Shade Problems? M.S.U. to the Rescue

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Trees are an integral part of most golf courses and turf landscapes. However, shade from trees often results in turf thinning or loss, especially on putting greens. While removing the tree(s) may be the most immediate and effective way to rectify problems associated with low light intensity, it is in the best interest of the game of golf that we develop turfgrasses and turfgrass management strategies that are better adapted to shade environments. Before we formulate strategies aimed at growing better turf in shade, let's briefly review some of the effects of shade on the turfgrass plant and the turf environment.

Shade Effects on the Turfgrass Plant

Shade from trees and other structures reduces not only the quantity of photosynthetically active radiation (PAR) but also the quality of PAR reaching the turf canopy. Turfgrasses grown in shade receive less PAR from the blue and red regions of the spectra and, especially under trees, a lower ratio of red/far-red radiation. Alteration in light quality and quantity regulates seed germination of some species. In addition, turfgrasses undergo significant morphological changes in response to altered light, including decreased leaf thickness, leaf width, tillering, and root mass and increased stem and leaf elongation and vertical growth habit. Low light causes several anatomical changes, including reduced chloroplasts, cuticle, and cell wall thickness and stomatal density and higher lignin content. Physiological responses to shade include reduced photosynthesis, respiration, carbohydrate synthesis and storage, and transpiration.

It's More Than Just a Color Issue

Turf problems in shade are caused by many factors other than just low light intensity. Shade from trees or other structures reduces turf canopy air temperatures by about 2° to 4°F and bare soil air temperatures by as much as 36°F. While cooler temperatures in shade may be beneficial to turf during hot and dry periods of summer, shade environments can exacerbate lower temperatures in fall, winter and spring, thus causing potential detrimental effects to turf growth. Shade also increases relative humidity above the turf canopy which, together with reduced temperature, results in lower evapotranspiration, increased soil moisture, and greater potential for disease development. The relationship of shade-to-soil moisture and temperature together with the physiological and morphological changes to plants grown in low light has led several turf scientists to conclude that resistance to drought, waterlogging, and low temperatures is equally important to low light adaptation when selecting turfgrasses for shade environments. From my experiences, I would add that resistance to traffic would play a significant role in turfgrass shade tolerance.

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In Search of Shade-Tolerant Turfgrasses

Plants adapted to full sun have been observed to exhibit greater morphological plasticity to grow in low light than plants adapted to shade. Furthermore, it would be important to select for shade tolerance among plants adapted to sun because of their higher seed yield potential (from a breeding standpoint) and greater potential to survive if the shade source is suddenly removed. From a morphological standpoint, selection for shade tolerance in turfgrasses should focus on plants that are able to maintain the same morphological characteristics as observed in full sun. Physiological adaptations to shade include increased chlorophyll content, decreased chlorophyll a/b ratio, increased photosystem II/I ratio, changed pigment composition, greater granal stacking, and reduced respiration.

Thus far, a gene or combinations of genes associated with shade tolerance have not been

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identified. As a result, the best approach to genetically improving turfgrasses for shade tolerance lies in the use of somaclonal variation. *In vitro* cultured plant cells frequently face nuclear genetic and cytoplasmic modification to adjust themselves to the unusually stressful *in vitro* culture media and environmental conditions. This phenomenon which is due to "microevolutions in the test tube" is referred to as somaclonal variation. Somaclonal variation is used by scientists to develop plants that may contain new desirable traits such as herbicide resistance (when cells are cultured in a medium containing a herbicide) or salt resistance (when cells are cultured in a highly saline medium). In addition, pre-existing *in vivio* genetic variability in cells, plus mutations and genomic rearrangement that usually occurs in cells grown *in vitro*, can result in new undesirable (i.e., sterility, albinism, etc.) or desirable (disease resistance, insect resistance, shade resistance, etc.) traits that could be inherited in plants that are regenerated from cells *in vitro* culture. Somaclonal variation is an excellent choice and a new tool to supplement plant breeding for crop improvement. Currently, there exists over 1,000 genetically improved crop species developed either via *in vitro* selection or somaclonal variation systems.

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What Should We Do in the Meantime?

While you are waiting for us to develop turfgrasses with improved shade tolerance, here are a few suggestions for managing your existing turf under low light conditions: 1) maintain a tree pruning and thinning program to maximize light pene-

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tration and air movement across the turf canopy; 2) raise turf mowing height to help counter-balance the detrimental effects of shade on rooting; 3) avoid excessive irrigation and maintain adequate drainage; 4) maintain satisfactory fertility; and 5) evade intensive traffic over heavily-shaded turf.

Where Do We Go From Here?

Managing turf under shade presents challenges that are common to most all turf sites, including golf courses, lawns, and sports stadia. As a result, Michigan State University has made a long-term commitment to study management and physiological factors related to turfgrass growth in shade and, as a result, develop turfgrass germplasm that is better adapted to shade conditions.

In order to launch our shade research project, the Michigan Turfgrass Foundation has committed funding for research equipment and construction of shade research facilities. In the first phase of our research, we will focus on strategies to grow creeping bentgrass in shade. Within this project, we plan to develop shade-tolerant creeping bentgrass via *in vitro* selection and somaclonal variation. Furthermore, we will evaluate the shade-tolerant species *Poa supina,* both as a model for shade tolerance and as a potential turfgrass species for use on golf courses in Michigan and abroad. *Poa supina* is a stoloniferous species native to the European Alps. Its desirable characteristics include tolerance of shade, low mowing heights, disease, and wear. Its undesirable traits include a light green color and drought susceptibility due to a shallow root system. The shade project will complement the ongoing indoor sports turf research program at MSU.

So before you cut down that tree that took the span of our lifetime to grow, remember that MSU is looking for ways in which we may enjoy great trees alongside great turf. ■