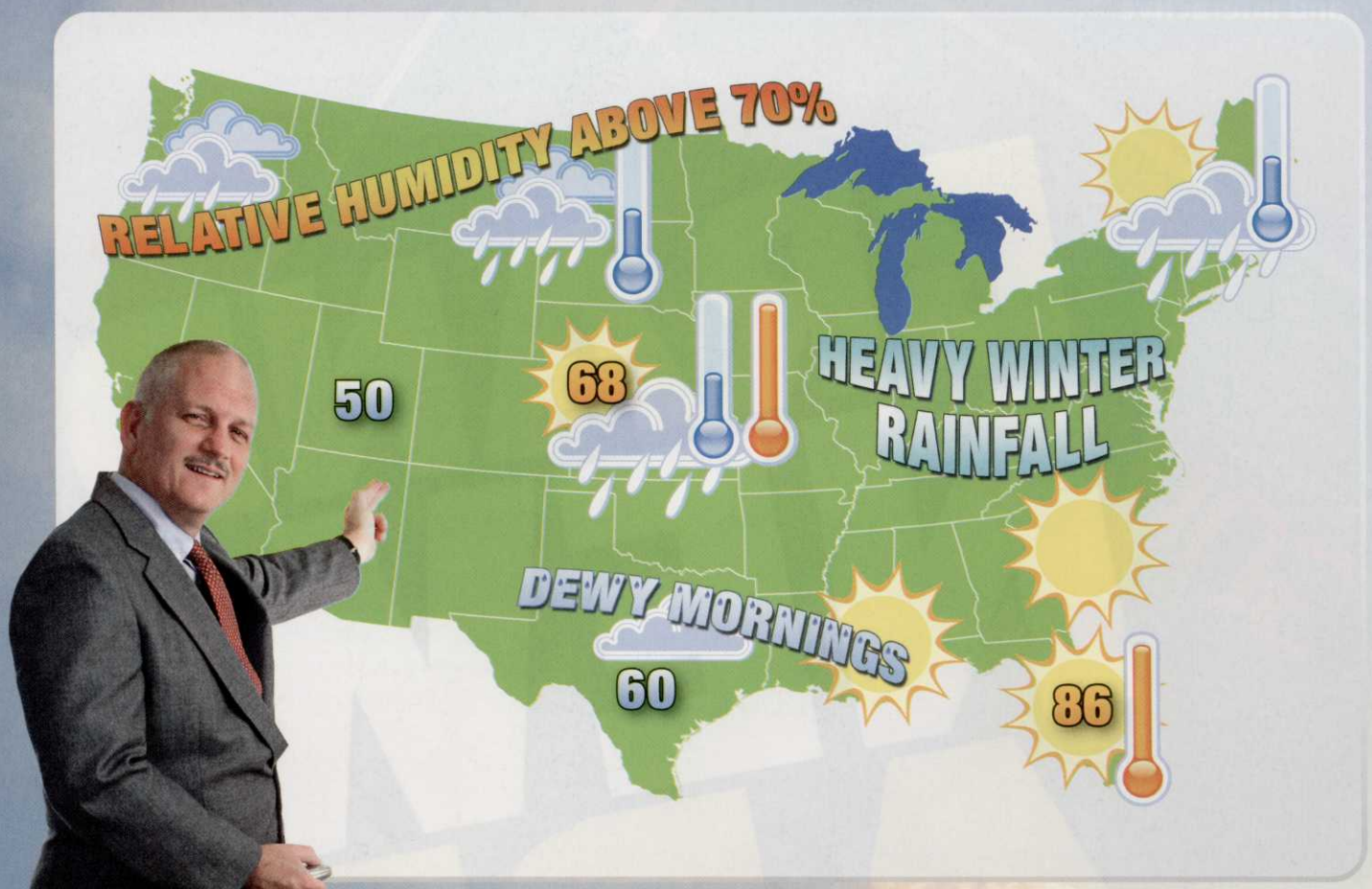


BLAME IT ON THE Weatherman

New research out of Wisconsin shows that weather may have an impact on fungicides.

By Rob Thomas

You've sprayed for dollar spot control and, in a perfect world, now you sit back and watch the results take place as the label suggests. This is anything but a perfect world when it comes to Mother Nature, however. What affect does the weather have on the efficacy of that costly fungicide?

Dr. Paul Koch, associate researcher and turfgrass diagnostic lab manager at the University of Wisconsin-Madison, has recently conducted studies that look at the effect of snow cover on the persistence of iprodione and chlorothalonil and the effect of temperature on these same two fungicides.

From the snow-cover study, Koch's team found snow cover itself didn't impact the persistence of either fungicide.

"This suggests that sunlight – or photodegradation – doesn't impact fungicide persistence significantly on turfgrass leaf blades, at least in a winter environment," Koch says. "What we did find was that winter rainfall or snowmelt events did lead to a fairly rapid reduction in fungicide concentration.

In addition, temperature did appear to impact fungicide persistence, as temperatures rose out in the field the fungicides degraded at a faster rate, Koch adds. "This was observed even on non-snow covered plots, so it wasn't just a factor of melting snow," he says.

These results led researchers to look more directly at temperature. Koch sprayed iprodione and chlorothalonil on fairway-height bentgrass, then sampled cores from each plot and placed them in growth chambers set at 10, 20 and 30 degrees C (50, 68 and 86 degrees F) and tested the fungicide concentration weekly over a five-week span.

"We found both fungicides degraded fastest at 30 (degrees C), slightly slower at 20, and slower still at 10," he says. "The degradation rate was linear for chlorothalonil, suggesting potentially that microbial degradation plays the key role in degrading that fungicide."

The degradation rate dropped much faster between seven and 14 days after application with iprodione, and barely dropped at all at 10C. So Koch is hypothesizing that plant metabolism may be the key degradative agent with that fungicide since it is absorbed into the leaf blade, while chlorothalonil, as a contact, stays on the outer leaf surface.

Additionally, at every time point they tested leaf blades from the growth chamber, they also took samples from the initial field plot sprayed and found that with both fungicides they could not detect any fungicide 14 days after the application.

"This was a much faster rate of degradation than we saw even from the plants in the 30 (degree C) growth chamber, and the temperatures were much cooler than 30 (degrees) out in the field," Koch says. "We hypothesized that the reason for this rapid loss was due to removal by mowing, and that in most situations – at least on fairways – all the fungicide will be removed from the plant within 14 days of application due to mowing."

One way to extend protection, Koch suggests, is to use plant growth regulators (PGRs) so less leaf tissue is removed by mowing – pointing to other studies that have found using plant growth regulators has led to extended durations of disease control.

"I want to stress that just because the fungicide is no longer present on the leaf blade it doesn't mean a fungicide cannot control a disease for 21 or 28 days," Koch says. "Fungicides do likely suppress disease by other means besides just residing on the leaf blade, and it likely relates to a fungicide's ability to knock the fungus back out of the turfgrass canopy, which then takes time to grow and reinfect the turfgrass plant."

KEY POINTS:

- **Snow cover on its own doesn't impact the persistence of iprodione and chlorothalonil.**
- **Winter rainfall or snowmelt does lead to fairly rapid reduction in fungicide concentration.**
- **Temperature appears to impact fungicide persistence.**
- **Microbial degradation potentially plays a key role in degrading the fungicide chlorothalonil.**

Dollar spot is easily identifiable because of its small, tan circular patches.

Mike Salinetti, golf course superintendent at Berkshire Hills Country Club in Pittsfield, Mass., has seen dollar spot occur in all types of weather, but it most commonly impacts his course – located in the state's western mountains – during moist, humid summer nights when the temperatures remain above 60 degrees F.

"This past summer was, by far, the worst for me trying to control dollar spot," Salinetti says. "Typically, we are a very windy course, with good air movement. That was not the case this past summer. I've never had any problems on greens because they get sprayed on a 10-to-14-day schedule with excellent fungicides and spoon-fed fertilizer."

With 34 acres of fairways and tees, Salinetti needs to get the most he can out of each spray.

"Last year, I was only getting eight days control at some points during the summer, spraying good fungicides at the label rate" he says. "Dollar spot was the only disease I had on fairways all year and [was] very difficult to control during hot humid weather, especially after we got a little precipitation."

PHOTO: PAUL KOCH

Salinetti believes the best way to counter the effects of weather on battling dollar spot is to have the proper amount of nitrogen feeding the turf throughout the year.

"The past two years I looked at some cost-saving approaches by lowering my nitrogen levels on fairways and tees from 3lbs. N/m/year to 1.5lbs. N/m/year," he says. "I'm a huge fan of polymer-coated slow-release Polyon fertilizer for fairways and tees. My first two years at BHCC I chose the 3-pound rate of nitrogen [and] never had any dollar spot issues, even when the weather was appropriate. Then, once I cut back to the 1.5-pound rate, the dollar spot has gotten worse and worse each year.

"Next season I'll be going back to the 3-pound rate, and if I was a betting man, I'd bet my dollar spot gets cleaned up and hopefully gone," Salinetti adds. "I feel proper nitrogen amounts will aid in dollar spot control, far better than fungicides."


Salinetti

Koch's research has shown fungicides will degrade faster at higher temperatures, but he's not positive on wet vs. dry. His feeling, however, is that fungicides will degrade faster in wet conditions, which he has seen with drops in concentration following winter rainfall and snowmelt events.

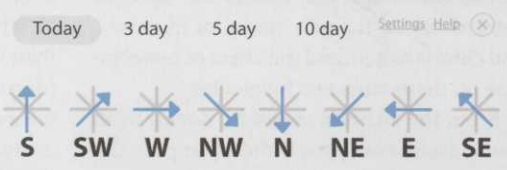
"Countering these effects aren't easy unless you can control the weather," he joked. "But probably the most effective way is to shorten the reapplication interval and/or increase the rate of fungicide application.

"In addition to pathogens being more aggressive and plants more susceptible during hot, humid conditions, I think superintendents should also be thinking that their fungicides are degrading more rapidly... and this more rapid degradation could be leading to disease breakthroughs," Koch adds. "I think PGRs can also extend the duration of control as well, as I mentioned before."

Megan Kennelly, associate professor in the department of plant pathology at Kansas State University, has been studying dollar spot since 2006. She says there is myriad research on the disease, including: efficacy

Spot on predictions

As superintendents look for ways to save money, a new model to prevent dollar spot is set to take the place of older, less precise models.



If you want to predict dollar spot on your golf course, there are two models available. Both were tested in the mid-80s and neither is 100 percent accurate.

"They either underpredicted the number of sprays or overpredicted the number of sprays," says Jim Kerns, Ph.D., turfgrass pathologist at North Carolina State University.

Kerns presented his findings at the Golf Industry Show in San Diego, Calif., "Dollar Spot Forecasting – Did It Work in 2012?" discussed his new model for forecasting dollar spot.

This new model is based on research conducted by both Kerns and Damon Smith, Ph.D., assistant professor at the University of Wisconsin-Madison. At the time of their research, Smith was an assistant professor at Oklahoma State University, and he began the initial research. Kerns and Smith then joined forces and did most of their field development at Oklahoma State and The University of Wisconsin-Madison.

The research involved the tedious task of counting dollar spots as they developed each day, seven days a week. They would then correlate the outbreaks back to seven or eight different weather parameters.

"Doing that allowed us to create a statistical model that would predict the probability of dollar spot showing up on any given day," Kerns says.

The next step was to pick a reapplication window. After they did that, they didn't have to worry about the disease within 14 to 21 days after application.

The project itself was two-fold. After the initial research, both Kerns and Smith had students conduct research to investigate how temperature influences the pathogen. This research found relative humidity was the most important variable, not temperature as originally believed. For dollar spot to develop, a mean air temperature above 55 degrees C had to be present, and there had to be 70 percent humidity for five days.

Kerns and Smith conducted a second stage to the research, adding three more locations: Penn State University with John Kaminski, Ph.D.; University of Tennessee with Brandon Horvath, Ph.D.; and Mississippi State with Maria Tomaso-Peterson, Ph.D.

In the past, since dollar spot was linked to temperature, most superintendents didn't concern themselves with the disease when the summer months started getting hotter, Kerns says. Now, with the new finding that humidity plays a major role, it's apparent that the reason for the decline in dollar spot later in the summer is because a rise in temperature indicates a decline in humidity.

Although there have been predictive models on dollar spot in the past, this new model takes it to the next level.

"None of them were shown to work outside of their place of origin," Kerns says. This new model has been tested and works through the Midwest and the East Coast. The only place the model has never been tested is the West Coast, but dollar spot isn't their major concern. "This model is most likely going to work for them," he says.

Another reason for the new model was that Kerns and Smith wanted to develop one that was precise. They wanted to do anything to help superintendents save money in this economy. "We found on average almost every year we tested it that there was at least one fungicide saving in almost every location. It's going to help [superintendents] very accurately target their fungicide applications," he says.

They also wanted to provide a scientific justification for making the applications. "We've done the research and it's shown that there are conditions where this disease can develop over a long period of time," he says.

As with any model, Kerns knows there is always room for improvement.

"The statistical components of the model will stay the same," he says. "But what we can tweak is the probability. We can take more of a gamble or less of a gamble, but that will depend more on what the turf manager's expectations are."

Kerns expects to publish his findings later this year. **GCI**

Katie Tuttle is GCI's assistant editor.

of fungicides and fungicide programs, forecasting models to help optimize the timing of applications, studies of which nozzles lead to best performance, and screening the causal fungus for resistance to fungicides. Researchers also are evaluating the susceptibility of different cultivars, she adds.

Kennelly says her area only sees a break during the winter and height of summer. "In Kansas, we most commonly see dollar spot in late spring/early summer, like late May through July," she says. "Then the disease usually decreases significantly during the hottest part of summer. Dollar spot is most severe again in late August through September, sometimes continuing through October. The disease really takes off when we get dewy mornings in late summer/early fall after the heat is done."

A superintendent has to be on alert from spring to fall. Fortunately, dollar spot isn't too difficult to spot, according to Salinetti.

"To the superintendent's eye, dollar spot is very easy to recognize," he says. "A morning tour of the course in the dog days of summer may reveal white mycelium with straw brown leaf blades underneath. Left untouched, it can spread quite rapidly, especially under moist, humid conditions."

Koch sprayed iprodione and chlorothalonil on fairway-height bentgrass, then sampled cores from each plot and tested the fungicide concentration weekly over a five-week span.

PHOTOS: PAUL KOCH

Koch agrees dollar spot is one of the most easily identifiable diseases in the field because no other disease produces such small, tan circular patches. That said, a superintendent can't jump to conclusions. "In certain cases the disease foci can blend together and become difficult to ID, and almost look similar to drought or anthracnose," he says. "In that case, pick out some affected leaf blades and look for bleached-colored lesions with a reddish brown border. These lesions don't have to be circular; sometimes they are encompassing

the entire width of the leaf blade."

Fortunately, greens aren't often the diseases target."It's usually most common on fairways or tee boxes, as opposed to putting greens," Koch says. "This might have something to do with a more dense turf canopy on these locations that can hold more moisture relative to the very short height of cut and often sandy conditions on a putting green. But more likely it's related to the more intensive management regime on putting greens compared to fairways or tee boxes."

While Koch acknowledges that dollar spot is possibly the most-studied disease in turf, there has not been a lot of research targeting weather's impact on fungicide efficacy and persistence. In conjunction with his current research, superintendents are going to have to trust their own experience in the field - apply, watch, react. **GCI**

Rob Thomas is a Cleveland-based freelance writer and frequent GCI contributor.

Research found winter rainfall or snowmelt lead to a fairly rapid reduction of fungicide.

CLOCKWISE UPPER LEFT: SYNGENTA; JIM KERNS; PAUL KOCH

Don't be fooled. Identify the tell-tale signs of spring dead spot early on so it doesn't become a season-long scourge.

By Rob Thomas

It has been a long, cold winter. Spring has sprung, turf is exiting dormancy and golfers are chomping at the bit to play. Unfortunately, your course is dotted with unsightly blemishes – spring dead spot (SDS) has reared its ugly head.

Spring dead spot is most common in the transition zone where Bermudagrass is grown and subjected to periods of cold temperatures that induce plant dormancy, says Dr. Nathan R. Walker, professor of turfgrass IPM/turfgrass pathology at Oklahoma State University. Depending on location in the United States, the causal agent is a soilborne fungus known as, *Ophiosphaerella korrae*, *Ophiosphaerella herpotricha* or *Ophiosphaerella narmari*.

"For example, in the Southeast and Atlantic coast states, *O. korrae* tends to be more common, while in the plains, *O. herpotricha* is more common," Walker says. "It is not uncommon to have regions where two or three of the species can all be found."

Symptoms of SDS are fairly diagnostic – patches from 6 inches up to 18 inches, or even several feet in diameter are present at spring green-up, says Dr. S. Bruce Martin, Jr., professor of entomology, soils and plant sciences at Clemson University.

"Superintendents can probe the soil to examine roots and rhizomes in the affected patches; dark brown to black rotten roots, stolons and rhizomes will be observed, even without a hand lens," Martin says.

SDS is most common in the transition zone or in environ-

Spring dead spot is most common in the transition zone where Bermudagrass is grown and subjected to periods of cold temperatures that induce plant dormancy.

ments where Bermudagrass tends to go semi- to completely dormant, Martin says. In areas where winters are cold enough for Bermuda to go completely dormant, SDS tends to be more severe than in climates with warmer winters.

"Symptoms are prevalent in the spring, but infections actually occur the previous summer and fall and perhaps some infection occurs in the spring," he says. "However, the summer and fall infections are probably the most important as they weaken Bermuda as it is going into dormancy, and this weakened, infected grass is what is ultimately injured or killed by low-temperature stress."

Different turf types are more susceptible to SDS, Walker adds. "It is important to remember the disease triangle here – host (grass), environment and pathogen – all are factors that determine the presence or absence of disease," he says. "Like many diseases, when a plant is grown outside its region of adaptation we see stress and disease. The damage SDS causes can range from low to very severe on different cultivars of common and interspecific hybrid Bermudagrasses. Generally speaking, cold tolerant Bermudagrasses are more tolerant and cold intolerant are more susceptible.

"So take Ultradwarf Bermudagrass, which is becoming more common in the northern region of the transition zone in Oklahoma, we will likely see more SDS on these grasses as they are grown farther north," Walker adds. "So within all the different types of Bermudagrasses there are differences, and these differences can be affected greatly by where and how the grass is grown."

The highest maintained hybrid Bermuda grasses are generally the most susceptible, says Blake Garrett, agronomist at FarmLinks in Sylacauga, Ala. Hybrid Bermudagrasses, which tend to produce excessive thatch, are the most prone to spring dead spot. Conversely, Bermudagrass variet-

PHOTOS COURTESY DR. BRUCE MARTIN

WARNING: DON'T BE FOOLED

Superintendents can't be too quick in diagnosing a patch of dead turf as spring dead spot (SDS). It is often confused with pink snow mold because, according to Blake Garrett, agronomist at FarmLinks in Sylacauga, Ala., the two share some similar symptoms, such as bleaching of turf in sunken circular areas that occur after the disease has affected the turf. In addition, both appear after the turf is transitioning out of winter dormancy.

Going beyond the naked eye, any competent diagnostician should be able to differentiate the diseases easily through microscopy, says Dr. S. Bruce Martin, Jr., professor of entomology, soils and plant sciences at Clemson University. "Pink snow mold or michrodochium patch produces abundant two-celled curved spores on infected leaves, while SDS has no spores typically associated with it, but abundant ectotrophic darkly pigmented fungal hyphae on roots, stolons and rhizomes," he says.

"Look at roots, stolons and rhizomes with a good hand lens for the typical rotting associated with SDS," Martin advises. "If they have a microscope, they can incubate foliage overnight in a refrigerator, which should allow growth of microdochium mycelia and spores, then observe through a microscope for the typical curved spores. Otherwise, send an untreated sample to a diagnostic lab. An answer should be forthcoming quickly."

MARY ANN HANSEN, VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY, BUGWOOD.ORG

A ring of salmon- or pink-colored growth is present on the outer edge of pink snow mold patches when the disease is actively developing, Garrett adds. The infected leaves within the patches are usually collapsed and matted down upon themselves.

"Fungicides are effective for control of pink snow mold," he says, if that's what the issue turns out to be. "In the case of pink snow mold, apply fungicides before snow cover to prevent disease development. Mapping and spot-treatment of areas where pink snow mold is most severe can significantly reduce fungicide expenditures. In regions where prolonged snow cover does not occur, apply fungicides when symptoms of microdochium patch are first observed."

Symptoms of SDS are fairly diagnostic – patches from 6 inches up to 18 inches, or even several feet in diameter are present at spring green-up.

ies with improved cold tolerance are more resistant to SDS. Guymon, Midlawn, Midfield, Midiron, Yukon, Mirage and Sundevil have been shown to have improved resistance to SDS, whereas Arizona Common, Cheyenne, Jackpot, NuMex Sahara, Oasis, Poco Verde, Primavera, Princess, Sonesta, Shanghai, Tifton 10, Tifway, Tifgreen, Tropica, Vamont and Sunturf are all susceptible to SDS.

Based upon its name, one might believe SDS is a season pathenogen, but Garrett says that's not the case... and can present problems for years.

"Initial signs and symptoms are visible in the spring, but once the affected Bermudagrass roots and stolons are severely rotted, patches are sunken, generally well defined and circular," he says. "Severely damaged areas may have symptoms that last well into the summer [and] the turf may not recover before fall dormancy.

"They may enlarge over three to four years, often developing into rings and then disappear," Garrett adds. "These spots usually reoccur in the same location over several years if disease-management practices are not put into place."

Unfortunately, the likeliness of SDS appearing is fairly high if conditions are favorable for disease. "It is difficult to avoid the disease, but management practices such as selecting a resistant cultivar, not conducting activities that delay dormancy or spread the fungus can reduce the severity of the disease and likely slow the spread of the disease," Walker says.

Superintendents should be vigilant for early warning signs, Martin says. "Perhaps the appearance of the dull or bleached turf in a patch pattern in fall; however applying a fungicide for control once symptoms appear will be less effective typically than earlier applications, but still may be helpful in late fall, especially on putting greens," he says.

Too late... the disease has been spotted. What now?

"If symptoms occur in a particular spring, then they are more likely to recur the following year if not controlled," Martin says. "Most of my work has been on putting greens where

PHOTOS COURTESY DR NATHAN WALKER

the tolerance of the disease is very low. On fairways, a superintendent frequently will opt not to bother with fungicides because control can be expensive and incomplete. This all depends on the budget and tolerance of the damage.

"Preventive approaches with fungicides usually include two applications of fungicides with known efficacy," he adds. "These have included Rubigan (being phased out), Torque, Banner Maxx and Eagle, primarily. Heritage has worked in some cases but not well in other cases, with the same inconsistent results from thiophanate methyl. However, rotations or tank mixes with t-methyl and Torque have shown improved efficacy over Torque alone, in my trials on putting greens."

Patience and smart agronomic practices are factors in winning the war against SDS, Garrett says.

"Spring dead spot can be managed with a multi-pronged approach, implemented over a period of several years," he says. "Management practices that improve the cold-hardiness of Bermudagrass are therefore very effective for SDS management.

"Preventative fungicide applications are an option in high-value areas or where cultural practices alone do not provide adequate control. Of the fungicides that are labeled for spring dead spot, fenarimol (Rubigan) is most effective," Garrett adds. "The timing of fungicide applications does not appear to be critical, as long as they are made in the fall before soil temperatures dip below 60 degrees (F).

> "They may enlarge over three to four years, often developing into rings and then disappear. These spots usually reoccur in the same location over several years if disease-management practices are not put into place."
>
> — *Blake Garrett, FarmLinks*

For best results, applications should be made at higher water volumes or watered-in with 0.25 inches of irrigation immediately after application in two gallons $H_20/1000\ ft^2$."

Walker points to timing. "Depending on the situation, it is best to avoid practices that can spread the fungus while soil temperatures are cool or delay normal cool temperature-induced plant dormancy," he says. "There are several studies where different fertilizer nutrients or formulations of the nutrient when used decreased the severity of the disease. Excessive nitrogen fertilization can increase the severity of the disease. Lastly, one can use fall applications of fungicides to suppress the disease."

Once diagnosed properly – in-house or via a lab – sound agronomic practices are always the best course. GCI