This research represents the first instance of a weed species having glyphosate resistance in bermudagrass turf.

bluegrass biotypes.

Alternative modes of action need to be used in regular rotation to guard against resistance development. This will involve using different chemistries at both pre- and postemergent timings. A list of herbicidal modes of action with activity against annual bluegrass is presented in Table 1 (pg. 40). In addition to rotating herbicides annually, tank-mixing active ingredients varying in mode of action can help mitigate the onset of herbicide resistance. However, modes of action included in these tank mixtures should also be rotated regularly.

Weed management programs focused on preventing the onset of herbicide resistance may be more costly than historical maintenance practices of applying the same product year after year. However, the investment in a rotation program will pay off in the long run as weed management costs have been shown to increase dramatically in crop production due to the evolution of herbicide-resistant weeds (Norsworthy et al. 2012).

Future research will evaluate programs for managing herbicide-susceptible annual bluegrass and other weeds in turf with alternative chemistries in rotation to prevent the evolution of new herbicide-resistant biotypes.

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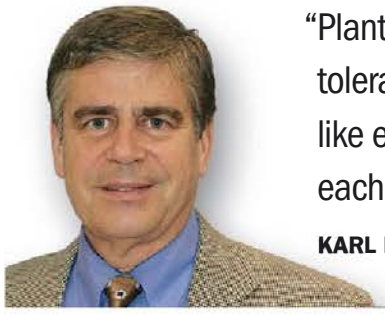

"Plants and pests tend to develop a tolerant relationship. They may not like each other, but they put up with each other."

KARL DANNEBERGER, PH.D., *Contributing Editor*

The plant and the pathogen

When discussing whether golf courses are sustainable or not, the focus is almost always on the putting green. The putting green quality expected by golfers requires an intensive level of management. In temperate regions, creeping bentgrass is the putting green turfgrass of choice. It is the most intensively managed of all the turfgrass species.

Subjected to low mowing heights, frequent mowing, rolling and intensive grooming under a variety of environmental conditions, creeping bentgrass is under environmental stress for most of the growing season. Given the constant or chronic stress, creeping bentgrass is predisposed to frequent attacks by pests.

Breeding efforts have brought us creeping bentgrass cultivars that are dense, fine textured, and have greater disease resistance than the previous generations of cultivars.

Most of us would welcome a creeping bentgrass cultivar that was resistant to dollar spot. We could eliminate the need for dollar spot fungicides and enjoy a more sustainable putting green that required less chemical input. Recently, some creeping bentgrass cultivars have shown dollar spot resistance in university trials.

However, in a recent paper, University of Wisconsin turf researchers (Koch and Kerns, 2012) reported that dollar spot-resistant cultivars exhibited partial resistance to dollar spot in comparison to older cultivars like Penncross. The authors concluded that the resistant cultivars might reduce, but not eliminate, fungicide applications.

At first glance one could dismiss the new resistant cultivars as just another folk tale, or account for the breakdown based on a wide geographical and climatic range that we are trying to grow the cultivars. I think, however, the study brings into focus what resistance and tolerance mean.

Plant resistance is defined as host traits that reduce pathogen infection, host contact with the pathogen and pathogen growth rate, in case infection occurs (Kover and Schaal, 2002). Visually, resistance would be a symptom-free turf.

Plant resistance places strong selection pressure on the pathogen. In response to plant resistance, the pathogen will eventually evolve and use a different means to attack the plant. In response to the new and improved pathogen, we breed a cultivar that has improved plant resistance to the new or evolving pathogen.

The relationship of plant resistance to the pathogen is like an arms race. Tolerance is defined by how much the plant can endure in the face of a pathogen attack. In agricultural crops, tolerance is often defined as the level of disease the crop plant can sustain without any measurable effect on yield. In turf, since we don't measure quality in yield, tolerance is a level of disease expression somewhere between immunity and full susceptibility.

In natural systems, plants and pests tend to develop a tolerant relationship. They may not like each other, but they put up with each other. Tolerance should be an important aspect of achieving the goal of sustainability.

From a management perspective, the introduction of a creeping bentgrass cultivar that is tolerant of dollar spot would likely maintain the desirable cultivar characteristics along with a certain level of disease. The impact, too, would reduce the genetic pressure on the plant and pathogen. We would avoid an arms race between the plant and the pathogen.

If tolerance exists in the turf community, management practices could be used to reduce the level of disease, too. Management practices could be timed along with an appropriate fungicide treatment when needed to maintain the acceptable threshold of putting green quality with minimal disturbance to the plant/pathogen relationship. Bottom line, we need more tolerant turfgrass cultivars to address a wide range of stresses.

Karl Danneberger, Ph.D., *Golfdom*'s science editor and a professor at The Ohio State University, can be reached at danneberger.1@osu.edu.

Recovering from spring dead spot damage

Dennis Martin, Ph.D., is a professor of turfgrass science at Oklahoma State University and is well versed in spring dead spot through his more than 20 years of research and extension activities addressing the disease. Martin can be reached at dennis.martin@okstate.edu.

Q Is there any way to predict during the winter or spring if the turf will suffer spring dead spot damage?

I am not aware of any method. While microscopic examination of plant parts can spot the fungus and damage on an individual plant basis, sampling on a large scale is impractical.

Q What is the general biology of the spring dead spot fungus?

In fall, the fungus causing the disease invades stolons, rhizomes and lower portions of aerial shoots. Tissue not killed outright is predisposed to the effects of freezing temperatures. The fungus grows radially, resulting in circular patches of dead turf seen in spring.

Q Outline the strategy you recommend to recover from spring dead spot damage.

When a superintendent first sees the symptoms at spring green-up, map the damaged areas through photography and in written form. Try to correlate damaged areas with suspect factors on the site. Usually damage is worse on north-facing slopes, highly susceptible varieties, fine-textured soils, heavily compacted areas and thatchy areas. Shade or sun seems to have little effect on occurrence.

Second, if a pre-emergence herbicide has not already been applied by the time spring dead spot symptoms are seen, a decision on product use is needed. With the exception of oxidiazon (example Ronstar), all other pre-emergence herbicides may damage new roots produced by stolons, slowing recovery in damaged areas. Use of other products depends on the extent of disease damage and how rapidly a superintendent wants the turf to recover, as well as tolerance of possible weed invasion.

> "Staying below 4 pounds nitrogen per 1,000 square feet per year is a good goal to pursue."
>
> **DENNIS MARTIN, PH.D.**

Third, cultivation is often necessary. If compaction is present, an aggressive aerification program is a good idea. On the other hand, if the damaged area has a thatch build-up, aggressive verticutting is a good idea. Scout the damaged area, look at many turf cores and decide which cultivation technique fits best for the circumstances. With all cultivation techniques, golfer satisfaction has to be factored in to the decision.

Soil test and make decisions on phosphorus, potassium and pH additions based on soil test results. My experience is that bermudagrass grows best at a pH of 6.0 to 6.8, but some varieties can differ. Below a soil pH of 5.9 it's advisable to lime to raise the pH. Most bermudagrasses tolerate soil pH values well into the upper 7s, so sulfur addition is generally not needed.

Apply 0.5 lbs. of soluble nitrogen per 1,000 sq. ft. in late March to early April in Oklahoma to damaged areas to promote early growth. After this application, monitor the weather and adjust as needed. After this early nitrogen application, continue with your normal nitrogen fertility program.

On our research plots and on some golf courses we have observed much less spring dead spot damage when the total yearly nitrogen application rate is 4.0 lbs. nitrogen per 1,000 sq. ft. or less. I recognize that this is a lean program and may not work in certain high traffic areas, but staying below 4.0 lbs. nitrogen per 1,000 sq. ft. per year is a good goal to pursue.

Q Anything else you'd like to add?

Start the recovery program early. It gets warmer much earlier in the spring than ever before. Promote stolon growth early in the spring, induce the turf to recover and then shift to a holding pattern throughout the rest of the growing season.

Clark Throssell, Ph.D., loves to talk turf. Contact him at clarkthrossell@bresnan.net.

The 19th Hole with...

Jeff Christensen

DIRECTOR OF GC MAINTENANCE // Robert Trent Jones Golf Trail at Oxmoor Valley, Birmingham, Ala.

What can I get you? A cold beer. Any kind.

Seen any good movies lately? I saw *Ted,* it's hilarious. It's not one to watch with your kids.

How old are your boys? Jack is 14 and Sam is 13. Jack is big into baseball, science and fish. Sam is into football. He's an offensive lineman, he's built like his dad.

It seems like the time commitment of having kids in sports is different than when we were kids. Doesn't it though? I go to every game. Go to a baseball or a soccer field and it's not hard to figure out why there aren't as many people on the golf course on a Saturday as there used to be.

Do you take more after your mom or your dad? Both. Dad was in the highway landscaping business, so that's how I got into what I do. When they built a new road, he'd go in and plant the grass. Dad was a get-it-done type person, which I think I am. My mom is a retired English teacher and I'm a fanatic for spelling. I think I got good parts from both of 'em. And probably some bad parts!

What do you mean by 'get-it-done' type person? Well, if something doesn't work, just get on with it. For example, my older brother is a CPA. Back before he was, he was doing some paperwork, and he was using an adding machine. Something was different about the adding machine, and he kept hitting the wrong key, and he was swearing at it. So my dad took it, unplugged it, stomped on it and shouted "Now go buy one that works!"

How long have you been at RTJ Golf Trail at Oxmoor Valley? For 15 years. My wife was pregnant with my older son when we moved here. And then also going from 18 holes to 54? No stress there!

Why not make a bunch of major life changes at once, right? How'd you handle it? It went well. I've got the best superiors. We're owned by the teacher's retirement fund. I don't work for doctors and lawyers, and people that grow a lawn so they think they know how to grow grass. I work for golf people.

What's your favorite tool in the shop? Chain saw comes to mind, but any power tool, really.

Kind of like your choice of beer — anything cold, right? Yes. Anything power.

As interviewed by Seth Jones on January 30th, 2013.

"I'M HOPEFUL WE'LL HAVE A GOOD SUMMER FOR TURF CONDITIONS, I'M HOPING FOR SOME GOOD PLAY. I JUST WANT TO HAVE A SUCCESSFUL GOLF YEAR — WE NEED ONE."

MAIN PHOTO BY SETH JONES / ISTOCKPHOTO

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