Golfdom'S PRACTICAL RESEARCH DIGEST FOR TURF MANAGERS

TURFGRASS TRENDS

THE QUALITY OF LIGHT

There's More to Tree Shade than Just Light Quantity

By Christian Baldwin and Haibo Liu

Shade has many negative effects on turfgrass growth and development, including an increase in disease outbreaks, reduction in carbohydrate production, lateral stem growth reductions, and tree roots that compete for water and nutrients in the soil. Most of these detrimental effects have been studied in previous research projects using black neutral shade material.

However, in nature, trees alter the spectral quality of light available for turfgrass development (Bell et al., 2000). The photosynthetic active radiation (PAR) available for turfgrass growth ranges from 400 and 700 nanometers (nm). Blue light occurs from wavelengths 400 to 500 nm, green light 500 to 600 nm, red light 600 to 700 nm, and far-red light 700 to 800 nm. Limited research has documented the effect of altering not only the quantity, but the quality of light on popular warm-season turfgrasses.

More than 40 years ago, researchers noted oak species (*Quercus stellata* Wang.) tend to filter wavelengths between 600 to 675 nm (McBee, 1969), while trees with a low canopy depleted blue wavelengths, and trees with a high canopy filtered red wavelengths (McKee, 1963). More recently, Bell et al. (2000) noted conifer and deciduous tree shade altered the spectral quality of light available for turfgrass growth.

While previous research has shown that different plant species in the landscape filter different types of light, very limited information is available on how turfgrasses are affected by different light spectrums. This is an important consideration because McBee (1969) noted blue light minimized stem elongation, while red light enhanced stem elongation for bermudagrass (*Cynodon* spp.) cultivars. In a separate study, McVey et al. (1969) noted blue light enhanced quality and color while reducing clipping fresh-weight production and vertical shoot elongation in both Kentucky bluegrass (*Poa pratensis* L.) and bermudagrass. More recently, researchers at The Ohio State University planted tall fescue cultivars (*Festuca arundinacea* Schreb.) under deciduous shade and neutral shade (92 percent light reduction). All cultivars grown under deciduous shade had less tillering, thinner leaf blades and lower chlorophyll concentrations than neutral shade grown cultivars (Wherley et al., 2005).

To begin to understand how light quality affects turfgrasses, a greenhouse project at Clemson University was conducted to investigate how Diamond zoysiagrass (*Zoy-*

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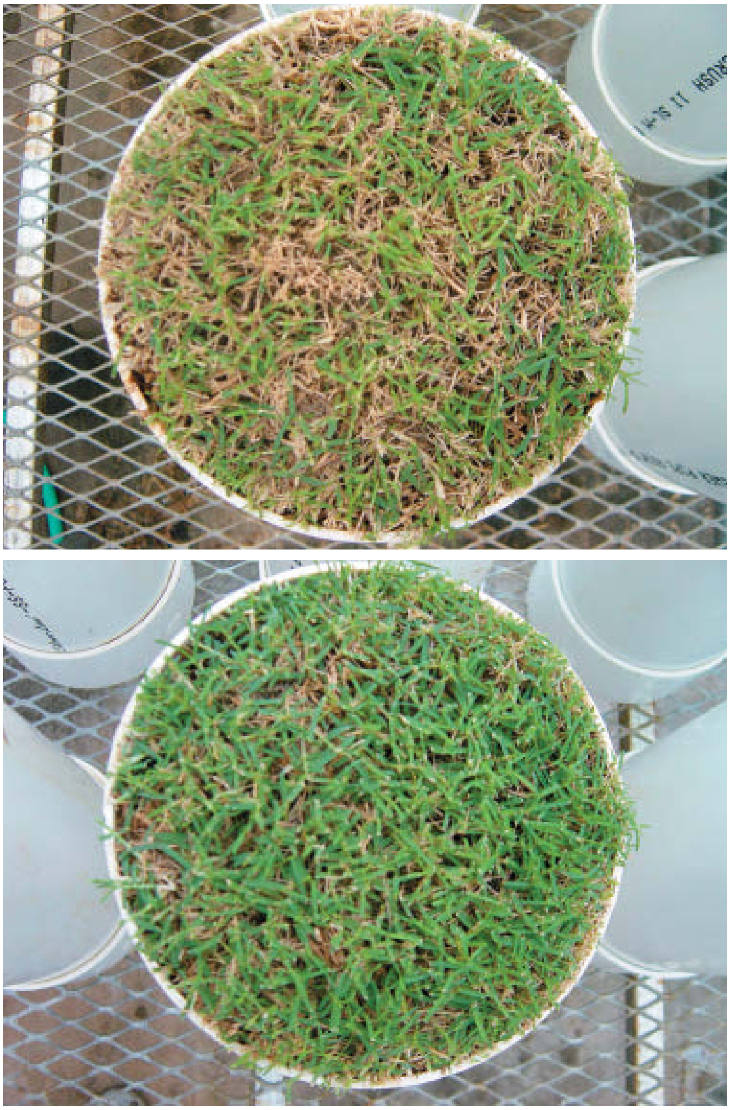

Bermudagrass varities, including Celebration, were studied under different shades. (Above) Celebration is shown grown under black shade and (below) red shade.

Continued from page 41

sia matrella (L.) Merr), Sea Isle 2000 seashore paspalum (*Paspalum vaginatum* Swartz.), and Tifway and Celebration bermudagrass (*Cynodon dactylon* X c. *transvaalensis*) responded to different types of light quality.

Light treatments included a full-sunlight control and four different color shade cloths filtering wavelengths 560 to 720 nm (blue shade cloth), 360 to 520 nm (yellow shade cloth), 360 to 560 nm (red shade cloth), and 360 to 720 nm (black shade cloth). Red to far-red ratio for each cloth was about 1.171, while percent light reduction for each cloth was about 65 percent. Turfgrasses were mowed every other day at 0.5 inches and fertilized weekly with 0.2 pounds of nitrogen (N) using a combination of 10Nitrogen-1.3Phosphorus-4.2Potassium and 5N-0P-5.8K liquid fertilizers (50:50 in the quantity of N) (Progressive Turf, LLC., Ball Ground, Ga).

Results

After eight weeks of shade treatment, Diamond was the only cultivar that remained above the acceptable total quality (TQ) threshold (greater than or equal to 6). However, all shade types reduced Diamond's TQ by about 1.5 rating units compared to full sunlight. Sea Isle 2000 TQ was greater than Celebration by 0.7, 1.2, and 1.4 rating units under yellow, blue and black shade, respectively. However, Celebration's TQ was approximately 1.4 rating units greater than Tifway under all shade types. The most shade-sensitive turfgrass was Tifway as TQ scores were less than or equal to 4 under all shade treatments. Other studies have noted similar responses among bermudagrass cultivars (Bunnell et al., 2005; Baldwin and Liu, 2007).

Regarding shade type, yellow and red shade cloths were the least detrimental, while black and blue shade cloths consistently resulted in lowest TQ scores. For example, Diamond, Celebration and Tifway grown under blue shade had TQ scores about 0.8, 1.3, and 1.4 rating units lower, respectively, compared to yellow and red shade.

Growth habit

Clipping yield and lateral spread were collected to determine how shade type influenced the growth habit of each cultivar. Under full sunlight, all grasses responded differently. So, to accurately assess how shade influenced each cultivar, relative values were calculated. For example, relative lateral spread = [(lateral spread under a shade type/lateral spread under full sunlight) x 100].

Lateral Spread: After six weeks, all cultivars grown under black shade had slower lateral spread compared with yellow and red shade. Sea Isle 2000 and Celebration lateral spread was 2.2 and 3.7 times lower, respectively, under black shade compared with blue shade. Under red shade, Sea Isle 2000 lateral spread was 35 percent lower than yellow shade. Diamond, Sea Isle 2000, Celebration, and Tifway lateral spread under red shade was 1.8, 2.9, 4.6, and 5.3 times greater, respectively, than black shade.

Diamond consistently had greater lateral spread, regardless of shade type, compared with all cultivars. Specifically, Diamond had about 2.8 times greater lateral spread than both bermudagrass cultivars under all shade types. Sea Isle 2000 and Celebration had similar lateral growth habits. However, under blue shade, Celebration showed 72 percent greater lateral spread than Tifway. This data is a likely indication of why Celebration has been reported to be a more shade-tolerant bermudagrass.

Typically, inhibited lateral stem growth negatively impacts warm-season turfgrass development when sunlight is intercepted (Beard, 1997), leading to excessive removal of top growth. However, Celebration appears to have a greater ability to maintain a lateral growth habit under shade compared with Tifway. Under full-sunlight, Karcher et al. (2006) reported Celebration had a more aggressive lateral recovery potential from divot stress than Tifway bermudagrass. This morphological adaptation under shade is possibly related to plant hormone manipulation, in particular, gibberellic acid (GA).

Clipping Yield: By week six, clipping yield differences between yellow and red shade and between red and blue shade were not detected. However, Tifway grown under blue shade had 76 percent lower clipping yield compared with yellow shade. Similar to lateral spread, all cultivars grown under black shade had a reduction in clipping yield compared with yellow and red shade. Diamond, Sea Isle 2000, and Celebration clipping yield under black shade was about 2.1, 2.2, and 2.5 times lower, respectively, compared with other shade types.

Comparing turfgrasses, Diamond clipping yield was about 42 percent lower than Sea Isle 2000 under yellow and red shade. Meanwhile, Celebration had 49 percent, 73 percent and 98 percent greater clipping yield under yellow, red, and blue shade, respectively, compared with Tifway. Normally, under shade, a low clipping yield value would be beneficial, but after six weeks of shade, Tifway was severely thinned (as seen in the picture), while Celebration was still able to support additional top-growth under shade.

Conclusion

When considering tree removal, thinning, or planting trees, light quantity and tree location are important factors in these decisions, but the type of light filtered by the tree should also be a relevant consideration. Overall, in this study, light filtered by the yellow and red shade cloth was least detrimental, followed by blue shade. Black shade (all wavelengths filtered) resulted in poorest performance of all turfgrasses. Regarding turfgrass selection, Diamond was the most shade-tolerant turfgrass. Under shade, Sea Isle 2000 and Celebration had similar growth habits; however, Sea Isle 2000 had better TQ scores. The least shade-tolerant turfgrass was Tifway.

Future research should continue to determine the type of light altered by trees commonly planted in the landscape. Also, screening more turfgrass species and cultivars in the field and investigating different management practices to improve turfgrasses response under different light qualities will be beneficial.

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Blue light minimized stem elongation, while red light enhanced stem elongation for bermudagrass (*Cynodon* spp.) cultivars.

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Nutrient Interactions In Turf Management

PART ONE
OF TWO PARTS

By Richard J. Hull & Haibo Liu

Over the past several years, we've discussed the roles of essential mineral nutrients in turfgrasses and their impacts on turf management in this journal. Rarely did we consider the interactions among nutrients and how such interactions influence turf quality and the appropriate nutrient management of turf.

While certainly not ignored by turf researchers, this subject has rarely been the primary focus of nutritional investigations. As a result, there appears to have emerged relatively few overarching principles governing the composition of turf fertilizers, especially the optimal balance between macro and micronutrients.

A compartmental model

Contributing to the complexity of nutrient balance in turf is the compartmental nature of the turf-soil ecosystem. For simplicity, we can visualize this system as consisting of three principal interacting compartments: soil (especially soil solution), root cell walls (apoplast) and interconnected protoplasts of root cells (symplast).

Nutrient absorption by turfgrass roots involves transfer of nutrient ions through these compartments such that the composition of nutrients within root cells will be very different from that of the soil solution. Differences will include the ratios of nutrients to one another and their concentrations. For example, there may be more calcium (Ca) than potassium (K) in the soil solution but substantially more K than Ca within the cytoplasm of root cells. Also, K within root cells may be 10 to 100 times more concentrated than it is in the soil solution.

There's obviously a good deal of quantitative and qualitative selectivity in the transport of individual nutrients through the compartments of a turf-soil ecosystem.

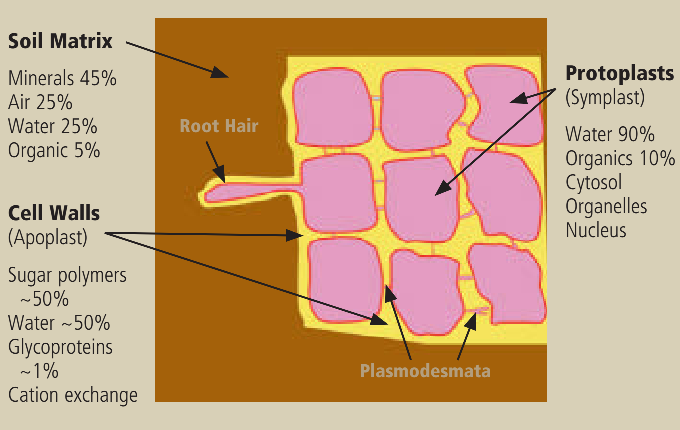
The environments within the three compartments comprising the turf-soil system also differ substantially. The nutrient cation (positively charged ion) composition of the soil solution is controlled by their relative ionic binding strength with the cation exchange sites on colloidal clays and organic gels. The comparative binding strength of common soil cations, in order of decreasing strength, is as follows (Brady and Weil 1999):

$$Al^{3+} > Ca^{2+} > Mg^{2+} > K^{+} = NH_4^{+} > Na^{+}$$

In most soils, cations of each nutrient element are bonded to negative charges on mineral and organic colloids. These ionic bonds are reversible and tend to maintain the free cation concentration in the soil water within a reasonably narrow range. However, these buffered concentrations can be disturbed dramatically following applications of a soluble fertilizer or during periods of drought. Nutrient anions are bonded only weakly to colloids but are often in equilibrium with almost insoluble salt crystals or gels that help maintain their ionic concentration in soil water.

Highly soluble anions are mostly in the soil solution and are free to leach to the subsoil and ultimately into the water table when water percolates through the soil pro-

Model of Root-Soil System Compartments



file. Root cells are enclosed within cellulose-based cell walls. The carbohydrate polymers that comprise these walls are highly hydrated and constitute an aqueous phase from which root cell protoplasts acquire their water and mineral nutrients. Since roots grow in the soil, their surface cells are bathed in soil water. Any nutrient ions available to a root must find their way from soil water into this cell wall space before they can be absorbed within living root cells.

The environment of the cell wall space is often quite different from that of the surrounding soil. Within the apoplast, much of the water is bonded to the polymers that comprise the cell walls but free water is reasonably abundant as well.

Some of these carbohydrate polymers (pectins) contain sugar-acid units that, at a pH above 4.5, will release a H^+ from their carboxyl group leaving a negative charge on the polymer. These negative charges will attract and bind with cations much as cation exchange sites do in the soil. Because of these cation exchange sites, water in the cell walls will contain a greater concentration of nutrient cations than will be present in the soil solution and likely a somewhat lesser nutrient anion concentration but one still greater than that of soil water.

Cell wall spaces will have an elevated H^+ concentration because H^+s are also attracted from the soil water and in addition, are pumped out of the protoplasts into the apoplast during normal cell functions.

For the reasons cited above, the apoplast from which nutrient ions are actually transported into root cell protoplasts is likely to be more acidic and have a greater nutrient concentration than the soil water.

The protoplasts of root cells are interconnected by tiny protoplasmic tubes called plasmodesmata and constitute a network of living protoplasts that can develop independently yet exchange materials and information among themselves and throughout the plant. This living protoplasmic network is called the symplast. Each cell's protoplast is enclosed within a plasma membrane that separates the living part of a cell from its external nonliving cell wall (apoplast). To enter into a protoplast, all water and nutrient ions must cross a plasma membrane that is selectively permeable, allowing some ions to cross while excluding others. Thus, the protoplast compartments of a root can have a nutrient composition very different from that of the soil solution and its surrounding apoplast.

It is within the plant that nutrient balance is most critical since it is here that nutrients perform their metabolic functions. Once absorbed by root cells, nutrients are distributed throughout stems and leaves via xylem elements of the vascular system. Transpiration of water from leaves provides the driving force for upward movement of water and nutrient ions within xylem elements. Some nutrient ions can exit the leaves via sieve elements of the phloem and circulate throughout the plant. Such nutrients are likely to be sufficient for growth of meristems (growing points) but may become deficient in leaves. Others have limited phloem mobility and may become deficient in meristems while remaining adequate in leaves. These resulting nutrient imbalances within the plant can cause problems that will be discussed later, but often may be addressed through foliar fertilization.

Plant nutrients will interact with each other differently within each of these three compartments making nutrient availability to, uptake by and distribution within plants a highly complex phenomenon.

We will explore these nutrient interactions in the soil in the next article in this series.

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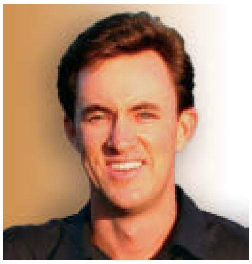
Score One for Supers

CHAMBERS BAY'S DAVID WIENECKE PUT HIS FOOT DOWN AND LET THE WORLD KNOW THAT HE KNEW HIS COURSE BETTER THAN ANYBODY ELSE



BY GEOFF SHACKELFORD

After one of the least agronomically friendly summers in decades, this probably isn't the time for golf course superintendents to open up a second-story clubhouse window and scream at unsuspecting golfers, "I'm mad as hell and I'm not going to take 12 on the Stimpmeter anymore!"

Such an outburst, while emotionally cleansing and the only appropriate way to communicate with some golfers, may not be ideal for job security. But after a prestigious list of courses lost parts or all of their greens in dreadful growing conditions and at today's ultra-low mowing heights, it's impossible not to revisit the tiresome and seemingly never-ending chase for green speed.

Because, as is always the case, it's not the golfers taking the blame for pushing the internal organs too hard. Instead, it's their doctors — superintendents — who are blamed for not keeping the hearts pumping even after ingesting the golf maintenance equivalent of a 12-pack a day topped off by a six-pack every night.

It's rather comical how most Americans take doctor's orders so seriously, popping pricey pills without a trace of skepticism. Yet, when golf course superintendents want to do some preventive care or back off the chase for speed, they're depriving the patients of fun and not doing their jobs.

I suppose superintendents shouldn't be treated with the same respect as doctors — after all, this isn't a life-and-death business. But short of donning white lab coats for their daily house calls around the course to inspect all 18 holes, there's only one way to make golfers understand who knows best. It's time to start screaming out of clubhouse windows. Or, at least, offering strong defenses when given the opportunity.

This summer, at least one superintendent did just that — David Wienecke, superintendent of Chambers Bay Golf Course in University Place, Wash., and site of the 2010 U.S. Amateur. After years of agronomic struggles brought on by tough Pacific Northwest winters and the arduous task of growing in fescue fairways and greens, the course was just where David Wienecke wanted it. But the week prior to a 36-hole stroke-play qualifier, the United States Golf Association arrived and said the course needed to be faster and firmer. It turned out to be the first real blunder in Mike Davis' otherwise impressive run of setting up courses for USGA tournaments.

"When Mike told me not to water at all, I got a little concerned," Wienecke told Cybergolf's Tony Dear. "The irrigation system had been turned off for nearly a week already at that point, but we hadn't been hand-watering the greens. I was worried that drying them out any more might cause a problem. I thought the course might become unfair because good shots wouldn't be rewarded, and I was worried we might lose some hole locations."

Wienecke turned out to be a prophet, as the stroke play portion of the U.S. Amateur produced an appalling 79.25 scoring average in benign weather. The best amateur golfers in the world were humiliated and, worse, most left Chambers Bay with a bad taste in their mouths.

While the USGA's quest to turn off the water and promote firm and fast golf is noble, the cause surely took a hit. But, admirably, Wienecke scored one for superintendents by putting his foot down and letting the world know that he knew his course better than the visitors.

Whether this episode translates into a wake-up call for golf's elite to listen to their superintendents more carefully is really up to the doctors themselves.

The only way to put an end to the madness is to speak your piece before it's too late. And, failing that, you can pick up white lab coats at any medical supply store.

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HERBICIDE