Shade and Turfgrass: Can They Peacefully Coexist?

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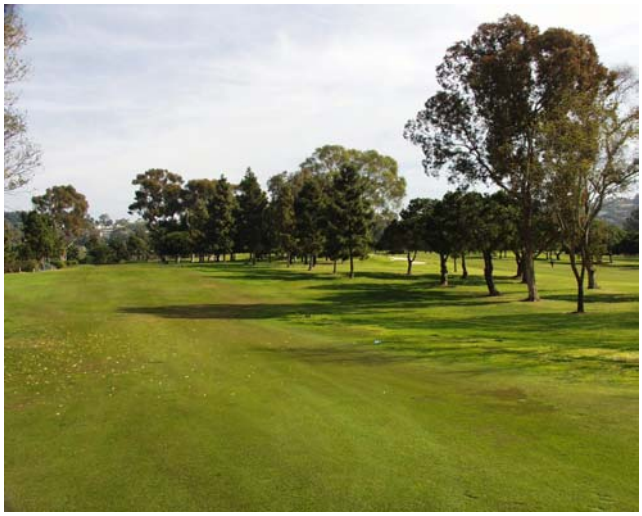
Bottom line: There's no way around it -- shade and turfgrass health are usually not compatible. When turf doesn't receive sufficient light, a smorgasbord of problems develop, including low quality turf, weed invasion, increased susceptibility to diseases, traffic damage, bare spots, wet spots, and reduced playability due to the growth of a heterogeneous mixture of turf and weed varieties. Pruning and tree removal are frequently the only solutions, but may not be acceptable for a variety of reasons. If you are forced to live with shade, there are management practices (increased mowing heights, increased fungicide applications, selective irrigation and fertilization, suspension of overseeding programs) than can partially alleviate the damage; but there is almost nothing -- save the use of shade-tolerant, non-turf varieties or mulches -- that you can do to avoid shade related damage to turf. Under these conditions, keeping golfers informed about what to expect in shady areas will become important component of your job.

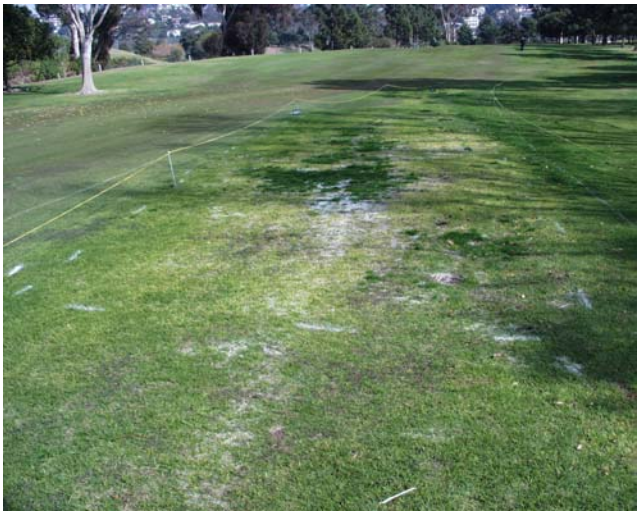


There are three critical factors required for turfgrass growth and development -- light, water and air. The absence of just one of these factors spells certain death for any green plant. Even small reductions in the required levels of light, water or air will result in turfgrass stress, which in turn leads to increased susceptibility to diseases, more competition from weeds, greater injury from traffic and lower quality turf. For example, in the photo above, the shade, which extends approximately half way across the fairway (photo taken in San Diego, CA January, 2001) has caused invasion by cool season weeds, bare areas, and reduced playability.

For anyone who has worked with plants, the above is an obvious, fundamental, and inflexible fact of Nature. But try telling that to a stand of 30 foot tall trees that are shading the fairway. Or to golfers who can't help but want to preserve the beauty that trees can bring to a landscape.

In this issue of *PACE Insights*, we'll concentrate primarily on shade from trees (buildings and cloudy climates can also cause similar problems), explain why shade can be so damaging to turfgrass, and suggest some steps that can be taken to alleviate the problem. Finally, we'll propose a few ways of communicating with golfers about this very technical, but also very emotional topic.

Figure 1. Shade results in invasion of warm season fairways by cool season turf. A winter time application of Kerb was made to stop the invasion of *Poa annua* from the shady areas on this warm season fairway, leaving many bare areas where warm season turf doesn't have sufficient light for survival. This is the classic Catch-22 situation, because without herbicide treatment, bare areas will also result -- but later in the summer when the poa dies out naturally due to higher temperatures and salinity stress. Other than removing trees, there is no solution to this problem.



The importance of light

Plants use light in the same way that 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 of shade-loving house plants. These require very 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 per day of high

intensity light, 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 fall into this group.

Most turfgrasses require significant light for optimum growth and development, although there are important differences among varieties (Table 1).

Made in the shade: how turf re-invents itself under low light conditions

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 that a plant receives each day and/or the intensity of the light received. Whatever the cause, when turf plants receive less light than is optimal for them, they begin to change almost immediately at the biochemical and molecular level, resulting in lower rates of respiration and photosynthesis and slower plant growth. These more or less invisible changes soon bring about some very obvious changes in the anatomy and appearance of turf including:

- Plants become elongated (taller), but stems are thinner, with longer internodes and fewer stolons.
- Root growth is significantly decreased. Shoot growth, shoot density and tillering are also reduced.
- The 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 seriously weakened. The succulent leaves with their thinner cuticle are more susceptible to damage from traffic and equipment, as well as to disease. The depleted root system and lower energy reserves makes 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 effectively compete with them for moisture, light and nutrients. And to complete this ugly picture, turf growing in shade is frequently damaged by over-watering and over-fertilization 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.

Table 1. Shade tolerance of some key golf course turfgrasses. Turfgrasses with **good to excellent** shade tolerance generally produce good quality turf, even when grown in partial shade (there are unfortunately no turfgrasses that grow well in full shade, though). Those with **poor** shade tolerance will produce poor quality turf, or will not survive at all under shaded conditions. Note that there may be certain varieties within each of the turf types listed below that will exhibit greater or lesser tolerance to shade than indicated below. 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 or 240 - 480 langleys/day	• **Chewings fescue** • **Hard fescue** • **Poa trivialis** • **Red fescue**	• **Tall fescue**	• **Annual bluegrass** • **Colonial bentgrass** • **Creeping bentgrass**	• **Annual ryegrass** • **Kentucky bluegrass** • **Perennial ryegrass**
WARM SEASON: optimum radiation = 390-465 watts/m^2 or 812-969 langleys/day	• **St. Augustinegrass**	• **Zoysiagrass**	• **Buffalograss** • **Carpetgrass** • **Centipedegrass** • **Kikuyugrass** • **Seashore paspalum**	• **Bahiagrass** • **Bermudagrass**

The big picture

How does shade affect turf management and golf course playability on a larger scale? Expect increased weed pressure, and an increase in your fungicide budget, due to 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 that wet spots will occur on a regular basi s, due to the reduced requirements for water in shady areas, and that more heterogeneous turf/weed mixtures will develop in shady areas.

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

Golf courses with warm season 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 in turn leads to bare spots, especially due to weakened warm season turf (Figure 1). In addition, spring/summer transitions will not be successful in shady reas, since cool season species will likely survive throughout the summer.

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

October, 1986

October, 1998

Figure 2. What a difference 12 years makes! Aerial photographs of fairways 14, 15 and 17 taken in October 1986 (top photo) and 12 years later in October, 1998. Note the increase in tree height and shade on green 13, fairway 14, green 14 and fairway 17. The increase in 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.

Managing shade

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

- Raise mowing heights to increase leaf area and therefore photosynthesis. Even slight increases in mowing heights may have a significant, positive effect. For example, Bell and Danneberger (1999) have calculated that bentgrass greens mowed at 9/64" will gain 13% more leaf area and 13% more photosynthetic potential than greens mowed at 8/64" (1/8"). An increase to 5/32 creates 25% more photosynthetic potential.
- Minimize traffic in shady areas as a means of avoiding physical damage to turf
- Be prepared to treat more frequently for weeds, disease, algae and moss.
- Where possible, decrease irrigation in shady areas.
- Avoid excessive nitrogen. Bell and Danneberger (1999) have shown that creeping bentgrass that is shaded for more than half the day may require less than half the N of bentgrass in full sun
- Discontinue overseeding programs in shady areas to avoid bare spots due to summertime competition between overseeded varieties and warm season turf.
- In areas of extreme shade where turf simply will not grow, consider replacement with shade tolerant plants, ground covers, or even mulches.

Managing expectations: one picture is worth a thousand words

Perhaps even more important than managing shade will be managing the expectations of golfers regarding the impact of shade on turf quality and performance. Though you may know exactly why and where shade is causing problems, communicating this information effectively, with words as your only tools, can be frustrating.

We have found that photographs -- particularly aerial photographs (Figure 2) are useful in documenting the extent of shade problems, as well as the increase in tree-generated shade over the years.

Aerial photography services are available in most locations. To obtain the most useful images, they need to be fairly high resolution, so altitudes of 5,000 feet or less and specialized 9X9" negatives should be requested (commercially available satellite images are unfortunately not of sufficient resolution -- at least not yet). Photographs should be taken at the time of day and time of year when you believe shade causes the worst problems. If you are lucky, aerial photographs of your golf course from years past may exist in photobanks; this is frequently the case in regions where building and development activity is high, thus necessitating frequent aerial surveys. If these photographs are available, they can be expecially useful in tracking the development of shade (and other problems such as irrigation distribution, reclaimed water) over time. When available, they can be obtained from aerial photography services, usually for a few hundred dollars, to anyone who is interested.

An additional option for improving communication about shade is the use of shade analyses, performed by companies such as ArborCom (Toronto, Ontario). After an extensive on-site visit, these companies perform analyses that can tell you how many hours of sunlight are occurring on problem areas, which trees are contributing most to the problem, and the effect of pruning or removal of specific trees. The expense makes this approach feasible primarily for greens, but it may be worth it to you if this type of quantitative analysis appeals to the golfers that you deal with.

References

Beard, J.B. 1973. Turfgrass: science and culture. Prentice Hall, Englewood Cliffs, NJ.

Bell, G. and Danneberger, K. 1999. Managing creeping bentgrass in shade. Golf Course Management, October 1999. Pp. 56-60.

Bell, G. and Danneberg, K. 1999. Temporal shade on creeping bentgrass turf. Crop Science 39:1142-1146.

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

Harivandi, A. and Gibeault, V.A. 1996. Managing lawns in shade. University of California Publication 7214.

Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology, 4th edition. Wadswoth Publishing Company, CA. 682 pp.