BY CHRISTOPHER S. GRAY SR.

Bug Off

A golf course superintendent's guide on how to **diagnose insect outbreaks** to eradicate them

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I've always found turfgrass insects to be particularly interesting and challenging because, while some are unquestionably harmful, others are completely benign or actually beneficial.

While nearly every insect can be found in all turfgrass and soils throughout the country, certain insects are obviously more adapted to specific geographic areas and environments, which makes them more likely to pose a threat. And to further complicate matters, insect infestation damage can often look a lot like fungus damage.

For these reasons, being able to accurately diagnose insect outbreaks is critical to manage insects successfully within an effective integrated pest management program. Here are a few tips to help ensure your success:

1 Build a scouting tool kit

Having the proper equipment to do any job assignment is fundamental, especially for something as critical as pest scouting and identification. This means developing a scouting tool kit that should be filled with the necessary tools and instruments to identify the type of damage being done to the plant, as well as the actual insect inflicting the damage.

Continued on page 42

Continued from page 41

Here's a list of items your tool kit should include:

TOOLS

Small soil-profile sampler
Tubular soil sampler
Hand trowel or small shovel
Macro-scope 25X and 45X power
Stress-detection glasses
Latex gloves
Pen, pencil and permanent marker
12-inch ruler
Sharp pocketknife
Irrigation flags
Sample bags of various sizes (with ties)
Index cards

REFERENCE MATERIALS

Insect identification photo cards
Disease identification photo cards
Scouting sheets and maps

These items should be considered basic tools for your kit. You'll also want to include additional tools and reference materials that make identifying typical and known insects and insect damage easier for your specific location. And take it from me, you definitely want to keep your tool kit in a protective, water-resistant bag or case that keeps all of them together during your scouting trips.

If you suspect insect activity, be sure to examine turf that's both healthy and damaged.

2 The scouting process

When you come across an area where you suspect insect activity, be sure to examine turf that is healthy and damaged. The most severe insects feed on living turf and move away from dead areas, as they no longer provide a food source.

In fact, insects found in dead turf are usually not responsible for the damage that killed it.

3 Insect classification

One of the most effective and easiest ways to identify insects is by the way they attack and feed on the turf plant. The physical damage inflicted can be visibly seen and will help lead you to a positive insect identification. The three largest classifications of insect damage are root-feeding, blade-defoliating and blade-sucking.

- **Root-feeding** insects include white grubs (immature masked chafers, Japanese beetles, May or June beetles, black ataenius, oriental beetle, aphodius beetles and green June beetle); mole crickets and bluegrass billbugs.
- **Blade-defoliating** insects include cutworms, sod webworms, armyworms and fall armyworms. Remember that it's the larvae stage of these insects that inflict the most damage to turf.
- **Blade-sucking** insects include aphids, chinch bugs, leafhoppers, bermudagrass scale, ground pearls and fiery skipper.

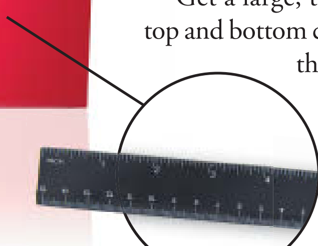
The one obvious insect group not mentioned here is ants, specifically because ants don't feed on the turfgrass plant itself. They do, however, tend to be somewhat of a nuisance because of their nest castings. Identification of ants shouldn't be difficult for anyone.

Drench testing

One of the most accurate tests you can perform to identify many of the blade-defoliating and blade-sucking insects is called a drench test. It's easy to do.

Get a large, tin coffee can with the top and bottom cut out and push it into the affected area about 1 inch to 2 inches deep. Be sure to pick an area that includes

Continued on page 44



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Continued from page 42

relatively healthy and unhealthy turf.

Mix 1 to 2 ounces of dishwashing detergent into 1 gallon of water and pour the solution into the coffee can. If the area is really dry, it may take 2 gallons. Wait about five minutes. The soapy water will irritate insects, making them release their grasp on the plant. The insects will then float in the water, making collecting and identifying them rather simple. This technique is equally successful in both close- and high-cut turf.

4 Inspect the roots

Root-feeding insects can't be identified by the drench test. Grubs feed by separating the turf blades, while the billbug larvae are legless and live inside the sheath until their last instar. You'll need to sample affected areas by actually looking in the root zone and the soil layer beneath the roots.

The easiest way to do this is by using an old cup cutter to pull soil cores, which can be visibly inspected for the root-feeding insects and then replaced with little disruption to the playing surface.

Scouting and identifying insect activity is as much art as it is science. Even well-trained professionals can have difficulty from time to time. In circumstances where you may have difficulty diagnosing outbreaks, it's a good idea to consult your local university or agriculture extension agency for assistance in positively identifying troublesome insects. ■

Gray, a contributing editor to Golfdom, is superintendent and general manager of the Marvel Golf Club in Benton, Ky.

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Researchers Study Impact of Golf Courses on Stream-Water Temperature

By Kevin Ashman and Weston Dripps

Golf courses have become a prominent feature within urban and rural landscapes. The environmental impacts that golf courses have on the surrounding aquatic ecosystem have been heavily debated and discussed. Some studies (Moss et al., 2006; King et al., 2007) have found that golf courses negatively affect the aquatic environment, primarily through excess nutrient loading, while others (Kenn and Snow, 1992; Beard, 2000) found that golf courses actually serve as a green space in an otherwise urban environment. The bulk of the previous work has focused on course runoff and potential non-point source pollution; significantly less research has been done on the impacts to physical parameters like stream temperature.

In this study, a comparative analysis of stream-water temperature was conducted at five different golf courses in Greenville, S.C. Courses were selected that had continuous, tributary-free, lake-free reaches that passed through the golf course grounds. (See chart on page 49.)

At each course, stream water temperature was measured at five-minute intervals from June 2008 through November 2008 at sites upstream and downstream of the course. An Onset Water Temp Pro V2 temperature logger secured to the stream bottom was used to measure water temperature. In addition to stream temperature, a number of other parameters were assessed along the golf course stream reach, including stream discharge measurements under base-flow conditions, stream length between sampling sites and the extent of riparian cover along the stream banks. Any human alterations to the stream's channel morphology were observed and noted in the field.

Stream-water temperatures exhibit a distinct daily cycle, which mimics and is a subdued replica of air temperature. Stream-water temperatures peak in the late-afternoon and early-evening hours (5 to 6 p.m.) and trough in the early morning hours (7 to 9 a.m.). At all five courses, the average daily stream-water temperatures downstream of the course were higher than those upstream of the course. Temperature differences between the upstream and downstream sites were consistently variable, exhibiting a distinct daily cycle with the biggest differences routinely occurring during the mid-late afternoon hours (3 to 6 p.m.) and the smallest differences during the early morning hours (6 to 8 a.m.). In many instances,

Continued on page 48

IN THIS ISSUE

Stream-water temperatures peak in the late-afternoon and early-evening hours and trough in the early-morning hours.

PHOTO BY: MIKE KLEMME

Continued from page 47

the downstream temperatures were actually lower than the upstream sites during early morning hours.

Although golf courses can often serve as green space in an otherwise urban or residential environment, they can still negatively impact local streams that pass through their grounds. This study found that stream-water temperatures downstream of golf courses can often be elevated as much as 6 degrees Fahrenheit to 8 degrees F higher during the day than those temperatures just upstream of the course.

Observed upstream versus downstream temperature differences among the five courses are attributed to differences in:

(a) actual stream length within each course;

(b) discharge of the streams; and

(c) extent of riparian cover along each course reach.

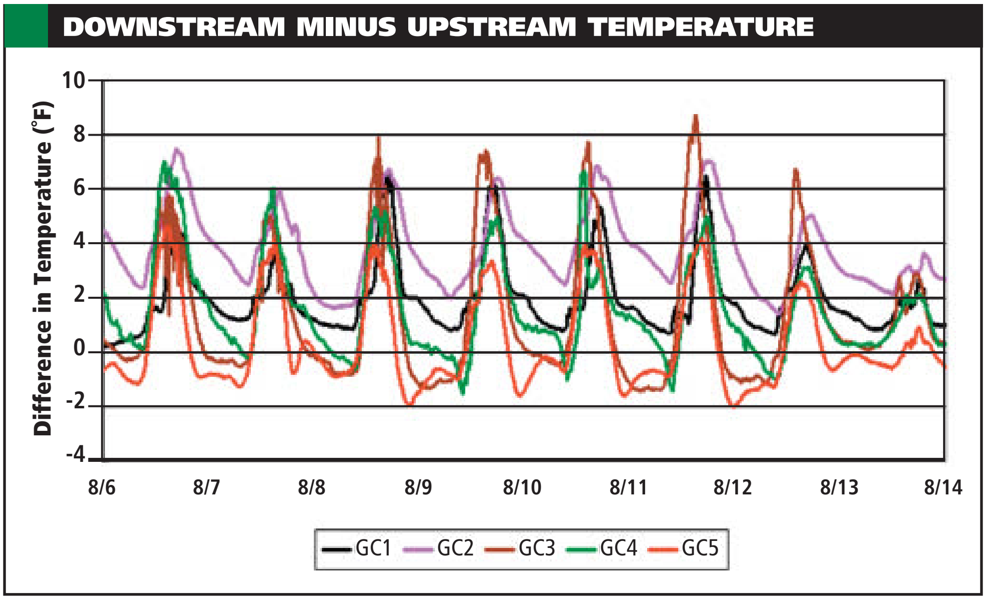
The lack of riparian cover along golf course stream reaches allows the sun to actively beat down on the stream water during the daylight hours. The increased sun exposure during the day causes the water in the streams to warm up as the water slowly makes its away across the course, leading to warmer stream temperatures and greater diurnal variability. The impacts are most pronounced during the peak solar hours. All stream reaches just upstream of the courses exhibited extensive riparian cover. This cover acts to insulate the stream, providing shade during the heat of the day and trapping heat during the evening. The reaches within each course were fully exposed.

Golf courses have a measurable impact on the stream-water temperature, primarily due to the removal of riparian cover.

The magnitude of the warming varied among the golf course sites, even after the data were normalized based on stream length. The remaining differences appear to be influenced by stream discharge, the extent of the riparian cover and the stream's geomorphology. Golf course streams with smaller discharge are more greatly impacted by the lack of riparian cover and the associated increase in sun exposure.

Water has the ability to absorb solar radiation. The larger the volume of water in the stream and the faster the flow, the longer it takes to heat the stream water and the less time it spends in the course fully exposed to the sun's rays. Those streams with larger discharge were less impacted with respect to changes in temperature than those with less flow.

At all five golf course sites, the streams exhibited a lack of riparian cover along the



stream reach, although the extent of riparian removal did slightly vary among the sites. These small differences in the degree of riparian removal, although certainly noticeable, didn't seem to account for observed differences in the temperature response. Furthermore, many of the courses intentionally altered the stream morphology in an effort to stabilize the stream's banks and/or fit within the course design. It was difficult to quantify the degree of alteration, but changes in the stream's cross-sectional area will impact flow rates and the addition of riprap in some cases may impact the local thermal properties, both of which could influence the stream temperature. More study is needed to quantify these impacts.

Golf courses have a measurable impact on the stream-water temperature, primarily due to removal of riparian cover.

A comparative analysis of stream-water temperature at the five courses showed that under base-flow conditions sites downstream of the courses exhibited consistently higher stream-water temperatures (on the order of 4 degrees to 10 degrees F during the afternoon hours), and significantly larger diurnal temperature ranges (typically two to three times larger) compared to their upstream counterparts.

Golf courses have a measurable impact on the stream-water temperature, primarily due to the removal of riparian cover along the stream banks. The impact that these temperature changes have on a stream's aquatic ecosystem are not fully known but should be considered in future course design. Providing good riparian cover and ensuring sustained flow within the stream reaches should help minimize impacts to stream temperature.

Kevin C. Ashman is a recent graduate from Georgia Southern University in Statesboro, Ga., with a major in geology. Weston Dripps is associate professor in the department of earth and environmental sciences at Furman University in Greenville, S.C.

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Turf Leaf Orientation Affects Water Use

Study on zoysiagrass shows water-use rates differ in response to cultivar and fertility programs

By John Erickson

The combination of population growth and drought conditions has intensified competition for public drinking water resources in many regions. As a result, thirsty grass is increasingly the target of water-use restrictions by regulatory agencies across the United States that limit irrigation of turfgrass. To help address these concerns, water management and conservation remain key focus areas of turfgrass industry and research programs.

FIGURE 1

Empire zoysiagrass (A) was selected for its prostrate leaf-growth habit, while experimental TAES 5343-22 from the UF Turf Breeding Program in collaboration with Texas A&M was selected for its erect leaf-growth habit (B).

So what can we do in order to reduce irrigation applied to turf? In order to answer this question, it is helpful to first look at a simplified equation representing water balance of turfgrass landscapes where water inputs are equal to water outputs:

Precipitation + *Irrigation*
=
ET + Drainage + Runoff

Evapotranspiration (ET) is the combined movement of water from the soil to the atmosphere by direct evaporation of water from the soil surface (evaporation) and by the biological use of water through plants (transpiration). From this water balance equation we can see that irrigation inputs can be reduced in a couple of notable ways. First, by shifting water outputs from drainage and/or runoff to ET, the plant (ET) uses more of the precipitation inputs and requires less irrigation inputs. This can occur, for example, with turfgrass species, varieties and management practices that favor deeper rooting habits, and thus an ability to acquire water from greater depths. Alternatively, but not necessarily mutually exclusive, irrigation inputs can be reduced by reducing turfgrass ET, which reduces the overall outputs in the equation above.

Determinants of ET are complex, but are related to both turf characteristics (White et al., 2001) and environmental conditions. Variation in ET can be as great among cultivars as it is among species (Green et al, 1991). While a number of morphological characteristics have been related to turf water use, leaf angle orientation has been related to water use in Kentucky bluegrass (Ebdon and Petrovic, 1998) and in several cool- and warm-season grasses (Kim and Beard, 1988). These studies reported that turfgrass with relatively horizontal leaf orientation (prostrate) had comparatively lower ET rates. Also, environmental conditions, especially light environment, can affect ET rates, whereby turfgrass growing in the shade uses less water (Feldhake et al., 1983). Finally, management conditions can also affect ET. One recent study showed that ET increased in warm-season turfgrass as nitrogen application rates increased (Barton et al., 2009).

Given the complex set of factors that contribute to ET rates, it's important to know how these factors interact with each other to develop integrated approaches to reduce water use in turfgrass systems. Thus, the question I wanted to answer in a recent study was how water-use rates of two zoysiagrass cultivars differing in leaf angle orientation, a key crop characteristic that affects ET, would vary across different management and environmental conditions that are also known to affect ET.

To answer this question, an outdoor pot experiment was conducted at the University of Florida during the summer of 2009. A

Continued on page 52