BY WENDY GELERNTER, PH.D. AND LARRY J. STOWELL, PH.D.

Shade versus turfgrass: a no-win situation?

When asked what your top five pest problems are, do you consistently put trees at the top of the list – ahead of the usual suspects such as *Poa*, white grubs, brown patch or dollar spot? If so, you're not alone. Trees, or more specifically, the shade that trees create, pose a significant management problem for golf courses almost everywhere throughout the world. The unfortunate truth is that turf plants require lots of light for optimum growth. Whether it's shade from trees, buildings or overcast weather, there hasn't been a turf variety developed that performs well when it's deprived of light.

THE IMPORTANCE OF LIGHT

Plants use light the same way animals use food – to fuel the chemical reactions that keep them alive. But different types of plants require different levels of light. Think of the mosses and ground covers that grow on the forest floor or shade-loving house plants. These require little light for survival and would actually suffer and even die if exposed to harsh, direct sunlight.

In contrast, there are plants that require many hours of high intensity light per day, and will die if forced to grow in the shade. Plants that grow in desert environments, as well as agricultural crops such as corn and sugar cane,

FIGURE 1

What a difference 12 years makes. Aerial photographs of fairways taken in October 1986 (top photo) and 12 years later in October 1998 (bottom photo). Note the increase in tree height and shade on the fairways and associated greens. The increase of shade has resulted in patchy turf and weed invasion in the warm-season fairways and a decision to avoid fairway overseeding programs. Fairways that are aligned east to west are particularly harassed by tree-related shade problems, especially during the winter when the angle of the sun is lowest and shade patterns are maximized.

fall into this group. Most turfgrasses require significant quantities of light for optimum growth and development, but there are important differences among turf varieties.

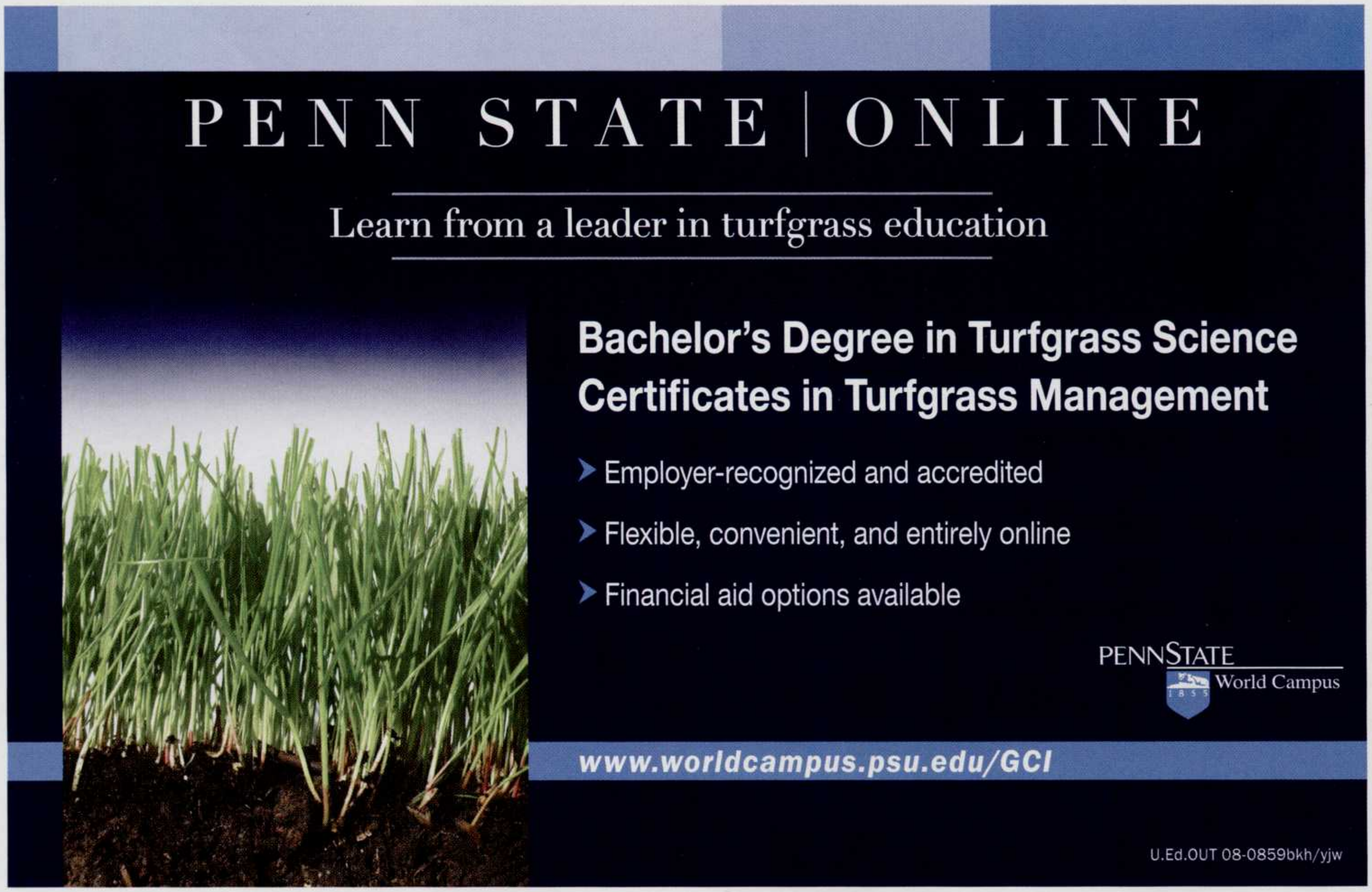
IS THE SUN SHINING ON YOUR TURF?

Warm-season turfgrass varieties require two or more times the amount of light as cool-season varieties (Table 1). When reviewing the solar radiation data for locations throughout the U.S., the one interesting thing that stands out is that optimum sunlight for warm-season turfgrass is a rare commodity; only a few areas in the U.S. are really suitable. Even in areas where there is sufficient heat for warm-season turf, sunlight levels are too low because of frequent rainfall and cloud cover (as in the southeastern U.S.) or simply because of chronically overcast conditions (as in many coastal locations).

TABLE 1. Shade tolerance of key golf course turfgrasses

Turfgrasses with good to excellent shade tolerance generally produce good-quality turf, even when grown in partial shade. Unfortunately, there are no turfgrasses that grow well in full shade. Those with poor shade tolerance will produce poor-quality turf or won't survive at all under shaded conditions. These ratings are based on the assumption that all other factors (fertility, irrigation, air temperature) are being optimized for that particular turf type.

	GOOD TO EXCELLENT	FAIR TO GOOD	POOR TO FAIR	POOR
Cool season: optimum radiation = 116 - 233 watts/m^2/day or 240 - 480 langleys/day	• Fine fescues (creeping red, Chewings, hard, sheep) • *Poa trivialis*	• Tall fescue • Velvet bent • Annual bluegrass	• Colonial bent • Creeping bent	• Annual rye • Kentucky blue • Perennial rye
Warm season: optimum radiation = 390 - 465 watts/m^2/day or 812 - 969 langleys/day		• St. Augustine • Zoysia • Kikuyu	• Bahia • Buffalo • Carpet • Centipede • Seashore paspalum	• Bermuda



www.golfcourseindustry.com/readerservice - #51

Despite the lack of sufficient solar radiation, many golf courses manage warm-season turf for at least part of the year because of its ability to withstand higher heat than cool-season turf. Nevertheless, the lack of sufficient light is an important stress that weakens warm-season turf, making it more susceptible to attack by pests, traffic and other stressors.

THE PROBLEM WITH SHADE

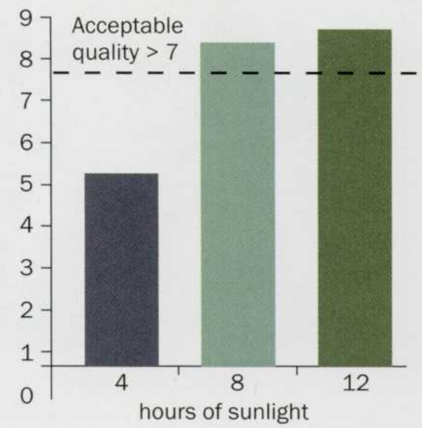
Light can be reduced by any number of factors. Interference from trees and buildings and cloudy weather are most common. These factors can cause a reduction in the number of hours of light a plant receives each day and/or the intensity of the light received. Whatever the cause, when turf plants receive less than optimal light, they begin to change almost immediately at the biochemical and molecular levels, resulting in lower rates of respiration and photosynthesis and slower plant growth. These more or less invisible changes soon bring about some obvious changes in the anatomy and appearance of turf including:

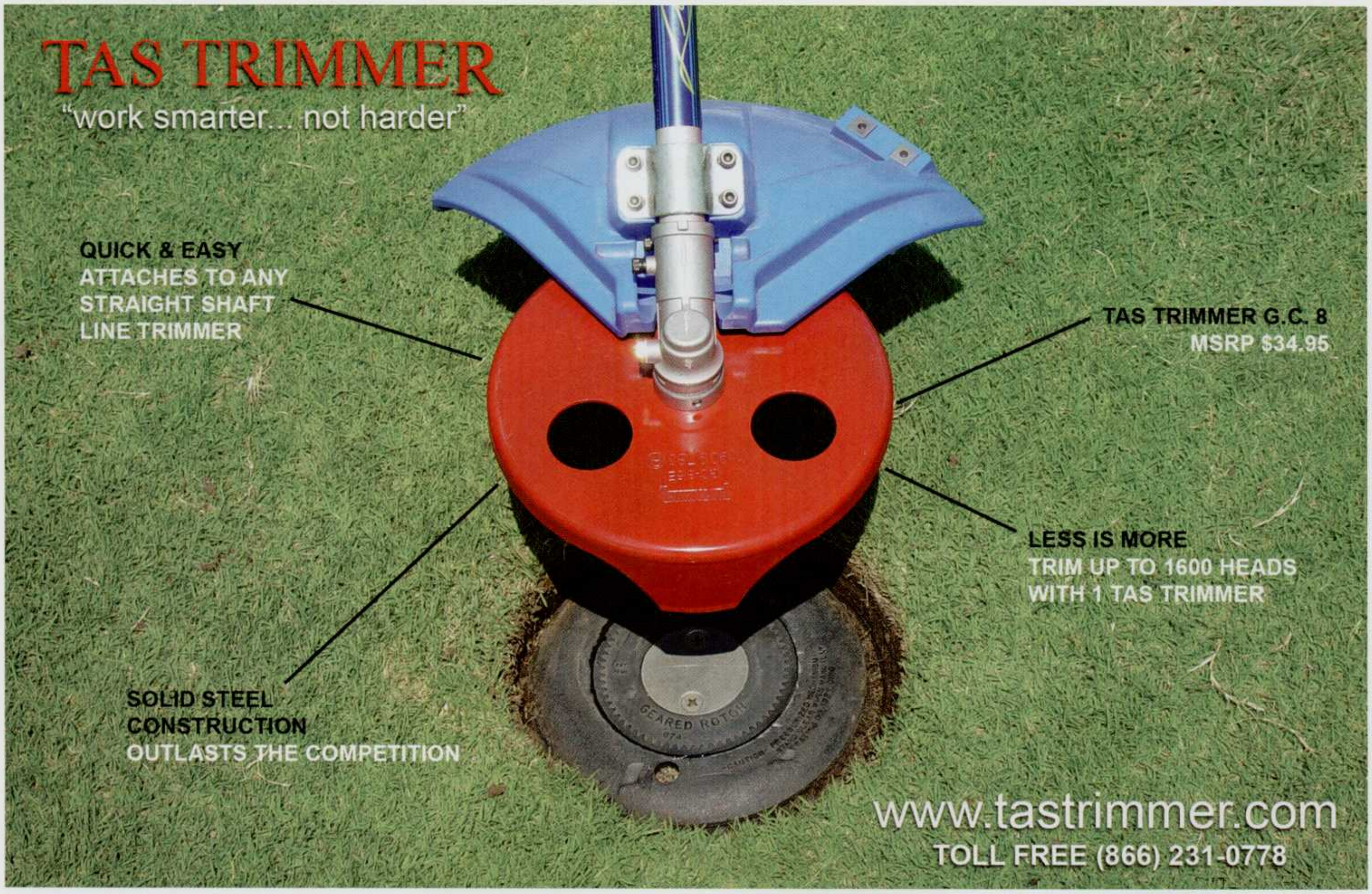
- Plants become elongated (taller), but stems are thinner and weaker. Internodes are longer, and stolons are fewer. Turf thins as a result.
- Root growth is decreased significantly. Shoot growth, shoot density and tillering are reduced, too.
- Leaves become darker, fewer in number, narrower and more succulent (more moisture is retained).
- The leaf's waxy protective outer layer, the cuticle, becomes thinner.

The resulting plants are weakened considerably, and turf quality is reduced significantly (Figure 2 and photo on page 78). The succulent leaves with their thinner cuticle are more susceptible to damage from traffic, equipment

FIGURE 2

Effect of duration of sunlight on TifEagle Bermudagrass greens. Acceptable quality turf was produced with eight hours or more per day of full sunlight. Turf quality suffered dramatically when sunlight hours were reduced by shade to four per day. Data from Bunnell and McCarty, 2004. Similar trends are observed for cool-season turf.





www.golfcourseindustry.com/readerservice - #53

and disease. The depleted root system and lower energy reserves make it more difficult for the plant to recover from any type of injury from heat, cold, excessively dry or wet conditions, or disease. Weeds become more common because the turf plant is unable to compete effectively with them for moisture, light and nutrients.

And to complete this ugly picture, turf growing in shade is damaged frequently by overwatering and overfertilization with nitrogen. This occurs because plants grown in shade are growing more slowly and, therefore, require less of all nutrients for growth and survival. The quantities of water and nitrogen that are essential for growth of turf in sunny locations can be fatal to turf grown in shade.

THE BIG PICTURE

Shade affects turf management and golf course playability on a larger scale. Expect increased weed pressure and an increase in your fungicide budget because of the increased susceptibility of shade-grown turf to disease. Consider the cost/benefit of separate irrigation and fertilization programs for shady areas. Make golfers aware of the likelihood of increased pest and stress problems on shaded turf.

Additionally, shade produces some specific problems, depending on the turf type and turf height of cut:

Golf courses with warm-season turfgrass on fairways. Shady areas will suffer from competition with cool-season turf varieties in the forms of weeds such as *Poa annua* or from purposefully overseeded varieties that fail to die during the summer. This leads to bare spots, especially because of weakened warm-season turf. Additionally, spring/summer transitions won't be successful in shady areas because cool-season species likely will survive throughout the summer.

Greens in partial shade. Moss, algae, weeds and disease will increase in shady areas, and turf will be thinner and more susceptible to damage from traffic. Shady areas will be wetter unless it's possible to irrigate the green selectively with less frequent irrigation in shady areas.

MANAGING TURF IN SHADE

Tree pruning or removal are frequently the only solutions to shade problems. If, despite your best efforts, these aren't options at your golf course, it's inevitable turf quality will be compromised somewhat. However, there are some steps you can take to help minimize the damage:

Raise mowing heights to increase leaf area and photosynthesis. For example, Bunnell and McCarty (2004) have shown that a 50-percent increase of mowing height (from 1/8 inch to 3/16 inch) can increase the quality of TifEagle Bermudagrass greens significantly. Comparable

www.golfcourseindustry.com/readerservice - #55

results have been shown for cool-season turf as well. Even a 10-percent increase of mowing height can make a difference.

Minimize traffic in shady areas as a means of avoiding physical damage to this more delicate turf.

Be prepared to treat more frequently for weeds, disease, algae and moss.

Decrease irrigation in shady areas. Turf in these locations grows more slowly and, therefore, requires less water for survival. Separate irrigation systems for consistently shaded areas should be considered.

Avoid excessive nitrogen. Turf grown in the shade will use less nitrogen than turf grown in the sun. Keep soil total nitrogen levels between

When turf plants receive less than optimal light, they begin to change at the biochemical and molecular levels. Photo: PACE Turfgrass Research Institute

www.golfcourseindustry.com/readerservice - #57

3 and 20 ppm.

Use growth regulators. Consider using multiple applications of low rates of plant growth regulators such as trinexapac-ethyl (Primo) or flurprimidol (Cutless). These gibberellic acid inhibitors will counteract some of the negative effects of shade by increasing plant density and decreasing plant shoot elongation.

Discontinue winter overseeding programs for warm-season turf in shady areas to avoid bare spots because of summertime competition between overseeded varieties and warm-season turfgrass.

Supplemental lighting might be useful in cases where a small area (a green, for example) is in need of extra light. The most efficient and most frequently used lights are high pressure sodium lamps. These can be obtained from greenhouse suppliers or manufacturers.

Switch to shade-tolerant turf if possible. Some options are listed in Table 1.

Document, document, document. We've found that photographs and graphics are useful to document the extent of shade problems, as well as the increase in tree-generated shade throughout the years. Generally, graphic representations of the problem are the clearest way to communicate with golfers and managers about the impact of shade.

Aerial photography (see Figure 1) services are available in most locations. To obtain the most useful images, they need to be high resolution, so altitudes of 5,000 feet or less and specialized 9-inch-by-9-inch negatives should be requested (commercially available satellite images are not of sufficient resolution unfortunately – at least not yet). Photos should be taken at the time of day and time of year when you believe shade causes the worst problems. If you're lucky, aerial photographs of your golf course from years past might exist in photobanks. If these photos are available, they can be useful when tracking the development of shade (and other problems such as irrigation distribution, reclaimed water) throughout time.

Shade analysis. After an extensive on-site visit, companies that perform these analyses can tell you how many hours of sunlight are occurring on problem areas, which trees are contributing to the problem the most, and the effect of pruning or removal of specific trees. The expense makes this approach feasible primarily for greens, but it might be worth it to you if this type of quantitative analysis appeals to the golfers that you deal with. While companies such as ArborCom deal primarily with tree shade, engineering companies such as RWDI can help predict the impact of a new building on turfgrass quality.

When all else fails. In areas of extreme shade where turf simply won't grow, consider replacement with shade tolerant plants, ground covers, or even bark or wood chip mulches. **GCI**

Wendy Gelernter, Ph.D., and Larry J. Stowell, Ph.D., are research directors with the PACE Turfgrass Research Institute (www,paceturf.org).

References

Beard, J.B. 2002. Turf management for golf courses, second edition. Ann Arbor Press, Chelsea, Mich.

Bell, GE and TK Danneberger. 1999. Temporal shade on creeping bentgrass turf. Crop Science. 39.1124-46.

Bunnell, TB and B. McCarty. 2004. PGRs and higher heights: improving TifEagle greens in shade. Golf Course Management 72(10):93-97.

Dudeck, A.E. and Peacock, C.H. 1992. Shade and turfgrass culture. pp. 269 to 284 In "Turfgrass," Waddington, D.V., Carrow, R.N. and Shearman, R.C., eds. American Society of Agronomy Monograph 32. ASA Publishers, Madison, Wis.

This warm-season (kikuyugrass) fairway was performing adequately in sunny areas, even though solar radiation was 224 watts/m^2 – suboptimal because of the perennially overcast conditions. However, in the shaded areas, light intensity was only 17 watts/m^2. As a result, kikuyugrass and *Poa annua* couldn't grow, and unsightly bare areas were the result. The only solution to this problem was a severe tree trimming and removal program. Photo: PACE Turfgrass Research Institute