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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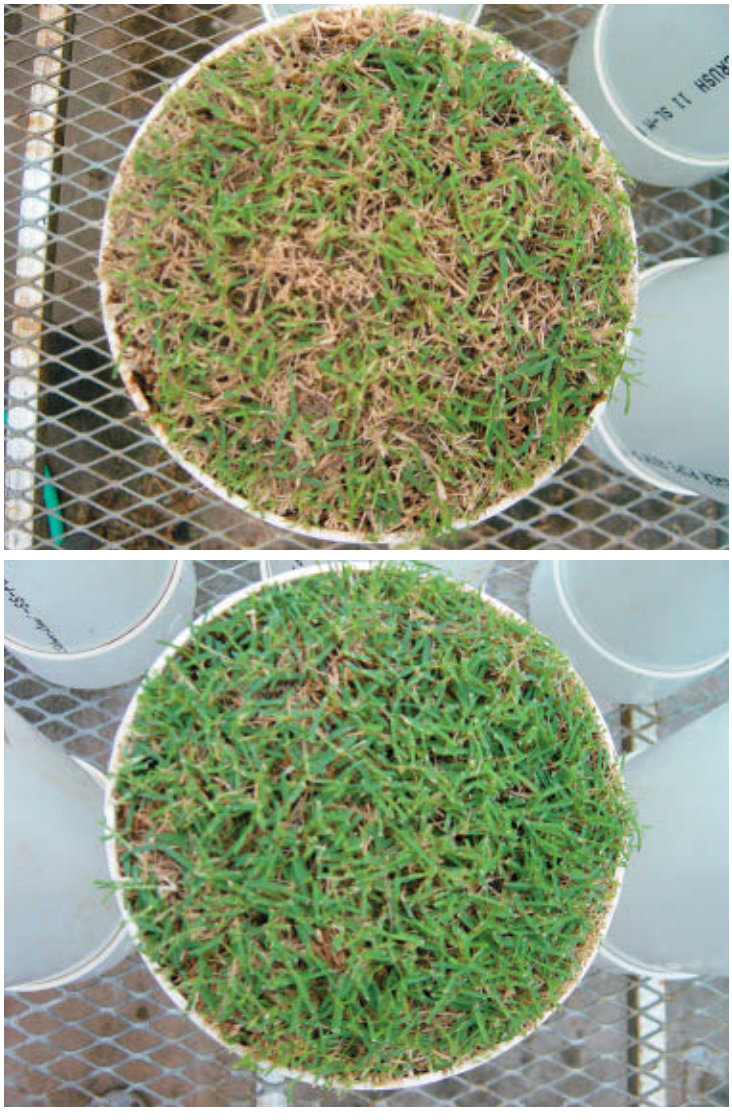

Bermudagrass varities, including Celebration, were studied under different shades. (Above) Celebration is shown grown under black shade and (below) red shade.

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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.

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

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