as a guideline to develop irrigation scheduling practices to maintain quality turf with limited water resources.

PGRs

It is obvious that irrigation is the most effective practice to manage drought stress if there is plenty of water available for irrigation. However, irrigation water is limited in many areas. Recently, plant growth regulators (PGR) have received increasing attention in promoting turfgrass tolerance to stresses. PGRs (synthetic) or hormones (endogenously produced in plants) are substances that regulate plant growth and development at very low concentrations. Abscisic acid (ABA) accumulates in plants in response to drought stress. It has been found to protect plants from drought damage by inducing stomatal closure and reducing water loss through transpiration, which is considered as anti-transpirants.

Photo courtesy of LebanonTurf

The use of ABA and other anti-transpirants has been used in drought protection for various agronomic and horticultural plant species. We found that exogenous application of ABA (100 (M) prior to exposing Kentucky bluegrass to drought stress delayed turf quality decline and maintained a better turf quality than untreated plants. ABA application reduced drought injury of Kentucky bluegrass by protecting cell membrane and photosynthesis apparatus. Other plant growth regulators, such as trinexapac-ethyl, may also be effective in reducing water consumption and delay drought stress injury. Trinexapac-ethyl has been widely used for growth reduction in turfgrasses, which reduces the amount of leaf area for transpiration, and thus may help plants to utilize available soil water for a longer period of time. In general, any cultural practices that reduce water consumption may be beneficial for improving turf performance in water-limiting environments.

Heat stress and growth

Heat stress may cause damages in turfgrass by affecting many physiological processes. One of the typical symptoms of heat injury in turfgrasses or the most visible symptom is leaf senescence or yellowing of leaves due to loss of chlorophyll (a green pigment for light absorption in photosynthesis). Several physiological parameters including the content of leaf chlorophyll content, photochemical efficiency, and cell membrane stability are often used to evaluate physiological health of the plant exposed to environmental stresses. Our recent study found that heat stress tolerance of Kentucky bluegrass was highly correlated to high chlorophyll content and photochemical efficiency. These are two essential components of photosynthesis, the process producing carbohydrates. Therefore, any cultural practices that can alleviate leaf senescence or increasing

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photosynthesis capacity or carbohydrate accumulation during hot summer months would help to maintain healthy, green turf.

One of the most effective practices to maintain green leaves or delay leaf senescence is through application of nitrogen. Nitrogen is an essential nutrient element forming chlorophyll molecules. Therefore, adequate nitrogen supply to plants during high temperature periods may prevent or delay leaf senescence by continuing support of chlorophyll synthesis. However, Kentucky bluegrass may be burned during summer months if too much nitrogen is applied at one time, particularly if the fertilizer is not watered in immediately after application. No more than one pound of soluble nitrogen per 1,000 sq. ft. should be applied in one application. Applying nitrogen in small amount but frequently may help turf to sustain green color during summer.

Increasing mowing height may also help turfgrass to better survive heat stress. Mowing removes large amount of leaves that are otherwise used for light absorption in photosynthesis. It is generally accepted that higher mowed turf is better able to tolerate heat stress by promoting carbohydrate production through photosynthesis than closely mowed turf. High-mowed turf may also promote deep rooting, resulting in higher water use efficiency and facilitating transpirational cooling.

Combined heat and drought

Heat and drought stresses often occur simultaneously during summer months, severely limiting turfgrass growth. Simultaneous drought and heat stress is more detrimental than either stress alone for plant growth. This is large due to the fact that plants under dry and hot environments have increased water demand, causing rapid soil moisture depletion than either stress alone.

For example, in a controlled-environment study with Kentucky bluegrass, we found that soil volumetric water content declined from 28% to 5% after 12 days of combined heat and drought stress, but soil moisture did not drop to 5% until 25 days if plants were exposed to drought stress alone. Our study demonstrated that the decline in turf quality for Kentucky bluegrass under the combined stress was mainly due to decreases in leaf water content or dehydration when plants were exposed for a short period of time, and prolonged heat and drought stress induced leaf senescence. Dry and hot environments cause rapid closure of stomata, resulting in suppression of transpirational cooling that may induce internal heat stress. Drought combined with heat causes permanent damage to the photosynthetic system.

The combined drought and heat stress not only increases evapotranspirational demand, but also has more negative impact on root growth than either stress presence alone. Kentucky bluegrass subjected to the combined stress had significantly smaller root system, limiting water uptake to meet the high transpirational demand of shoots and thus, plant desiccation.

When compared effects of drought stress with heat stress, we found that prolonged periods of drought stress was more detrimental than heat stress alone for Kentucky bluegrass growth and

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physiological functions. Kentucky bluegrass is able to maintain good turf quality even under high temperature conditions as long as it is frequently supplied with adequate water. Therefore, sufficient, frequent irrigation can be an effective means in alleviating summer stress, especially during extended, dry and hot periods.

Water for irrigation, however, is becoming increasingly limited in many areas due to the decline in availability of fresh water and increasing demand, which have provided the impetus to seek for alternative methods to maintain high quality turf with limited irrigation.

One approach is to increase water retention in leaves during dry and hot periods. As discussed earlier, stomatal pores must stay open for transpiration to continue, which help cooling plants at high temperatures. Potassium as the major osmoregulants in turfgrass plants is known to help stomata stay open through maintaining cell turgor pressure. The maintenance of guard cell turgor pressure with high potassium supply under conditions of low water availability has been correlated with drought resistance in various grass species, because it facilitates cooling of turf canopy though transpirational water loss. Turfgrasses grown under high potassium fertility have also been shown to recover more quickly from drought stress injury than those maintained under low potassium fertility programs. High potassium fertility may provide a means of maintaining turf quality during heat and drought stress periods.

Rapid recovery from the combination of those stresses is important for the persistence of perennial turfgrasses. We found that simultaneous drought and heat stress could cause permanent physiological damage for Kentucky bluegrass, particularly for stress-sensitive cultivars. Irrigation was essential for physiological recovery from the combined stress, regardless of temperature conditions.

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