Super Science

//CAUTION: OIL SPILL

HYDRAULIC OIL SPILLS ON HYBRID BERMUDAGRASS GREENS

William L. Berndt, Ph.D.

Hydraulic oil injures turf. Vegetable-based hydraulic oil is marketed as being less toxic to turf than petroleum-based hydraulic oil. If this is true, then healing times from vegetable-based hydraulic oil spills should be shorter.

Research is being conducted at The Golf Club at Magnolia Landing Course in North Fort Myers, Fla. to determine healing times for spills of petroleum-based and vegetable-based hydraulic oil. When 3 mL (1 mL is equal to 0.2 teaspoon) of each oil was applied to Tifeagle hybrid bermudagrass mowed at 0.10 inches in December 2013, visible injury persisted for greater than 106 days. Injury area due to petroleum oil expanded to 8.4 square inches 36 days after application, then contracted to 3.6 square inches by 81 days after application.

Top photo is petroleum-based oil injury and bottom is vegetable-based oil injury at 14 days after application. Note the color difference of the injured turf between the two spills.

PHOTO BY: LEE BERNDT

Modeling indicated that the relationship between the injury area and the time predicted is a healing time of 108 days. In contrast, the injury area due to vegetable oil expanded to 6.2 square inches 10 days after application, contracting to 3.3 square inches 81 days after application with a predicted healing time of 115 days.

As of day 106, visible injury was still evident for both oils, though substantial healing had occurred. Reduced healing times were not observed for vegetable-based oil spills occurring during this minimal growth period. This experiment is being repeated during an active growth period, beginning March 2014. Additional research involving NDVI measurements and image analysis of hydraulic oil injury is also being conducted.

William L. Berndt, Ph.D., Florida Gulf Coast University, Fort Myers, Fla. Lee can be reached at lee-berndt@aol.com for more information.

NEWS UPDATES

PERFORMANCE NUTRITION ENTERS INTO AGREEMENT WITH EC GROW

Performance Nutrition, of Hazlet, N.J., has entered into an exclusive agreement with EC Grow, of Eau Claire, Wis., to produce and market a fertilizer in 23 states that is pre-blended with NutriSmart eco-fertilizer humate soil amendment. It will be sold under EC Grow's Award Turf fertilizer brand for the turf and ornamental market.

A patented, environmentally friendly granular eco-fertilizer humate soil amendment, NutriSmart contains beneficial microbes that fix nitrogen from the atmosphere, solubilize phosphate and unlock potassium from the soil. Its 'smart technology' creates a balance of nutrients that make applied fertilizer more efficient and can replace up to 30-percent of soil applied N, P and K.

"We are seeing more states regulate the amount of nitrogen they will allow per application. By adding NutriSmart to our Award Turf Fertilizer blend, we can reduce the amount of nitrogen by up to 30 percent and achieve similar quality and color," says Chris Bluemke, marketing manager for EC Grow. "We are always looking for value-added products to bring to the T&O market. NutriSmart is a good fit for us because it's clean, consistent and easy to work with."

"MY GOAL IS NOT TO FRIGHTEN SUPERINTENDENTS, BUT TO EDUCATE ON ALL THE FACTORS THAT ENCOMPASS FUNGICIDE PROGRAM DEVELOPMENT."

Jim Kerns, Ph.D.

(see full story on page 42)

//FIGHTING THE GOOD FIGHT

Factors affecting fungicide performance

Part 3 of 3: Depletion factors

By Jim Kerns Ph.D.

***Editor's note:** This is third of three articles by Dr. Kerns on disease management and control.*

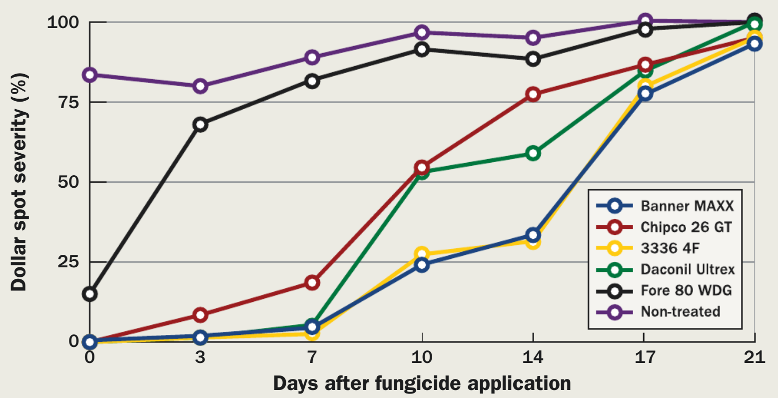
In the two previous articles we discussed the importance of fungicide selection, application rate, application timing, disease pressure and fungicide resistance. All of these factors help turfgrass managers develop solid disease management programs, but what happens to the product once it is applied?

Six processes affect the persistence of fungicides in an environment: volatilization, plant uptake, biotic degradation (microbial metabolism), abiotic degradation (photodegradation or pH activity), solubility-based movement in water and sorption and desorption to plant and soil surfaces.

After application of a fungicide, there are many different fates for the product.

FIGURE 1

Depletion of five fungicides commonly used for dollar spot control in creeping bentgrass turf.



The study was a bioassay in which fungicides were applied to field plots and cores were removed and inoculated with the dollar spot fungus at zero, three, seven, 10, 14, 17 and 21 days after fungicide application. Figure was adapted from Latin, 2011.

FUNGICIDES ARE FUNGISTATIC

Dr. Rick Latin conducted an interesting experiment investigating the depletion of commonly used dollar spot fungicides. Fungicides were applied in the field, cores were collected and inoculated at zero, three, seven, 10, 14, 17 and 21 days after the initial fungicide application. The fungicides he used were Banner MAXX (propiconazole), Chipco 26 GT (iprodione), 3336 4F (thiophanate methyl), Daconil Ultrex (chlorothalonil) and Fore (mancozeb).

Figure 1 shows his results nicely, yet notice that in almost every case, protection of the foliage started to break down around seven to 10 days after the initial fungicide application. Although many of these products may provide 14 days of dollar spot suppression, this work clearly shows that these products were depleted fairly rapidly from the leaf surface (Latin, 2011). Please do not view this as justification to apply fungicides every seven days.

We know that fungicides are really fungistatic. Fungistatic means that fungal cells are killed, but the entire fungal body is not destroyed in response to a fungicide application. Therefore, once the fungus overcomes the shock of cell death, growth can resume if conditions are favorable. The current suite of fungicides is effective, but they only kill small portions of the fungal body. Keep in mind that once we see disease develop, the amount of fungal tissue required to induce that reaction is large.

Fungi are extremely prolific organisms and even the absolute best fungicides cannot kill all the fungal cells present in the tissue. So depending on the current environment, it may take the fungus a few days or weeks to recover from the fungicide applications. For example, our research with dollar spot clearly shows that the fungus needs four or five days of colonization before inducing plant symptoms. If we apply one of the fungicides above and assume eight to 10 days of protection of the foliage, another four or five days of conducive conditions for fungal re-growth, then 12 to 15 days of dollar spot suppression should be expected. In some cases, the disease may "break through" the common re-application interval for a fungicide, but that does not necessarily mean fungicide resistance has developed in the population. Under certain circumstances we may be fighting an active pathogen population and active depletion of the fungicides as well.

TEMPERATURE TREATMENTS

Of the six processes that affect fungicide persistence in the environment, the first four mentioned above [volatilization, plant uptake, biotic degradation (microbial metabolism), abiotic degradation (photodegradation)] are governed by temperature.

We wanted to examine the influence of temperature on the persistence of iprodione and chlorothalonil to see if fungicide indeed breaks down faster as temperatures increase. We followed a similar protocol as Dr. Latin's experiment, where we applied both fungicides to field plots and collected cores for sampling. We used commercially available ELISA (enzyme linked immunosorbant assay) kits for each fungicide to determine fungicide concentration on the leaf surface in response to the following temperatures: 50, 68 and 86 degrees F. We collected tissue at zero, seven, 14, 21 and 35 days after the initial fungicide application and this data allowed us to calculate half-life values for each fungicide within each temperature treatment.

For iprodione we found average half-life values of 39, 8.6 and 4.4 days at 50, 68 and 86 degrees F respectively. For chlorothalonil we determined that half-life values were 9.48, 8.5, 4.0 days at 50, 68 and 86 degrees F respectively. These values are averaged across two or three experiments we conducted in 2010 and 2011 (Koch, 2012). Clearly temperature has a profound influence on the persistence of these two fungicides and most of the fungicides we use in turf.

With these experiments, cores were removed from the field and placed in growth chambers without mowing. When we collected cores from the field at each of the sampling dates above, without incubation at a specific temperature, half-life values for iprodione and chlorothalonil were 1.76 and 2.1 days, respectively. Not only does temperature influence depletion of fungicide, but so does physical removal due to mowing (Koch, 2012).

SCIENCE OF RE-APPLICATION

Most fungicide failures occur during the summer months when most turf pathogens are highly active and fungicides are readily depleted. With certain diseases, it may be necessary to use high rates and short intervals in order to maintain adequate protection, regardless of the status of fungicide resistance within the population. On the other hand, when pathogens are not as active and fungicide depletion is minor, extended residual control can be expected.

PHOTO BY: JIM KERNS

Fairy ring is shown on an ultradwarf bermudagrass putting green.

The two extremes are Pythium blight or Pythium root rot and snow mold. When Pythium blight or Pythium root rot develop, many times shortened application intervals and potentially high rates are recommended in order to maintain disease suppression. However with snow molds, one or two properly timed fungicide applications protect turf plants for many months. Turf managers should not expect protection well after snow melts in the spring. Our research shows that fungicides deplete readily as snow melts in the spring. Re-application of fungicide will be required to protect turf against Microdochium patch.

The science behind re-application intervals is not exact. Most of the recommendations come from fungicide efficacy testing at universities. I think these are solid, but they can fail too. We do not have a handle on how many fungal cells are killed with an application and then how long it takes for the fungus to recover in every situation. For example, Dr. Latin conducted another experiment investigating the residual efficacy of fungicides for brown patch control. Again he found that fungicide residues were not sufficient on the leaf surface to protect against brown patch beyond seven to 10 days after the initial application (Latin, 2011).

This study was conducted in a similar fashion to his dollar spot study mentioned above. Yet, we routinely see 21 to 28 days of control with some of the products he used in his study: azoxystrobin and flutolanil. So why do we see extended control of brown patch in many cases, but not with dollar spot or Pythium blight?

It could be that fungicides that are superior for brown patch may be ultra toxic to *Rhizoctonia solani* and many more fungal cells are killed when applying fungicides for preventative control of brown patch. Another possible explanation could be that these fungicides persist longer in thatch and soil where the brown patch fungus resides.

Dr. Gail Schumann investigated the fate of fungicides in a Kentucky bluegrass sward in 2000. She found that propiconazole was not detectable seven days after application on the leaves, similar to the findings of Dr. Latin and our results mentioned above. However, her work examined more components of the turf systems such as roots, soil and thatch. She found almost no propiconazole in the soil or roots; rather most of the residue persisted for 28 days in the

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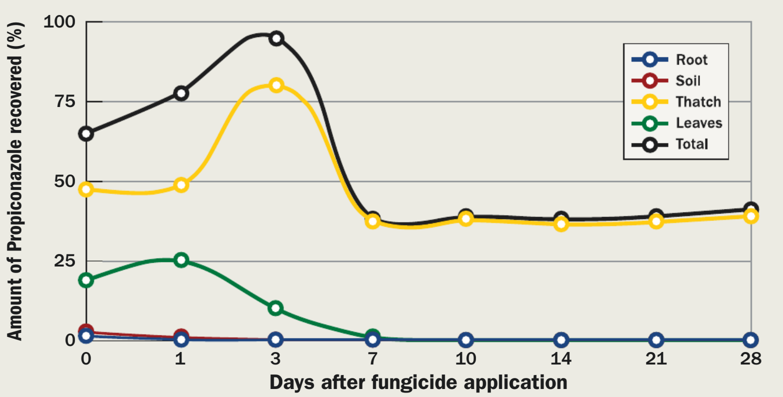
FIGURE 2

Fate of propiconazole after application using a boom-sprayer in a Kentucky bluegrass sward.



Roots, soil, thatch and leaves were sampled zero, one, three, seven, 10, 14, 21 and 28 days after the initial fungicide application to determine percent recovery of propiconazole. Figure was adapted from Schumann et al., 2000.

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thatch (Figure 2) (Schumann, 2000).

Most turf pathologists acknowledge that the thatch is where *R. solani* survives when not causing disease; therefore it is plausible that fungicide residues in the thatch may prevent the fungus from starting new infections for about one month or so. Of course the major assumption here is that products, such as azoxystrobin and flutolanil, follow the same fate as propiconazole. At least with azoxystrobin, Syngenta materials claim the product readily binds to organic matter. It is likely a safe assumption that most azoxystrobin residue would reside in the thatch (Syngenta, 2005).

KNOW YOUR ENEMY

Many different factors affect fungicide persistence in the environment. Turfgrass systems are extremely dynamic with respect to plant growth and microbial metabolism and consequently, fungicides applied to the foliage do not persist for more than seven to 10 days. Although most fungicides are re-applied every 14 to 28 days when conditions favor disease development, in some cases it may be necessary to tighten that re-application interval to account for increased pathogen activity and fungicide depletion.

Alternatively, fungicides may persist for long periods of time (> 28 days) when pathogen activity and/or fungicide depletion is low. Fungicide depletion is important to consider when breakthrough occurs because not all fungicide failures should or can be attributed to fungicide resistance. During hot, humid summers when pathogen activity is high, shorter intervals may be needed to overcome fungicide depletion and intense disease pressure, regardless of the status of fungicide resistance in the fungal population.

My goal with these articles are not to frighten superintendents, but to educate on all the factors that encompass fungicide program development. Developing a fungicide program is more complex than simply picking a product or products and applying them on a pre-designated application strategy. Improvisation is likely needed depending on what Mother Nature deals us during the season.

Most superintendents develop sound fungicide programs that hold up season after season, but if problems have occurred I encourage you to investigate some of the topics I've discussed. In some instances we can extend residual control of fungicides and in others we cannot. Fungicides are essential, valuable tools for superintendents, but they do have limitations. When used in conjunction with sound agronomic practices they will work. However there are times when they fail and it is not necessarily the fault of the chemistry.

The best way to combat diseases and thereby maximize fungicide efficacy is to understand the diseases and the fungicides that are used to control them.

Remember that when fighting diseases and good luck this season!

Jim Kerns, Ph.D. is an assistant professor and extension specialist in turfgrass pathology in the Department of Plant Pathology at North Carolina State University. Dr. Kerns can be reached at jpkerns@ncsu.edu.

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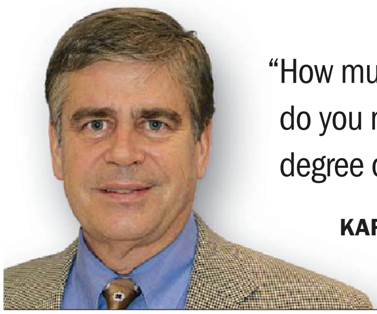

"How much diversity in functional grouping do you need? The answer depends on the degree of extreme environmental change."

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

Resisting change

Climate change induced by global warming has greatly impacted the stability of the world's ecosystems. Weather patterns resulting from climate change have become more extreme. Whether it is too hot or too cold, too wet or too dry, a "normal" year seems to be a rare event.

On a smaller scale, but still just as devastating, we see how climate change has impacted our turf systems. We are seeing bermudagrass use expand further north to account for the increased stress of managing creeping bentgrass. At the same time, as we saw this past winter, extreme cold in combination with ice and snow, wreak havoc on annual bluegrass (*Poa annua*) turf around the Great Lakes region.

In natural systems, the centerpiece for stability is biodiversity. Biodiversity as related to stability, is the idea that multiple or numerous species provide stability by filling gaps that are created by a species that is sensitive to an environmental change or a biotic factor like predators and diseases. The implication often assumed is that a whole lot of species in a habitat or ecosystem are more stable than one with fewer species. This is not always true.

Species diversity has two primary components: richness (the number of species), and the composition (what the species are). When we talk about large natural systems, we often focus on species richness. However, it is the identity or what the species are and their function in the ecosystem, often called functional traits, that are important for stability. Species that have similar functional traits are grouped into similar or functional groups.

Your habitat may be species rich, but if all the species were contained in one or two functional groups the level of stability would be low. In a previous *Golfdom* column (2007 — "When are golf greens stable?") I wrote along similar lines with regard to complexity/biodiversity.

How much diversity in functional grouping do you need? The answer depends on the degree of extreme environmental change. Using a putting green as our habitat, located in a temperate region that consists of creeping bentgrass and annual bluegrass, we can see that under normal conditions we might be stable, but under extreme conditions not so much.

Let us assume our putting green is primarily annual bluegrass and is infected with the pathogen that causes the disease summer patch. In year one, the summertime temperatures are considered normal to below normal. We might see a summer patch yellow ring symptom develop on the annual bluegrass, but not much else — no turf thinning or loss to the annual bluegrass.

The second year is warmer than normal and summer patch is much more active to the degree it is killing the annual bluegrass, but at a rate equal to that of creeping bentgrass, filling in the center areas. So in this instance, the idea is that diversity in the form of the additional turfgrass species (creeping bentgrass) is contributing toward stability.

However, let's say that the third year the summer is much warmer than normal, to the point where annual bluegrass is rapidly dying at a rate where the creeping bentgrass cannot match because it is under stress due to temperature. Now we have large gaps or patches of dead grass on our green. In this situation we do not have the diversity to be stable. More specifically, the functional grouping of creeping bentgrass and annual bluegrass in this situation is not different enough to contribute to stability.

Although we do not have the plant diversity in a putting green that many other habitats may have, we do have one big advantage: We can intervene to provide some stability through management practices. In future columns we will look at how management practices impact turfgrass populations and communities.

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

Timing for ABW control

Ben McGraw, Ph.D., is an associate professor of turfgrass science at the State University of New York at Delhi, where he leads the teaching program in turf management and devotes a portion of his research effort to the biology and control of annual bluegrass weevil. McGraw can be reached at mcgrawba@delhi.edu for more information.

Q What is the current range of annual bluegrass weevil and why is it spreading to new areas?

Annual bluegrass weevil causes the most damage in the metro New York City area. It can be found as far north as Quebec and Ontario, west to the Cleveland area and as far south as western North Carolina. Annual bluegrass weevil is native to the U.S. and can be found in many locations. It does not always cause damage to turf. We find it on golf courses, but in the absence of an additional stress, such as low mowing height, heat or drought, the turf does not always show damage.

One hypothesis why the annual bluegrass weevil is spreading is that it is undergoing a host shift and is now able to feed on annual bluegrass and to a lesser degree, creeping bentgrass.

Q What are the best sampling techniques to determine the presence of annual bluegrass weevil?

Careful observation for the adults still tops the list. On warm days in spring, the adults can be seen walking from overwintering sites to closely mown greens, tees and fairways. Vacuuming is an effective and efficient way to collect adults and is gaining in popularity. Soap flushes can be used to find larvae and sometimes, early instars within the plants.

Q What is the ideal timing for insecticide applications to control annual bluegrass weevil?

I believe the most effective insecticidal approach is to target the overwintering adults and first generation larvae. The reason adults are targeted is to prevent adult females from laying eggs. They cause little damage.

Adults have a staggered emergence following winter and the first insecticide application should be applied to coincide with peak emergence of the adults. The half-green and half-gold forsythia is a good time to apply an insecticide to control adults.

The second most effective time for control is to target the first generation larvae. Larvae cause the most damage to annual bluegrass. Younger larvae feed inside the stems of turf, causing the turf to turn yellow and thin out. Older larvae drop from the stems and reside at the soil surface where they feed on turfgrass crowns causing additional damage. Blooming of hybrid rhododendron is a good indicator of when the first generation larvae of annual bluegrass weevil are beginning to exit the plant and can be found in the thatch and soil.

The larger larvae at the soil surface can be controlled with an insecticide application. This stops these larvae from causing any more damage and prevents, or reduces the population of, a second generation of annual bluegrass weevil.

Q What insights do you have on the resistance of some populations of annual bluegrass weevil to synthetic pyrethroids?

Annual bluegrass weevil resistance to synthetic pyrethroids is a serious problem. Entomologists are also discovering that populations of annual bluegrass weevil resistant to synthetic pyrethroids are also resistant to other insecticides.

For most courses, pyrethroids remain effective. I recommend that a superintendent make no more than one application of a synthetic pyrethroid per year to control adult annual bluegrass weevils. If a pyrethroid is applied to target annual bluegrass weevil adults, a repeat application should not be made against other insect pests later in the year (e.g. black cutworm), so that the effectiveness of the pyrethroids and, more importantly, other controls remain effective for as long as possible.

Superintendents should focus on managing a healthy turfgrass stand that can withstand some damage from annual bluegrass weevils. We may have to learn to live with a modest amount of annual bluegrass weevil damage.

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

PERFECT PONDS

We were in London (what a fun — yet pretentious — way to start a paragraph) last year when we were accosted for being in the American golf business. "You over manage your courses so much!" we were told. "You even dye your ponds!" We didn't see that coming as the key to American golf's over management, but we didn't mind admitting that, yes… a beautiful, healthy pond is something we admire. And these products help accomplish that.

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U.S. Aqua Vac Inc.

4

1. Aqua-T Pond Bacteria

Manage the health of your water features naturally and effectively with **ECOLOGEL'S** Aqua-T Pond Bacteria. This product offers a combination of specific strains of bacteria and bacterial enzymes that reduce sludge, control foul odors and digest the excess nutrients, which may cause problematic algae growth. These naturally occurring soil and water bacteria work to clean the entire water column and sludge layer by digesting organic waters and contaminants. Aqua-T is not an algaecide; therefore it can be used in recreational and irrigation ponds where water quality is an issue. This includes ponds receiving effluent water. This product is available in half-pound, water-soluble bags. Aqua-T makes pond treatment safe and easy.

ecologel.com

2. Algae Control System

The **RAIN BIRD** Algae Control System (ACS) is an environmentally safe algae control system that uses state-of-the-art ultrasonic technology to eliminate algae without harming other aquatic life such as plants or fish. The ACS transducer, submerged just beneath the surface, is programmed to generate ultrasonic waves that inhibit the growth and spread of algae. The Algae Control System requires no EPA certification and reduces application and maintenance costs associated with chemical applications. Results can be seen in as few as three to four weeks.

rainbird.com

3. SeClear Algaecide and Water Quality Enhancer

SECLEAR is the first algaecide and water quality enhancer in one, designed to replace routine algaecide programs. SeClear provides effective control of a broad-range of algae species while reducing in-water phosphorus levels with each application. The result is longer lasting control, improved water quality and aesthetics with reduced maintenance through time.

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4. U.S. Aqua Vac

A pond cleaning company, **U.S. AQUA VAC** has state of the art equipment and trained personnel that will remove the muck, sludge, silt and sediment from your waterway. Their nationwide service can be done while your golf course is open without interruption to players. U.S. Aqua Vac will also remove cattails and weeds from your waterways, as well as do special shoreline restoration. They can be contacted for a free estimate at 866-989-MUCK (6825).

usaquavac.com

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For more listings of pond protection products, go to **golfdom.com/category/products**

TIPS FROM DR. FRANK

Dr. Kevin Frank at Michigan State University recommends irrigation sensors to monitor the amount of water required for a green or fairway. But he cautions – even just for monitoring water needs – proper placement of the sensors is vital. "If you get to the point where you use sensors to control and not just monitor irrigation, keep in mind that placement is a key issue." *(Continued, page 50)*

1. Profile solid metal sprinkler nozzles

The Profile solid metal sprinkler nozzles are designed to improve irrigation distribution uniformity rates (DU) on tees and greens, while saving water. Consistent DU rates can translate to healthier, greener turf and the elimination of dry patches and donuts. Featuring solid brass construction with stainless steel outlets, Profile nozzles replace plastic nozzles, which may be clogged or eroded after years of use. These **UNDERHILL INTERNATIONAL** nozzles can be retrofitted to plastic OEM nozzles with 1 ¼" and 1 ½" inlets. Replacement sets include full-circle, mid-range and close-in coverage.
underhill.com

2. Infinity Series golf sprinkler

The **TORO CO.**'s Infinity Series golf sprinklers boast new features and benefits. The key benefit of the Infinity Series is the innovative Smart Access feature that allows crews quick and easy access to internal components, including solenoids, pilot valves, 2-wire control modules and wire splices — all without digging, to provide significant labor savings. The Smart Access compartment provides system protection by isolating all electrical components, such as wire splices, from soil moisture to prevent ground shorts and repairs. The INF34/54 and INF35/55 models provide dual trajectory adjustment selections of 15 or 25 degrees. The INF35-6/55-6 is available with the TruJectory feature that allows users to adjust the main nozzle trajectory from the top of the sprinkler, and easily fine-tune radius and spray heights from seven to 30 degrees in one degree increments.
toro.com

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For more listings of irrigation products, go to **golfdom.com/category/products**

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TIPS FROM DR. FRANK

(Continued from page 48) "If your sensor sits at three inches deep and the root zone extends down only 2.5 inches, your data are meaningless to the turf," he says. Also, remember that the system may slightly over-water to get the water level where it needs to be on a particular green, Frank says.

1. BunkerBlaster

The BunkerBlaster is the most effective tool to help control flooded bunkers on your golf course. This **DARLEY** product connects to most standard bunker rakers and immediately helps to reduce time, labor and equipment cost. One operator can efficiently clear the most saturated bunker in a few minutes. A high or low profile nozzle allows the end user flexibility when deciding where to discharge the water. Pumping at 300 gallons per minute, The BunkerBlaster is a perfect tool for any golf course with water in its bunkers.

darley.com

2. POGO Turf and Soil Insight Tool

The **STEVENS WATER MONITORING SYSTEMS** POGO Turf and Soil Insight Tool is fast becoming a staple in superintendents' programs around the world, the company says. The ultimately portable POGO quickly and easily measures moisture, salinity and temperature precisely in the mat zone and uppermost soil region. It wirelessly utilizes a powerful app on any Apple or Android device (mobile phone, iPod touch, iPad, Android tablet, etc.) with no calibration required so that the user can be confident he or she is making decisions based on relative information over time. The POGO streams real time collected information to the POGO Turf Pro cloud analytical and mapping system where tournament logs, daily trends, variations across a property, mapping and charting among other analytical features are easily done from any Internet connection. This allows for on-the-fly information in the hands of the superintendent to make valuable decisions quickly and decisively. Taking less than two minutes to log an average size putting green, the POGO is fast becoming the superintendent's most trusted resource.

POGOTurfPro.com