Summer Stress Management for 2003

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Bottom line: Some components of summertime turf management are familiar and proven practices -- aeration, salinity management, raised mowing heights, traffic and heat management and properly targeted and timed pesticide applications. We have also recently taken a look at some less familiar -- but we believe, equally important -- sources of summer stress, including drought (due to poor irrigation distribution), nitrogen toxicity, oxygen depletion in the soil and phytotoxicity due to fungicide and growth regulator applications made on very hot days. In this issue of *PACE Insights* and its accompanying Reference (9:5), we will review some of the most important factors contributing to summer stress, as well as strategies for avoiding or overcoming the damage that they produce.

For most superintendents, summer is the time of year when all the years of study, knowledge, experience and intuition are put to the ultimate test. Battling everything from heat, torrential rains, increased traffic and compaction, high soil salts, and peak populations of insects and diseases (and golfers!) makes summer stressful not just for turf, but for managers as well. Every year at about this same time, we try to help alleviate some of the anxiety with an update on turf stress management programs.

Heat and drought stress

It seems as though diagnostic samples suffering from heat and drought have become more common in the past few years. With better management skills and more effective products available for control of diseases, insects and weeds, heat and drought damage remain two of the most difficult summer problems to avoid.

Figure 1. A combination of heat (several days over 100F) and drought (due to poor irrigation distribution) selectively damaged poa plants on this bent/poa green.

Symptoms of heat stress

While poa is generally more sensitive to heat and drought than bentgrass (Figure 1), the green in Figure 2 should convince any skeptics of the devastating effects of high temperatures on bentgrass as well.

Figure 2. This bentgrass green completely failed after two days of maximum temperatures above 115°F, and little or no air movement. No fans were present. Although syringing was implemented, the lack of air movement resulted in insufficient cooling for bentgrass to survive.

The critical role of turf canopy temperature

The turf canopy refers to the small area defined by the verdure (turf foliage) above the thatch area.

Monitoring turf canopy temperatures is the best way to avoid damage from heat stress.

The canopy temperature at which irreversible turf damage occurs – the **thermal death point** – varies from one turf variety to the next. Based on our field research and observations, we have been able to come up with some rough estimates for these values. For *Poa annua*, canopy temperatures of 115°F for two hours or more will result in death. For bentgrass (which is a bit more heat tolerant), a canopy temperature of 120°F for two hours will result in turf death. It is important to realize that even lower canopy temperatures can cause problems if they persist for longer than two hours. In other words, four hours at a canopy temperature of 110°F might cause the same damage as two hours at 115°F.

In most situations, the canopy temperature will run 10 or 15 degrees higher than the air temperature, though this is not always the case (see below).

What about warm season greens?

As a warm season turf, bermudagrass can withstand higher canopy temperatures -- up to about 130°F -- than either bentgrass or poa. Yet we still receive a sprinkling of heat stressed and heat killed bermudagrass diagnostic samples every year. We believe that this occurs because there are conditions that can elevate the canopy temperature to damaging levels for bermudagrass, even when air temperatures are in the 100s. For example, low mowing heights, disease or other stressors can disable turf to the point that it doesn't transpire properly, thus losing its ability to cool itself via evaporation. When this occurs, the plant's ability to regulate its temperature is lost, and canopy temperatures can become much higher than air temperatures. If the humidity is high and/or there is little air movement on the green, the canopy temperature can escalate even further. Heavy thatch layers can also add to the problem. As the older plant tissue in the thatch begins to breakdown or decompose, the process of composting is occurring -- and composting is a heat generating process that can contribute to higher canopy temperatures.

The heavy, straw-like, and frequently dry thatch layer that is sometimes associated with ultradwarf bermudagrass presents an additional challenge to the development of new roots, especially if the plants are stressed due to heat or other factors. We frequently receive samples where turf damage has been caused by lack of sufficient water to the roots. When plants are under stress, make sure that the straw/thatch layer is moist, and syringe if necessary. This will help promote root growth and will aid the struggling plants in their recovery.

For all of these reasons, it's no longer safe to assume that bermudagrass greens are immune to heat and drought damage. It's not a common problem, but it can occur.

PREVENTION: Cooling programs

Preventive cooling strategies that lower the temperatures in the turf canopy must be started **before** the critical canopy temperatures are reached. Based on our observations, preventive actions should be taken for cool season turf when maximum air temperatures reach about 90°F, or when turf canopy temperatures reach 100°F (for poa) or 105°F (for bentgrass). For bermudagrass, preventive cooling should be triggered by canopy temperatures of about 125F, or by air temperatures of 115F. These are rough numbers, empirically developed, and need much refinement, but should help provide some guidelines until more data is available. Your preventive cooling program should include one or more of the following components:

Temperature monitoring (see Reference 8:6, "Keep turf cool" for details)

Fans and blowers (Figure 3): In hot weather areas of the country, fans are relatively common and reliable tools for reducing turf canopy temperatures. They are particularly useful on greens with low air movement and/or greens that don't drain well. In these situations, fans have been observed to decrease turf canopy temperatures by 10°F or more when they are situated correctly (two to four fans are usually required per green, depending on the size, conformation and surrounding areas of the green).

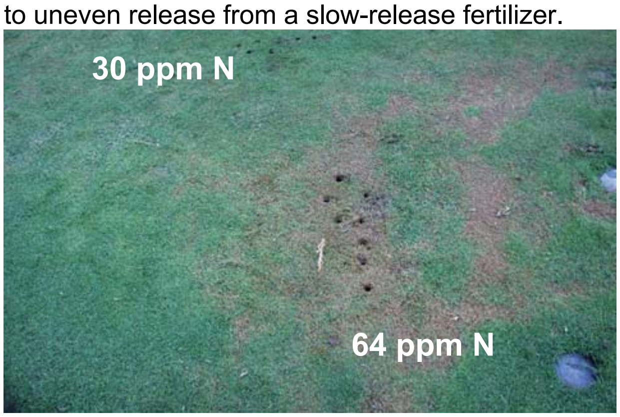
Figure 3. August 5, 1998. Death of the turf in the bentgrass nursery shown on the right followed several days where maximum temperatures were 115°F or more. There were no fans at this location on the golf course. The use of fans on the same golf course, with the same bentgrass variety, resulted in good turf survival despite the high air temperatures, as shown in the photo to the left.

Although fans are a large investment, they should be considered for golf courses where heat stress has resulted in greens failures on a regular basis. A variety of commonly used fans are available from Patterson Fan, Blythewood, SC (800-768-3985 or www.pattersonfan.com/) and other suppliers. If you are located in an area where temperatures get into the dangerous zone only occasionally, or if your greens are not wired for electricity, or if you budget simply won't withstand the purchase of fans, you may want to consider the use of leaf blowers, or tractor mounted blowers as a stopgap measure. While these measures are not practical (from a time and labor efficiency standpoint) when used on a regular basis, they can simulate the effects of fans in hot spots on the golf course during the occasional hot spell.

Syringing: There are a variety of syringing techniques that superintendents have developed over the years that fit the profile of their course. Variation exists in the duration and frequency of syringing, and the use of hand watering vs. irrigation heads, for example. Whatever the method, it is clear that that application of light volumes of water to greens for short periods of time can produce significant (a decrease of 10°F or more) cooling of the canopy, especially when there is sufficient (4 mph) air movement, either from wind or fans. The amount and frequency of syringing will vary from course to course depending on your irrigation system, weather patterns and drainage. To determine how frequently syringing is needed at your location, select a green with high canopy temperatures, and use the bead thermocouple to determine canopy temperatures before and after a single syringe cycle. Check the canopy temperature every 10 or 15 minutes after this initial syringe to determine how long it takes for the canopy temperature to climb back to the 100-105°F danger level. This period of time then becomes your syringing frequency. For example, if it takes 1 hour for turf canopy temperatures to rise again to 100-105°F, then your syringe cycles should be 1 hour apart until canopy temperatures begin to decline.

Nitrogen toxicity

Figure 4. Soil samples taken from healthy turf had 30 ppm nitrogen, while samples from damaged areas had more than double the level of soil nitrogen. The differences in nitrogen levels appear to have been due to uneven release from a slow-release fertilizer.



Turf damage as a result of excess soil nitrogen is a more common problem for turf managers than you might suspect. We see the problem on greens, tees, fairways and roughs from all parts of the country and on all turf varieties.

The PACE guidelines shown below are based on our database of several thousand green, tee and fairway samples. When we examine the data, some clear patterns with regards to plant-available soil nitrogen levels -- whether the nitrogen occurs as nitrate (NO_3) or ammonium (NH_4) -- emerge. Staying within these guidelines will help you to avoid one important source of turfgrass stress -- nitrogen toxicity.

PACE guidelines for plant available nitrogen in soil

- **Nitrate (NO_3) 3 — 20 ppm**
- **Ammonium (NH_4) less than 7ppm**
- **Total plant available nitrogen less than 20ppm**
- **Nitrate to ammonium ratio greater than 3:1**

Once nitrogen levels are high, it takes a long time for turf to recover. It's clear that avoiding the build-up of soil nitrogen in the first place should be a key goal in all fertility programs.

Testing for soil nitrogen

Regular monitoring (twice yearly is usually recommended) of soil nutrients is the foundation for many management decisions, and can be carried out by a variety of analytical labs across the country. We have also developed a quick, easy, on-site test for soil nitrates that can detect excessive levels of soil nitrates. Although this test does not replace the analytical testing described above, it provides values that are rough estimates of nitrate levels, and should be a useful and rapid diagnostic tool.

Materials needed:

- Hach water test strips for nitrate/nitrite (Cat. # 27454-25, Hach Company, PO Box 389, Loveland, CO 80539. Phone: 800-227-4224. Website: www.hach.com). A bottle of 25 strips is $14.95.
- Small beaker or container
- Tablespoon
- Soil from problem area and from nearby area of healthy turf
- Notebook for recording data

1. Mix equal volumes of soil and tap water (for example, 1 tablespoon of each) in a small container and stir thoroughly. Allow the soil to settle for 1 minute
2. Dip the test strip into the soil suspension.
3. Allow the strip to develop for 1 minute
4. Lightly rinse the strip with water to remove soil
5. Compare the color on the tip of the strip to the nitrate nitrogen color chart on the test strip container as shown in the photo below. Write down the ppm value that you think is closest to the color you see on the strip.
6. This value must be converted to obtain the nitrate concentration (in parts per million) of your soil.

(Dipstick value X 1.5) + 2.9 =
Soil nitrate concentration (ppm)

Example: In the photo below, the dipstick color was estimated to be 15 because it fell in between the 10 and 20 ppm squares on the nitrate color chart. The soil nitrate concentration is therefore = (15 X 1.5) + 2.9 = 24.9.

7. If the final value is over 20 ppm as it is in the example to the right, nitrogen applications of all types should be halted until levels are well below 20 ppm. If possible, leach the area to help bring nitrogen levels down more rapidly.

It's important to remember that this test does not measure ammonium levels – it is only valid for nitrate levels. Therefore, if you have high ammonium levels in your soils, you may get a low reading from the dipstick.

Primo on cool season greens

Superintendents who manage bentgrass, bent/poa or Poa annua greens are reporting excellent results with monthly applications of low rates (1/8 oz or less per 1000 sq ft) of the turf growth regulator, Primo Maxx (trinexapac-ethyl). Beneficial effects including denser, finer and darker green turf, as well as overall improved quality. There is one important watch-out with use of this product, however. **Application should be delayed if the turf is growing slowly or is stressed for any reason.** Because Primo works by slowing down turfgrass growth, the added decrease in growth due to heat or other stresses (such as disease or insect damage, low mowing heights, tournament preparations, drought, etc) is frequently too much for the turf to handle. For this reason, if maximum air temperatures are expected to reach 90F or above, Primo applications should be delayed until temperatures cool to below 90F. Likewise, if you have recently vented the greens and are hoping for rapid recovery, it's best to hold off on Primo applications until the turf has fully recovered.

DMI fungicides and heat stress

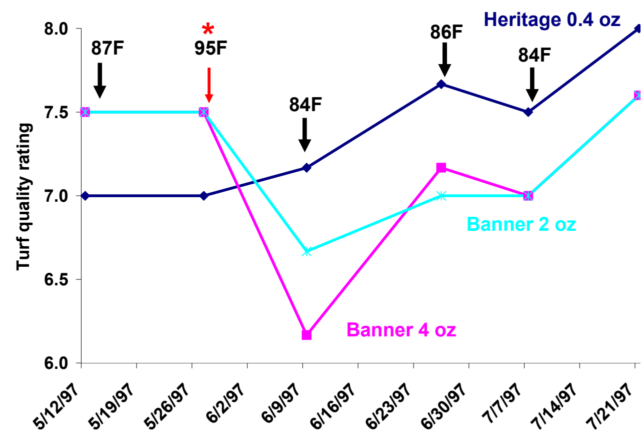
The group of fungicides known as demethylation inhibitors (sometimes also called DMIs, sterol biosynthetsis inhibitors or SBIs) includes Banner (propiconazole), Bayleton (triadimefon), Eagle (myclobutanil) and Rubigan (fenarimol). These products provide good control of a wide spectrum of diseases including summer patch, anthracnose, dollar spot, take-all patch, decline, Fusarium patch, Rhizoctonia (brown and yellow patch) and others. They cause the death of these fungi by interfering with the production of sterols – essential molecules in the formation of fungal cell membranes.

Interestingly, DMI fungicides also have a (usually) subtle effect on turf plants as well, causing a slowing of growth and darkening of the green color. Although very different from one another chemically speaking (including the fact that Primo does not have any fungicidal activity), Primo and the DMI fungicides cause some of the same growth regulation-type effects on turf plants.

What does this mean in practical terms? It means that heat stress, or other forms of stress that may slow down turf growth can interact negatively with DMI fungicides, producing very similar negative results as the interaction between heat and Primo.

In summer patch trials that we conducted at Arrowhead Country Club in San Bernardino, CA (John Harkness, former superintendent), we saw that when either Eagle or Banner were applied when maximum air temperatures were 90F or higher, turf quality suffered a set-back that lasted two or more weeks. However, half rates of either product (2 oz/1000 sq ft Banner or 0.6 oz/1000 sq ft Eagle) produced much less damage than the full labeled rates did.

Figure 5. Interaction of DMI fungicides with heat on Poa annua greens. Arrowhead Country Club, San Bernardino, CA, 1997. When maximum air temperatures were 90F or higher, Banner applications resulted in a decrease in turf quality, while Heritage applications (Heritage is not a DMI fungicide) did not cause damage. The high rate of Banner (4 oz/1000 sq ft) produced significantly more damage than the ½ rate of Banner (2 oz/1000 sq ft). A very similar, though not quite as severe pattern was observed with applications of Eagle. Arrows represent fungicide application dates, and the temperatures above them indicate the maximum air temperature on the day of application. Turf quality was measured visually on a 0 – 9 scale. Quality of 6.5 or higher is considered acceptable.



For these reasons, we suggest the following actions:

- If maximum air temperatures are likely to be 90F or higher, applications of DMI fungicides should be made at no more than the half the maximum labeled rate. Alternatively, other non-DMI fungicides that are labeled for the diseases you need to target can be substituted.
- Primo applications should be delayed if maximum air temperatures are 90F or higher.
- DMI fungicides should be avoided on bermudagrass greens during the summertime.
- Separate applications of Primo and DMI fungicides by 1 week or more, especially when weather is hot. Because these products both act to retard growth, they may cause severe growth decreases if applied on the same day, or within a few days of one another.