PACE INSIGHTS

Summer Stress Management

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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. But there are also some less familiar -- but we believe, equally important -- sources of summer stress, including drought (due to poor irrigation distribution), nitrogen toxicity, and phytotoxicity due to fungicide and growth regulator applications made on very hot days. In this issue of *PACE Insights* , we will review some of the most important factors contributing to summer stress, as well as strategies for avoiding or overcoming the damage they produce. We will focus on greens, because they are generally most susceptible to summertime woes, but the principles we present apply across the entire golf course.

The many faces of drought stress

Heat and drought damage remain two of the most difficult summer problems to avoid, and sometimes even to diagnose as Figure 1 illustrates. Greens, tees, fairways and roughs can all be affected.

Figure 1. Disease — or drought? A combination of heat (several days over 100F) and drought (due to poor irrigation distribution) selectively damaged poa plants on this bent/poa green. The symptoms suggested a disease, but drought was the culprit.

When you see disease-like symptoms during the summer months, don't automatically assume that pests are responsible. In the case illustrated above, visual examination of the soil for moisture content and a quick 2-can irrigation distribution test confirmed that drought was responsible for the yellowed and dying Poa annua.

Diagnosing drought stress

In addition to visually examining the soil underneath good vs. poor performing turf to determine whether there are moisture differences involved, a simple two-can irrigation distribution test can get to the bottom of a drought related problem rapidly.

1. Order catch cans and metal stands The catch cans should collect 16 square surface inches of water and can be obtained from The Toolkit Company (Bakersfield, CA; 661-587-9854).
2. Set up at least two catch cans per test area - one catch can in good performing turf and another in an adjacent area of poor performing turf. Set them up in the late afternoon/early evening before the normally scheduled irrigation cycle begins.
3. Collect catch cans in the morning and record the volume of water collected in each of the good vs. poor performing areas.
4. To calculate the precipitation from your irrigation run, divide the volume from each catch can by 262. For example, a catch can that collects 60 ml overnight indicates precipitation of 0.23 inches per cycle (60/262 = 0.23).
5. If your poor performing turf is being irrigated with a lower precipitation than you desire, the system will have to be adjusted to compensate. To do this, divide the desired precipitation volume by the observed volume. The number that you obtain is the factor by which you will need to increase water delivery by. For example, if the desired precipitation is 0.18 inches per cycle, and you observe 0.15 inches, then you will need to increase the volume of water delivered by a factor of 1.2. (0.18/0.15 = 1.2)

Symptoms of heat stress

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.

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.

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. Heat can build up here — it is frequently 10 to 15 degrees hotter in the canopy than in the air, especially in locations with low air movement, or in areas where turf is stressed. **For this reason, you need to monitor canopy temperatures — and not air temperatures —** in order to know what temperatures the turf is "seeing" and when you need to implement strategies to avoid heat damage.

Table 1. Thermal death point canopy temperatures and trigger canopy temperatures for preventive cooling. The **thermal death point** refers to the canopy temperatures at which irreversible turf damage occurs. The **preventive trigger** temperatures are estimates of the canopy or air temperatures at which cooling strategies should be implemented. Canopy temperatures will always be a more accurate gauge of what the turf is experiencing than air temperatures will be.

	CANOPY TEMPS		AIR TEMP
Turf type	Thermal death point	Preventive trigger	Preventive trigger
Poa	115F for >2 hrs	100°F	90°F
Bentgrass	120F for >2 hrs	105°F	95°F

It is important to realize that even lower canopy temperatures than those shown in Table 1 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.

Canopy temperatures vs. air temperatures

With a small investment in equipment, you will be able to easily monitor turf canopy temperatures, as described in "Canopy temperature monitoring" below. Although it's a bit easier to monitor air temperature than canopy temperature, we really want to encourage you to make the effort to track canopy temperatures.

Why are we so insistent on the importance of monitoring turf canopy temperatures? Because there can be up to a 15 degree difference between air and canopy temperatures, with the canopy almost always hotter than the air. If you were just tracking air temperatures, you could easily miss the warning signs of heat stress.

Canopy temperature monitoring

Preventive cooling strategies (see below) that lower the temperatures in the turf canopy must be started **before** the thermal death points are reached. Based on our observations, preventive actions should be taken for cool season turf when the canopy temperatures in Table 1 are reached. These are rough numbers, empirically developed, and need much refinement, but should help provide some guidelines until more data is available.

We have also provided in Table 1 the air temperatures at which we think preventive cooling activities should take place, but these numbers are even rougher. If at all possible, we encourage you to monitor turf canopy temperatures as described below, and to depend on air temperatures only in a pinch.

Equipment needed:

- bead thermocouple probe (available from Grainger's part # 1T322: $15.00). See Figure 3.
- digital thermometer (Thermometer Type K, Grainger part # 4PC59: $89) or multimeter (Omega HHM29 multimeter: $138).
- Grainger's: www.grainger.com. Omega: www.omega.com or 888-826-6342.

Figure 3. Bead thermocouple probe. The small size of this sensor allows you to place it directly in the turf canopy for temperature readings.

Turf canopy temperature monitoring procedure:

1. Select a minimum of three greens for turf canopy monitoring. Choose those greens that have failed in the past during hot weather.
2. Begin monitoring when maximum air temperatures reach 85°F.
3. Make measurements during the hottest part of the day (usually around 2:00 pm). Place the bead in the area between the base of the foliage and the top of the thatch layer. Allow a few moments for the thermometer to equilibrate, and for the reading to remain stable. Record the readings in a hardbound notebook, with a ballpoint pen, so that your records remain legible for years to come.
4. Begin preventive cooling programs (syringing, fans, blowers) when turf canopy temperatures reach the temperatures shown in Table 1.
5. If you are unable to regularly monitor turf canopy temperatures, monitoring air temperatures is a distant second choice, but still much better than not

monitoring at all. Preventive cooling programs should be initiated using the air temperature triggers in Table 1.

6. A quick test for turf canopy temperatures, if you don't have a bead thermocouple, is to place the flat of the palm of your hand on the turf surface. If the surface feels warm, the canopy temperature is probably above 98°F (your body temperature) and therefore close to the danger zone of 100°F - 105°F for cool-season turf.

Preventive cooling strategies

Fans and blowers are 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).

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.

Syringing: 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 up to the danger level. This period of time then becomes your syringing frequency. For example, if it takes 1 hour for poa turf canopy temperatures to rise again to 100°F), then your syringe cycles should be 1 hour apart until canopy temperatures begin to decline.

Nitrogen toxicity

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 in Table 2 are based on our database of several thousand green, tee and fairway samples. Staying within these guidelines will help you to avoid one important source of turfgrass stress -- nitrogen toxicity.

Table 2. 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. These guidelines apply to greens, tees, fairways and roughs.

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. When you test, be sure to ask the lab to run nitrate, ammonium and total plant available nitrogen analyses. This will allow you to compare your soils against the values shown in Table 2 above. These tests are not typically run, but all labs should be able to complete the tests for a just a few dollars extra.

Primo on cool season greens

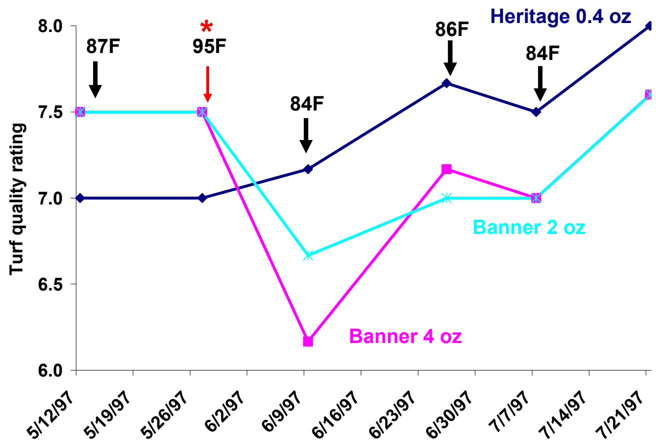
Superintendents who manage bentgrass, bent/poa or Poa annua greens are reporting excellent results with low rates (1/8 oz or less per 1000 sq ft), used every 2 to 4 weeks, of the turf growth regulator, Primo Maxx (trinexapac-ethyl). Beneficial effects including denser, finer and darker green turf, as 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 plus heat do not mix well

The group of fungicides known as demethylation inhibitors (sometimes also called DMIs, sterol biosynthesis inhibitors or SBIs) includes **Banner** (propiconazole), **Bayleton** (triadimefon), **Eagle** (myclobutanil) and **Rubigan** (fenarimol). These products provide good control of a wide spectrum of diseases, but their use during the summer needs to be watched closely.

This is because DMI fungicides have growth regulator-like qualities that act to slow turf growth and produce a darker green color. Although very different from one another chemically speaking, Primo and the DMI fungicides cause some of the same growth regulation-type effects on turf plants.

Figure 4. Interaction of DMI fungicides with heat on Poa annua greens. Arrowhead Country Club, San Bernardino, CA, 1997, John Harkness, former superintendent. Following application at 95F, 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), while Heritage (not a DMI) produced no damage. 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 to 9 scale. Quality of 6.5 or higher is considered acceptable.



In summer patch trials that we conducted (Figure 4), 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. Therefore:

- 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.
- Unless you have had positive experiences in the past with Primo during hot weather, 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 retard growth, they may cause severe growth decreases if applied on the same day, or within a few days of one another.

Traffic: an ounce of prevention…

- Change pin placements and avoid traffic in areas that show stress
- Route traffic onto the green at multiple locations.
- Rope off areas that exhibit excessive wear
- Keep the traffic moving by regularly updating traffic flow and pin placements to prevent excessive wear.

For best results, these actions should be taken before damage due to traffic is seen.

Monthly venting: a breath of fresh air

On greens, schedule a monthly "venting" (aeration) using small (1/4 inch) diameter hollow cores or solid tines This practice helps prevent surface sealing and black layer. The small diameter holes are relatively non-disruptive to play, but allow oxygen into the root zone, and enhance water movement.

Always check soil salt levels and leach to remove excess salts prior to venting.

The venting procedure may cause some bumpiness for one to two days, but recovery is rapid when the turf is healthy. Bumpiness can be further reduced via rolling. However, when stressed or dying turfgrass is vented, recovery will be prolonged during the hot summer months. For this reason, *venting or aeration should be used as a preventive strategy, and not as a remedial tool that is used after damage has occurred.*

Raise mowing heights, increase rolling

Raising mowing heights by even 1/32" can give the turf a big boost in its ability to tolerate stresses from pests, heat and traffic. That tiny fraction of an inch is sometimes all that stands between you and a make or break summer.

To keep greens speeds up, consider rolling up to 4 times per week Applications of Primo (see above) every 14 – 28 days at low labeled rates will tighten the turf canopy and also help keep greens speeds up.

Avoid the build-up of soil salts

Keep soil salinity levels at 3.0 dS/m or lower (equivalent to a reading of approximately 0.7 on the Field Scout Soil EC Probe, available from Spectrum at http://www.specmeters.com/). Monitor soil salinity regularly with EC probe, and leach when soil salts reach 3.0 dS/m. For more information on monitoring soil salinity, go to the PACE Member Edition website (www.paceturf.org) and type "check soil salinity" into the SEARCH box.