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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
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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

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1. How Do You Want to Receive Your Subscription?
   • 1-Digital and Print
   • 2-Print Only
   • 3-Digital Only (No Print Copy Received)

2. What is your primary business at this location? (check one)
   • 1-Bentgrass
   • 2-Poa annua
   • 3-Poa/Bentgrass mix
   • 4-Bermudagrass
   • 5-Ryegrass
   • 6-Ryegrass
   • 7-Paspalum
   • 8-Other (please describe)

3. What best describes your title?
   • A-Golf Course Superintendent
   • B-Director of Golf/Head Pro
   • C-Director of Golf, Course
   • D-Club President
   • E-General Manager
   • F-Chief Financial Officer
   • G-Building/Engineer
   • H-Architect/Engineer
   • I-Research Professional
   • J-Assistant Superintendent
   • K-Manager/Associate
   • L-Other (please describe)

4. Number of Holes: (check one)
   • A-9 Holes
   • B-18 Holes
   • C-27 Holes
   • D-36 Holes
   • E-Other

5. Total Annual Maintenance Budget: (check one)
   • 1-$25,000 or less
   • 2-$25,000-$49,999
   • 3-$50,000-$99,999
   • 4-$100,000-$249,999
   • 5-$250,000-$499,999
   • 6-$500,000-$749,999
   • 7-$750,000-$1,000,000
   • 8-$1,000,000+

6. Total Course Acreage: (check one)
   • 1-Under 100
   • 2-100-299
   • 3-300-599
   • 4-600-999
   • 5-1,000-1,999
   • 6-2,000-2,999
   • 7-3,000-4,999
   • 8-5,000-9,999
   • 9-10,000-19,999
   • 10-20,000-49,999
   • 11-50,000-99,999
   • 12-100,000-149,999
   • 13-150,000-199,999
   • 14-200,000-499,999
   • 15-500,000-999,999
   • 16-1,000,000-

7. Course Renovation Plans for the Next 12 Months: (check one)
   • 1-Total Reconstruction
   • 2-Partial Reconstruction
   • 3-Addition
   • 4-Expansion
   • 5-Fairways
   • 6-Greens
   • 7-Other

8. If Only a Partial Reconstruction is Planned, Please Indicate the Number of Holes: (check one)
   • A-9 Holes
   • B-18 Holes
   • C-27 Holes
   • D-36 Holes
   • E-Other

9. What Year was the Course Built? (check one)
   • 1990
   • 1991
   • 1992
   • 1993
   • 1994
   • 1995
   • 1996
   • 1997
   • 1998
   • 1999
   • 2000
   • 2001
   • 2002
   • 2003
   • 2004
   • 2005
   • 2006
   • 2007
   • 2008

10. What is the Name of the Architect Who Designed the Course?

11. What Year was the Course Built?

12. Is this course part of a resort?
   • Yes
   • No

13. What is the name of the Resort Chain, Golf Course Management Company, or Municipal Course System?
   • 1-Resort Chain
   • 2-Club Chain
   • 3-Drowing the Green
   • 4-Other

14. What turf do you maintain on fairways? (check one)
   • 1-Bermudagrass
   • 2-Poa annua
   • 3-Poa/Bentgrass mix
   • 4-Bermudagrass
   • 5-Ryegrass
   • 6-Ryegrass
   • 7-Paspalum
   • 8-Other (please describe)

15. What turf do you maintain on greens? (check one)
   • 1-Bermudagrass
   • 2-Poa annua
   • 3-Poa-Bentgrass mix
   • 4-Bermudagrass
   • 5-Ryegrass
   • 6-Ryegrass
   • 7-Paspalum
   • 8-Other (please describe)

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Research

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.

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

**References**


This warm-season (kikuyugrass) fairway was performing adequately in sunny areas, even though solar radiation was 224 watts/m² – suboptimal because of the perennially overcast conditions. However, in the shaded areas, light intensity was only 17 watts/m². 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
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The little things count, too

An accessory upgrade is part of an overall course improvement project in Nebraska

Prairie Hills Golf Course in Pleasanton, Neb., had seen better days. The condition of the course has declined during the past few years, but Nick Erdman, co-superintendent at the public 18-hole course, and his family are changing that. They’re improving the course in many ways, including upgrading accessories.

The course hadn’t been run correctly, Erdman says, adding it had several owners during the past five years. Erdman and his in-laws, who live in the area, bought the course in June 2007 from the previous individual owner, who also managed the course.

“The course was in pretty bad shape,” he says. “We’re putting a lot of money into it. Although new sprinkler heads were installed by the previous owner, we put money into every aspect - equipment, fertilizer, irrigation, cups and the two-level, 5,000-square-foot clubhouse. We spent $5,000 on accessories, including flagsticks, tee markers, fairway markers and cup cutters.”

All of the new accessories were purchased at the same time last year.

Going forward, Erdman budgeted $2,500 a year for accessories.