FOUNDATION NEWS

A PUBLICATION OF THE TRI-STATE TURF RESEARCH FOUNDATION WINTER 2015 VOL. 18 NO. 1

PRESIDENT'S MESSAGE

Where Would We Be Without Research?

Matt Ceplo, CGCS, President
Tri-State Turf Research Foundation

I have to admit, I'm finding this message difficult to write. Difficult because the subject—research—is so important to each and every one of us that I want to be sure I do it justice.

Imagine where we would be without research. I, honestly, can't think of any advances—from technological and medical to ecological and, yes, turfgrass management—that have not been the result of research.

Research has clearly enhanced our world. So why am I finding it so hard to convince golf courses to contribute a few dollars from their budgets? We are asking for only $225 to help support our cause. That's less than .025 percent of our budgets. (I researched that!!)

FOUNDATION DOLLARS AT WORK

Because of Tri-State-funded research, golf course superintendents have found environmentally safe control options for numerous turf-threatening pests and problems, not the least of which are summer patch, anthracnose, and the annual bluegrass weevil.

With the knowledge research trials have provided, we've saved thousands of dollars in unwarranted fertilizer and pesticide applications—and skirted added labor costs and environmental liabilities. And of course, research has led to many of the advances in turfgrass management practices that have guided us in providing top-notch conditions for the millions of people who enjoy playing golf.

All of our research is conducted by local universities—the very same universities that produce forward-thinking interns and assistants who ultimately become the industry's golf course superintendents.

Each and every study is made possible with the contributions of the Tri-State Turf Research Foundation's six affiliated associations (see Masthead on back page for list) and donations from area clubs and vendors. This is why we need your help.

A CALL TO ACTION

If you are reading this and you are a member at a club, please be sure to support your superintendent's efforts to support the Tri-State Turf Research Foundation. It's one of the most worthwhile investments a club can make—for the

(continued on page 20)

INSIDE THIS ISSUE

TRI STATE

The ABW Battle Takes New Twist

Researchers From Rutgers and URI Continue Their Pursuit of Controls for Chemical-Resistant ABW Populations

The annual bluegrass weevil (ABW), technically known as *Listronotus maculicollis,* remains the most highly destructive, difficult-to-control insect pest of short-mown golf course turf (greens, collars, approaches, fairways, tee boxes), with severe infestations now being reported in all states across the Northeast and Mid-Atlantic region.

The damage begins when young larvae tunnel the grass plant's stems causing the central leaf blades to yellow and die. The older larvae later feed externally on the crowns, sometimes completely severing the stems from the roots.

The most severe ABW damage is normally caused by first-generation older larvae around late May/early June in the New York metropolitan area. Damage from the second-generation larvae, in early to mid-July, is usually less severe and more localized.

Turf managers have been controlling the ABW with chemical insecticides, preventively spraying much of the short-mown areas of the golf course up to 10 times during the season. Unfortunately, overreliance on synthetic insecticides, particularly pyrethroids, has led to the development of insecticide-resistant populations, some of which are already resistant to most of the currently available chemistries. Though organophosphate chlorpyrifos is currently the preferred adulticide, ABW populations are already showing resistance to this class of chemicals, albeit at lower levels than to the pyrethroids.

With the ongoing threat of chemical resistance, the Tri-State Turf Research Foundation has invested in providing golf course superintendents with a concrete plan for managing this seemingly unstoppable pest, funding Rutgers University and University of Rhode Island (URI) research teams in their pursuit of viable ABW monitoring, assessment, and nonchemical control methods.

As Rutgers' commitment with the Tri-State draws to a close, the team from URI has entered into a new phase of ABW research with the foundation's support. On the following pages, you will find Rutgers' latest findings and recommendations, as well as URI's plan of attack in its endeavor to uncover a reliable way to stop the ABW in its tracks.

Nematodes Show Promise in ABW Control

Rutgers Researchers Make Strides Toward Viable Biological Control for the ABW

With nearly three years of Tri-State Turf Research Foundation funding behind them, Rutgers University's Dr. Albrecht Koppenhöfer and his team of researchers have explored three different aspects of IPM and their effects on ABW populations, hoping to develop effective alternatives to chemical pesticides for ABW control. They examined:

1. Monitoring methods
2. Plant resistance/tolerance
3. Biological controls

In this last phase of their study, the researchers examined combinations of biological control agents—namely entomopathogenic nematodes (EPNs)—with standard insecticides for improved ABW control and reduced selection for insecticide resistance. Here is a look at the Rutgers researchers' latest work.

THE LIFECYCLE OF THE ENTOMOPATHOGENIC NEMATODE

Entomopathogenic nematodes (EPNs) are obligate insect parasites that spend a portion of their lifecycle as a free-living, non-feeding injective infective juvenile. This is also the nematode stage present in EPN-based products.

As an infective juvenile, the EPN finds a host insect and makes its way into the insect's body cavity. There, it releases specific symbiotic bacteria that kill the insect, creating an environment suitable for nematode development and reproduction.

After the nematodes have developed through one to three generations and resources in the insect cadaver are depleted, hundreds to hundreds of thousands of new infective juveniles emerge to seek out a new host.

EPNs are present in soils of most ecosystems around the world and are very common in turfgrass areas. The researchers found that indigenous populations of the EPN species *Steinernema carpocapsae* and *Heterorhabditis bacteriophora* were common in the soils of fairways that received few insecticide applications.

Nematodes Show Promise in ABW Control

These native EPNs were estimated to kill up to 50 percent of the larvae and pupae of some ABW generations but were not reliable in reducing ABW densities in a biological-control approach.

ENTOMOPATHOGENIC NEMATODES VS. THE ABW

In an attempt to harness the EPN's potential for ABW control, the researchers conducted numerous field trials, targeting 3rd through 5th larval-stage ABW and using commercial strains of multiple EPN species at multiple rates.

Though *Steinernema carpocapsae* proved the overall best and most consistent species, the trials suggested that EPNs provide acceptable, but somewhat variable control against moderate larval densities (<80 larvae/sq. ft.).

Dr. Koppenhöfer and his team felt the efficacy of the EPN in combating ABW larvae may be limited by a combination of factors:

» First, young ABW larvae are protected from EPNs while still feeding inside the grass stems.

» Second, the larvae emerge from the stems over a period of several weeks.

» Third, persistence of the applied EPNs is limited. Therefore, splitting EPN applications in two and making them about 5 to 7 days apart may alleviate this limitation.

The good news: EPNs are tolerant of a wide range of chemicals and amendments commonly used in turfgrass management. In fact, EPNs have been shown to interact synergistically with neonicotinoids—especially imidacloprid (Merit), and chlorantraniliprole (Acelepryn)—in combating white grubs.

It seems feasible, then, that these combinations would also be effective in controlling ABW larvae. Imidacloprid, after all, is already widely used for white grub management, and combinations could be applied at the appropriate time to control both ABW larvae and white grubs.

IMPROVING EPN PERFORMANCE IN COMBATING ABW LARVAE

The researchers then looked at combinations of EPNs with imidacloprid for control of the ABW, conducting a series of greenhouse studies and field experiments.

In the greenhouse tests, a low and a high rate of the EPN species *Heterorhabditis bacteriophora, Steinernema carpocapsae*, and *Steinernema feltiae,* as well as imidacloprid were tested alone and in combination against ABW fourth instars. The outcome:

» The nematodes and imidacloprid generally did not interact synergistically but still provided additive control.

In the first field experiment, two rates (0.5 or 1.0 billion per acre) of *H. bacteriophora* and *S. carpocapsae* were tested alone or in combination with the labeled rate of imidacloprid (0.3 lbs. AI per acre). The outcome:

» All treatments provided significant control, with 59 percent for imidacloprid alone and around 70 percent for the higher rate of both EPNs alone *(Figure 1).*

» Imidacloprid and both EPN species, when applied together, offered increased control, with 81- and 83-percent control observed for the combination of imidacloprid with the lower and higher rates, respectively, of *S. carpocapsae*.

(continued on page 4)

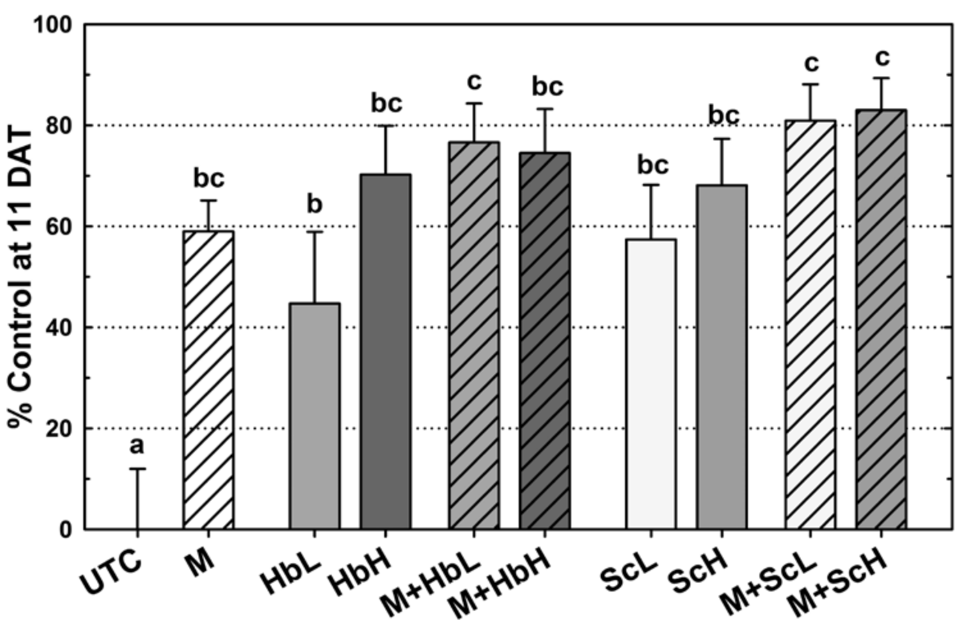


FIGURE 1

Efficacy of the nematode species *H. bacteriophora* (Hb) and *S. carpocapsae* (Sc) at low (L = 0.5 billion per acre) and high (H = 1.0 billion per acre) rates, the neonicotinoid insecticide Merit (M), and their combination against ABW larvae in a spring test. UTC = untreated control.

Nematodes Show Promise in ABW Control

In the first leg of the second field experiment, *S. carpocapsae* (0.5 or 1 billion per acre) and imidacloprid (0.3 lbs. AI per acre) were either applied alone or in combination. The outcome:

» All treatments, except imidacloprid alone, provided significant control *(Figure 2)*.

» *S. carpocapsae* alone offered 50- to 58-percent control.

» *S. carpocapsae*-imidacloprid combinations offered 77- to 78-percent control, which was significantly better than imidacloprid alone.

In the next leg of the second field experiment, the researchers tested whether split applications of *S. carpocapsae* (2 x 0.5 billion per acre) could further improve efficacy. The first half of the application was made at the same time as the non-split treatments. The second half was applied five days later.

In addition, a split application of *S. carpocapsae* was also tested in combination with imidacloprid and was applied either at full rate with the first application only or also split into two half-rate applications. The outcome:

» Split applications of nematodes, whether with *S. carpocapsae* alone (88-percent control) or in combination with imidacloprid (95- to 96-percent control), showed the greatest potential *(Figure 2)*.

A third field experiment was conducted at a site with pyrethroid-resistant ABW.

» The efficacy of *S. carpocapsae* alone was similar to that observed against pyrethroid-susceptible ABW: 67-percent control at half rate and 76 percent at full rate.

» When applied alone, imidacloprid provided 40-percent control, but when applied in combination with *S. carpocapsae,* there was an additional benefit: 77-percent control at half rate and 78 percent at full rate.

» Split applications did not provide additional control for *S. carpocapsae* alone (64- and 77-percent control) but provided the highest control rate in combination with imidacloprid: 87-percent control for two applications at half rate.

Therefore, *S. carpocapsae* is at least as effective against pyrethroid-resistant ABW as against pyrethroid-susceptible ABW.

WHAT WE CAN CONCLUDE

Through their work to uncover a biological control for ABW, the researchers have concluded that:

» The efficacy of entomopathogenic nematodes for control of ABW larvae can be improved by split applications of *S. carpocapsae* (about one week apart).

» Simultaneous application of *S. carpocapsae* or *H. bacteriophora* with imidacloprid (applied for white grub control) have an additive effect on larval mortality. Imidacloprid-nematode combinations would, at the same time, also give white grub control for the season.

» Ongoing studies suggest that nematodes and their combination with imidacloprid are at least as effective against pyrethroid-resistant ABW as against nonresistant ABW.

» When it comes to managing resistant ABW populations, against which most synthetic insecticides are more or less ineffective, nematodes offer a useful alternative that can give good larval control while reducing the selection for resistance.

For further information on the Rutgers teams' ABW research and future plans, you can contact Dr. Albrecht Koppenhöfer at koppenhofer@aesop.rutgers.edu.

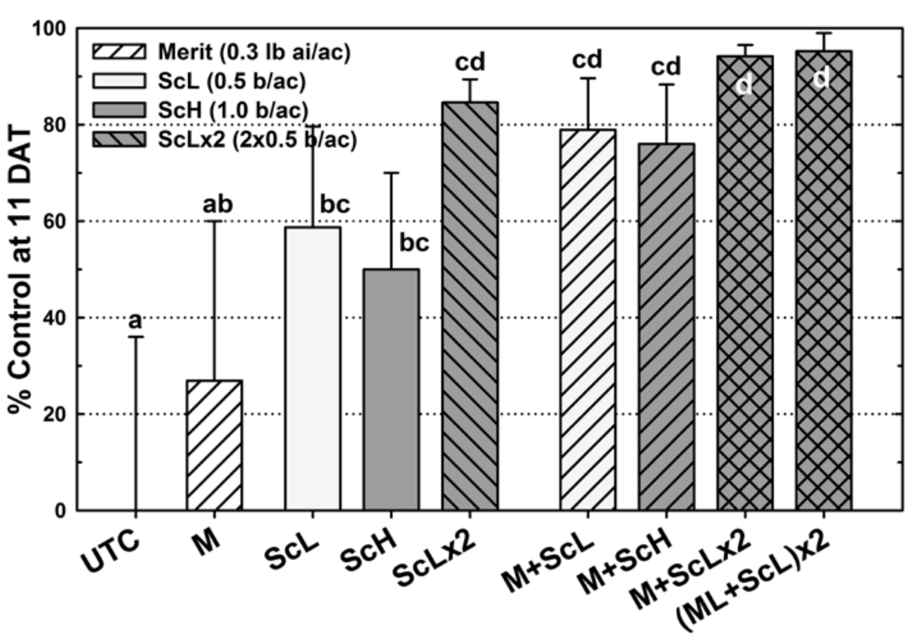


FIGURE 2

Efficacy of the entomopathogenic nematode *Steinernema carpocapsae* at low (ScL = 0.5 billion per acre) and high (ScH = 1.0 billion per acre) rates, the neonicotinoid insecticide Merit (M), and their combination as single or split (x2) application against ABW larvae in a spring test. UTC = untreated control.

URI Researchers Take All-New Tack in ABW Control

The annual bluegrass weevil (ABW) is still alive and well, managing to elude or become resistant to not just pyrethroids, but many of the newer chemistries being developed as well. As the cost of formulating and marketing new insecticides continues to rise, it is unlikely that superintendents will have the benefit of as many new chemistries as they've had in the recent past to overcome resistant ABW populations by alternating different modes of action.

Recognizing the growing need to provide turfgrass managers with alternative strategies for avoiding chemical resistance and protecting their turf from ABW devastation, the Tri-State Turf Research Foundation has agreed to fund URI's Dr. Steven Alm and his team of researchers in their pursuit of a promising new method for putting a stop to ABW devastation.

BACKGROUND

While researching the possibility of using the fungus *Beauveria bassiana* (BotaniGard) as another control option for annual bluegrass weevils, the URI researchers discovered that the "inert" oil carrier for the product was *extremely* toxic to weevils in petri dishes lined with filter paper.

The mode of action is apparently suffocation of the insects. The oil carrier reduces the surface tension of water to the point that it enters the spiracles (openings to the breathing tubes of insects) and drowns them.

Because the composition of the oil carrier used in BotaniGard is proprietary information, the researchers turned to Silwet L-77, a commonly used organosilicone surfactant that is used in conjunction with pesticides to improve wettability and spreading of an application by reducing surface tension of the water.

It has been known for some time that Silwet L-77 can kill various insects and mites, so with three years' funding from the Tri-State, Dr. Alm and his team have launched into a series of trials.

Their first objective: To find a Silwet rate, application water amount, and soil saturation combination that would control both ABW larvae and adults in fine turf areas on golf courses.

What follows are the preliminary results of their 2015 trials with Silwet L-77 and their future plan of action.

PRELIMINARY TRIALS IN 2015

The researchers' first trial was to experiment with Silwet for control of ABW adults in petri dishes. They collected weevils at golf courses and placed them on filter paper treated with various concentrations of Silwet in what would be the equivalent of 4 gallons of water per 1,000 sq. ft.

The outcome: The researchers were encouraged by how quickly Silwet could kill ABW in petri dishes *(Figure 1)*, particularly because it is highly unlikely that an insect would develop resistance to drowning.

In the next phase of the study, Dr. Alm and his team applied Silwet to turf plugs carrying ABW adults. The results were less promising. The researchers believe that the thatch and soil "wick away" the water too quickly to be available to drown the adults.

(continued on page 6)

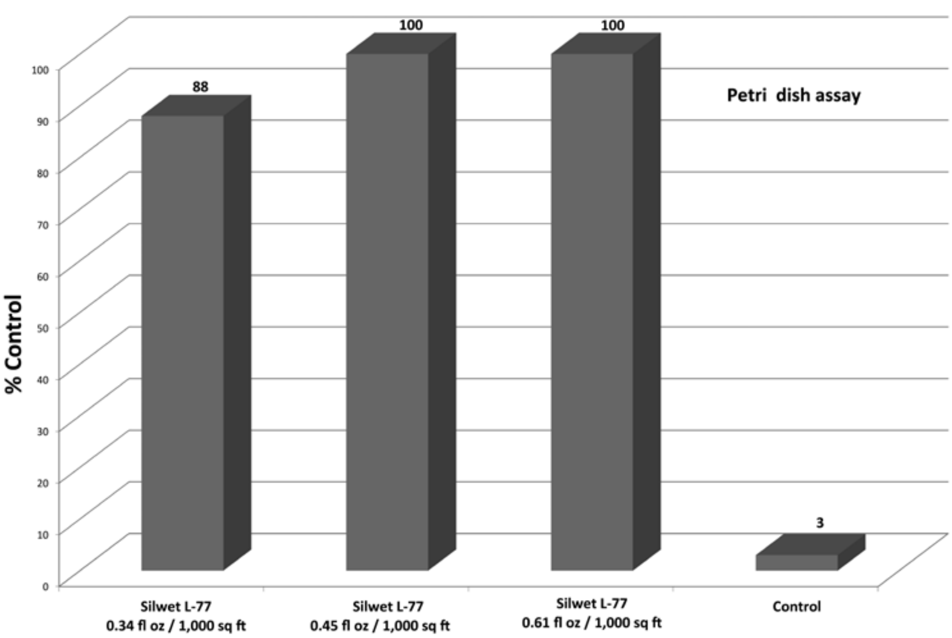


FIGURE 1

Various rates of Silwet L-77 in the equivalent of 4 gals. H_2O per 1,000 sq. ft. versus adult ABW in petri dishes.

URI Researchers Take All-New Tack in ABW Control

Their plan of attack:

» The researchers will continue various experiments with Silwet and differing amounts of water and soil saturation in the future. By placing water-sensitive paper under the turf canopy, the researchers have already seen that the coverage between 2 and 4 gallons of water per 1,000 sq. ft. varied significantly. There may be times in the spring or after a heavy rainfall event when the soil is saturated and there would be enough "free water" for a long enough period to control adults and/or larvae.

» The team will also try using Silwet to control fourth- and fifth-instar larvae. With adults collected in the fall and insects raised during the winter, they will continue experiments throughout the winter months.

THREE-YEAR PLAN OF ACTION

Over the course of the next three years, the researchers will be working to determine the most effective surfactants, rates, insecticides, DMI (dimethyl inhibitor) fungicides, GI (gibberellin inhibitor) plant growth regulators, and carrier water combinations to significantly increase levels of ABW control in the field. Here is their plan of attack:

1: Evaluate Silwet L-77 and other surfactants to determine if they can work together with various insecticides or on their own to control ABW.

» Silwet L-77 and other surfactants commonly used on turfgrass, such as Duplex Infiltration Surfactant, will be tested alone and in combination with with insecticides from all chemical classes, including pyrethroids, neonicotinoids, spinosad, chlorantraniliprole, cyantraniliprole, and organophosphates.

» The tests will be run in the spring and summer on ABW generations in infested golf course fairways, tees, and collar areas of putting greens.

» Larvicidal products will be tested separately from adulticides. Insecticides commonly in use—Scimitar, Talstar, Dylox, and Dursban—will be included in the tests. Other products to be tested are the neonicotinoids imidacloprid and clothianidin.

» Plots (usually 4' x 10' with one-foot spacing) will be arranged in a randomized complete block design with four replicates per treatment.

» Treatment timing will depend on the researchers' laboratory observations but are likely to be applied against the overwintered adults in late April and against third- to fifth-stage larvae and adults in late May.

» Treatments will be evaluated two weeks after the last application by taking five cores (4.25" diam. x 3" depth) from the center of each plot and examining them for ABW life stages.

2: Continue to field test new chemistries, such as Ferrance (cyantraniliprole) and combinations of DMI fungicides and GI plant growth regulators, to minimize resistance development and improve efficacy.

» Insects have developed a variety of mechanisms that allow them to survive exposure to potentially toxic chemicals. It is well known, however, that demethylation inhibitor (DMI) fungicides (e.g., propiconizol BannorMaxx) and gibberellin inhibitor (GI) plant growth regulators (e.g., Cutless), inhibit some of these mechanisms and may restore pyrethroid efficacy to initial control levels.

» Laboratory studies have indicated that the addition of an insecticidal synergist may restore the toxicity of pyrethroids. The researchers' next step is to test these combinations in the field.

3: Develop more reliable monitoring techniques to better time applications for second- and third-generation ABW adults and larvae.

» The overwintering generation of adult ABWs is fairly easy to target because it generally emerges between forsythia and dogwood full bloom. Similarly, we know the first generation larvae emerge the last week in May when the Rhododendron catawbiense is in full bloom. After the first generation, timing insecticide applications becomes time-consuming and largely guesswork.

» To aid in the timing of insecticide applications for second- and third-generation ABW adults and larvae, the researchers propose to monitor pitfall traps, perform salt solution monitoring for larvae, and then correlate these data to temperature data recorders and plant phenology.

» Developing more reliable and accurate timing will reduce the number of insecticide applications and slow the rate of resistance development.

For further information on Dr. Steven Alm's research, you can reach him at 401-874-5998 or at stevealm@uri.edu.

URI Researchers Find Success With Current Chemical Controls

In trials conducted in 2014 and 2015 by URI's Dr. Steven Alm and his team of researchers, they found success with currently available products that may well improve turfgrass managers' control of ABW in the coming year.

TRIAL #1

Conducted in 2014, the first trial looked at various timings and combinations of Scimitar, Talstar, Aloft, Acelepryn, Provaunt, and Ference. The researchers chose the edge of a fairway to apply four replicates of the treatments to 40-square-foot plots. All told, there were nine treatments (including untreated plots) times four replicates, which equals 36 plots. The treatments' effect on overwintered adults and first-generation larvae were rated on June 11 by pulling five cup-changer-sized plugs from each plot (180 plugs total) and then placing them in a saturated salt solution and counting larvae and adults as they floated to the surface.

The targets for the May 6 and May 16 applications *(Figure 2)* were:

» adults, using the pyrethroids Scimitar, Talstar alone and in Aloft

» first-, second-, and third-instar larvae within the plant, using Ference and clothianidin in Aloft

» fourth- and fifth-instar larvae, using Provaunt

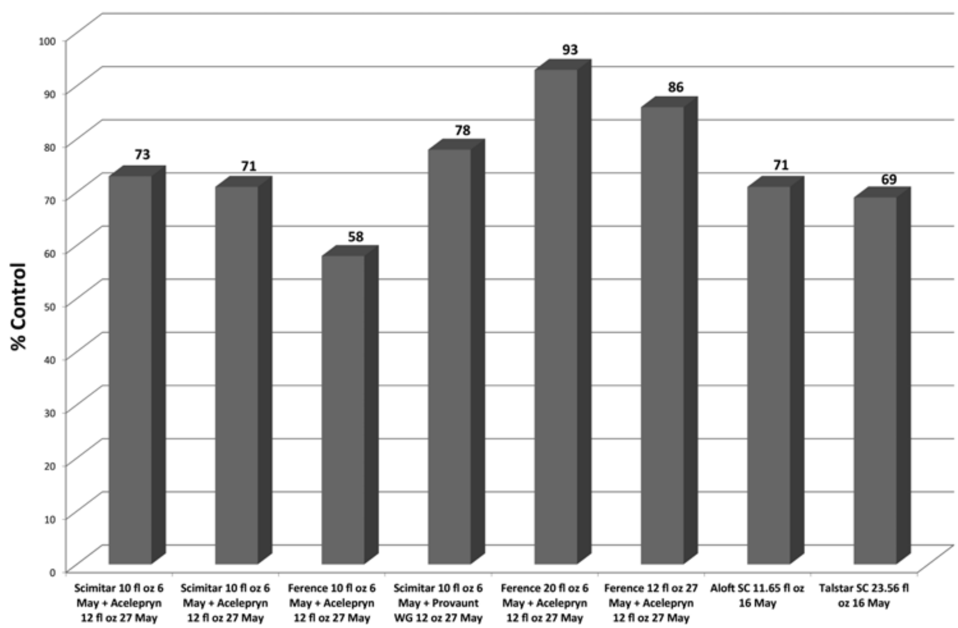
(The Acelepryn should have been applied earlier than it was to target early instar larvae.)

The control provided by Ference and Acelepryn was very encouraging with 93-percent control.

TRIAL #2

Conducted in 2015, a second field experiment demonstrated Ference to be effective when applied on June 16 to control late first-generation larvae *(Figure 3)*.

Ference is cyantraniliprole, another anthranilic diamide similar to Acelepryn, which is chlorantraniliprole. These products are systemic and their mode of action is interference with ryanodine receptors and calcium in muscles.



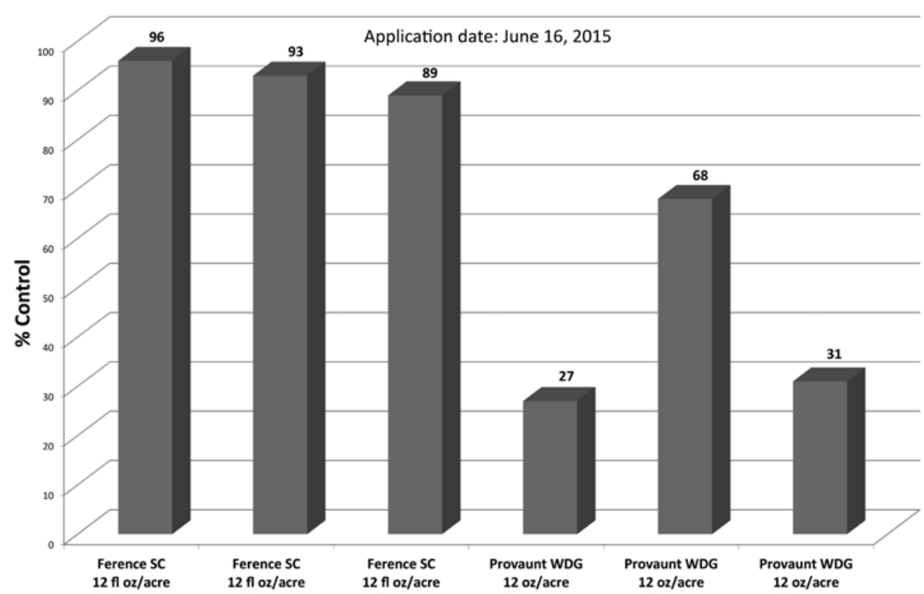


FIGURE 2 (TOP)

Efficacy of Scimitar, Acelepryn, Provaunt, Ference, Aloft, and Talstar for control of annual bluegrass weevil larvae and adults, 2014.

FIGURE 3 (BOTTOM)

Efficacy of Ference and Provaunt versus late first-generation larvae with 0", 0.05", or 0.1" post-treatment irrigation, 2015.

Seeking Best Management Practices for Dollar Spot Control

Rutgers Researchers Examine the Role of Bentgrass Tolerance, Disease Predictive Models, and Fungicide Timing in Controlling Dollar Spot on Fairway Turf

Dollar spot, caused by the fungus *Sclerotinia homoeocarpa* F.T. Bennett, is a common and persistent disease of golf course turf throughout the world. More money is spent on controlling this disease than any other in the United States. Therefore, practices to reduce fungicide inputs to control dollar spot on fairways—the greatest acreage of treated turf on a golf course—could provide significant economic, as well as environmental benefits.

With funding from the Tri-State Turf Research Foundation, Dr. Bruce Clarke, Dr. James Murphy, and graduate student James Hempfling have embarked on research that seeks to develop best management practices (BMPs) for the control of dollar spot disease on fairway turf. In the first phase of their study, they plan to:

1. Study the changes in dollar spot activity throughout the season (epidemiology) on six bentgrasses (*Agrostis* spp.) with a range of susceptibility to this disease
2. Learn if outbreaks of dollar spot can be reliably predicted
3. Determine whether this information can be used to target (time) fungicide applications to maintain acceptable disease control and turfgrass quality while reducing fungicide inputs

DOLLAR SPOT DISEASE DEVELOPMENT ON SIX BENTGRASS CULTIVARS

In May 2015, the researchers began evaluating disease progress and severity on six bentgrass cultivars that vary in tolerance to dollar spot. The six cultivars being studied are:

CREEPING BENTGRASS *(A. stolonifera)* CULTIVARS

» Independence

» Penncross

» 007

» Shark

» Declaration, which has consistently ranked among the bentgrass cultivars with the greatest tolerance to dollar spot in NTEP trials

COLONIAL BENTGRASS *(A. capillaris)* CULTIVAR

» Capri, which is also well known for its tolerance to this disease

» In addition, the researchers are assessing two weather-based models for predicting dollar spot activity on these cultivars and species:

» One model uses growing degree days (GDD) to predict the first occurrence of dollar spot symptoms in the spring. This model was developed by Christopher Ryan, Dr. Peter Dernoeden, and Arvydas Grybauskas at the University of Maryland and uses a base air temperature of 60° F and a start date of April 1.

» The other model—the Smith-Kerns Model—uses air temperature and relative humidity to forecast the development of dollar spot epidemics throughout the growing season.

NOTE: These models have not been validated on bentgrass cultivars that are highly tolerant to this disease (e.g., Declaration and Capri) and have not been field tested in the tri-state region.

METHODOLOGY AND OBSERVATIONS

The researchers inoculated the trial plots with the dollar spot pathogen in early April 2015 to ensure uniform disease pressure. Each plot was mowed 3 days per week at 0.5".

They observed:

» Disease severity was intense and very uniform during June 2015 and reached peak levels—more than 500 infection centers per plot—by mid-July.

» Dollar spot was most severe on cultivars Penncross and Independence. The ranking of cultivar susceptibility during 2015 was Penncross > Independence > Shark > 007 > Declaration > Capri.

» The onset of disease symptoms occurred on May 17 for the susceptible cultivars and on May 19 for the moderately tolerant cultivars; this is about one week later than the GDD and Smith-Kerns models forecasted dollar spot development.

» Throughout much of the remaining growing season, disease was active and fairly accurately forecasted by the Smith-Kerns Model.

BENTGRASS TOLERANCE AND FUNGICIDE TIMING EFFECTS ON DOLLAR SPOT CONTROL

Superintendents sometimes apply fungicides in the early spring hoping to delay the initial onset of dollar spot on turf. The effectiveness and optimum timing of these presymptomatic fungicide sprays, however, are unknown.

Though disease predictive models may be helpful in determining the best timing of presymptomatic fungicide applications, the researchers first needed to determine if

Seeking Best Management Practices for Dollar Spot Control

this practice is, in fact, effective in delaying the initial onset of dollar spot and whether the effectiveness is dependent on the level of cultivar susceptibility to this disease.

The researchers, therefore, set out to assess the effects of:

1: Initial fungicide application timings, when applied:

» At the first appearance of disease symptoms (threshold-based; < 2 infection centers per 8 sq. ft.)

» On May 20 (calendar-based)

» As the Smith-Kerns Model reached a 20-percent risk index

» At a GDD range of 40–50, 60–70, 80–90, 100–110, or 120–130.

2: Subsequent fungicide application timings, which were based on:

» A disease threshold

» A predictive model (Smith-Kerns Model)

» A calendar schedule

The researchers also experimented with withholding subsequent applications completely to assess long-term effects of initial fungicide timings.

3: Bentgrass susceptibility—Independence (susceptible) and Declaration (tolerant)—on total fungicide use in a growing season. The researchers applied all possible combinations of initial and subsequent fungicide timings on both cultivars.

Other trial components:

» The researchers included untreated plots (negative control) and plots treated every 21 days from May 20 to November 21, 2015 (positive control; calendar-based program).

» All fungicide applications consisted of boscalid (Emerald 70WG at 0.18 ozs. per 2 gals. water per 1,000 sq. ft.).

NOTABLE RESULTS

Analysis of the 2015 data is not complete, but the researchers' preliminary results indicate that:

» There was minimal impact of the initial fungicide application timing on long-term (May through November) control of dollar spot.

» Conversely, subsequent fungicide timing and the type of bentgrass cultivar had a much greater impact on disease control. Excellent (< 1 infection center per 8 sq. ft.), long-term control of dollar spot was achieved for both cultivars when subsequent fungicide timing was based on either the Smith-Kerns Model or the calendar-based program.

» The Smith-Kerns Model reduced fungicide inputs by one application compared to the calendar-based program (nine applications).

» Good to excellent, long-term disease control was also achieved with subsequent fungicide timing based on a threshold program, but the total fungicide input and the level of disease control depended on the cultivar and initial fungicide timing.

» Subsequent applications based on a threshold program on Declaration plots produced excellent disease control and resulted in only three fungicide applications, regardless of the initial fungicide application date.

» Whereas the subsequent threshold schedule on Independence plots resulted in a total of six or seven fungicide applications, depending on the initial fungicide timing. Moreover, disease severity occasionally surpassed the target threshold value on Independence plots and reached levels (up to 3.5 infection centers per 8 sq. ft.) during the growing season, which may not be acceptable at some golf courses.

LOOKING AHEAD

Drs. Clarke and Murphy note that additional years of data collection are needed to determine the consistency of these treatment responses and, ultimately, which practices have the greatest impact on dollar spot control.

As they refine their understanding of dollar spot epidemiology on fairways, they will develop additional research objectives for assessing the impact of other cultural practices on the suppression of this disease.

The researchers' ultimate goal is to develop a set of BMPs that will allow superintendents to maintain excellent turf quality and dollar spot control on golf course fairways with reduced fungicide inputs.

For further information on the researchers' trials, you can reach Dr. Murphy at Murphy@aesop.rutgers.edu or Dr. Clarke at Clarke@aesop.rutgers.edu.

Special Thanks to Our 2015 Contributors

We'd like to thank our contributors for their generous show of support to the Tri-State Turf Research Foundation. Your contributions go a long way toward helping the foundation continue its mission "to provide turfgrass research for better golf and a safer environment." We hope those of you on the list will continue to support the foundation's work. We also hope you will encourage more of your fellow turfgrass professionals to add their names to the growing list of contributors.

CLUB CONTRIBUTORS

ALPINE COUNTRY CLUB
Stephen Finamore, CGCS

ARCOLA COUNTRY CLUB
Paul Dotti

ATLANTIC GOLF CLUB
Robert Ranum

BACK O'BEYOND, INC.
Michael Maffei, CGCS

BALTUSROL GOLF CLUB
Mark Kuhns, CGCS

BEDFORD GOLF & TENNIS CLUB
Robert Nielsen, CGCS

BEEKMAN COUNTRY CLUB
Stephen Spontak

BIRCHWOOD COUNTRY CLUB
Justin Gabrenas

BLIND BROOK CLUB
Lester Kennedy Jr., CGCS

BONNIE BRIAR COUNTRY CLUB
Nicholas Lerner

BRAE BURN COUNTRY CLUB
Blake Halderman, CGCS

BROOKLAWN COUNTRY CLUB
Peter Bly

BULL'S BRIDGE GOLF CLUB
Rob Giampietro, CGCS

CENTENNIAL GOLF CLUB
Glen Dube, CGCS

CLINTON COUNTRY CLUB
Michael Decker

COLD SPRING COUNTRY CLUB
Peter Candelora

CONNECTICUT GOLF CLUB
Mark Fuller, CGCS

COUNTRY CLUB OF DARIEN
Timothy O'Neill, CGCS

COUNTRY CLUB OF FAIRFIELD
David Koziol

COUNTRY CLUB OF FARMINGTON
John Ruzsbatzky, CGCS

CRESTMONT COUNTRY CLUB
Peter Pedrazzi Jr.

ECHO LAKE COUNTRY CLUB
Christopher Carson

ELMWOOD COUNTRY CLUB
Christopher Alonzi

ESSEX FELLS COUNTRY CLUB
Richard LaFlamme

FAIRMOUNT COUNTRY CLUB
Vincent Bracken

FAIRVIEW COUNTRY CLUB
Vincent Pavonetti, CGCS

FARMSTEAD GOLF & COUNTRY CLUB
Robert Phoebus

FENWAY GOLF CLUB
Robert Alonzi Jr.

FISHER'S ISLAND CLUB
Donald Beck

FISHKILL GOLF CLUB
John Villetto

FRESH MEADOW COUNTRY CLUB
Joseph Gardner Jr.

GARDEN CITY COUNTRY CLUB
Russell MacPhail

GARDEN CITY GOLF CLUB
David Pughe

GLENARBOR GOLF CLUB
Kenneth Benoit Jr., CGCS

GLEN HEAD COUNTRY CLUB
Ken Lochridge

GLEN OAKS CLUB
Craig Currier

GOLF CLUB OF PURCHASE
Robert Miller

HAWORTH COUNTRY CLUB
Timothy Garceau

HEMPSTEAD GOLF CLUB
Joseph Tamborski, CGCS

HIDDEN CREEK GOLF CLUB
Clark Weld

HUNTINGTON COUNTRY CLUB
Glenn Creutz

INNIS ARDEN GOLF CLUB
Neil Laufenberg

INWOOD COUNTRY CLUB
Kevin Stanya

KNICKERBOCKER COUNTRY CLUB
Samuel Juliano, CGCS

LEEWOOD GOLF CLUB
Timothy Walker, CGCS

LIBERTY NATIONAL GOLF CLUB
Gregory James

MADISON GOLF CLUB
Patrick Quinlan

MAIDSTONE CLUB
John Genovesi, CGCS

MEADOW BROOK CLUB
John Carlone, CGCS

MENDHAM GOLF & TENNIS CLUB
Christopher Boyle, CGCS

METROPOLIS COUNTRY CLUB
David Morrow

MILL RIVER CLUB/NY
Steven Sweet

MONTCLAIR GOLF CLUB
Gregory Vadala, CGCS

MOUNTAIN RIDGE COUNTRY CLUB
Cliff Moore

MOUNT KISCO COUNTRY CLUB
Andrew Agnew

NASSAU COUNTRY CLUB
David Delsandro

NATIONAL GOLF LINKS OF AMERICA
William Salinetti III, CGCS

NEW HAVEN COUNTRY CLUB
Jason Booth, CGCS

NISSEQUOGUE GOLF CLUB
Jeffrey Hemphill, CGCS

NORTH HEMPSTEAD COUNTRY CLUB
Thomas Kaplun

NORTH HILLS COUNTRY CLUB
Peter Nystrom

NORTH SHORE COUNTRY CLUB
John Streeter, CGCS

OLD OAKS COUNTRY CLUB
Shannon Slevin

OLD WESTBURY GOLF & COUNTRY CLUB
Thomas McAvoy, CGCS

ORANGE HILLS COUNTRY CLUB
Jud Smith

PELHAM COUNTRY CLUB
Jeffrey Wentworth, CGCS

PINE HOLLOW COUNTRY CLUB
Brent Pevich

PINE ORCHARD YACHT & COUNTRY CLUB
Peter Gorman

PINE VALLEY GOLF CLUB
Richard Christian Jr.

PLAINFIELD COUNTRY CLUB
Travis Pauley

PLANDOME COUNTRY CLUB
Ken Frank

QUAKER RIDGE GOLF CLUB
Thomas Ashfield

QUOGUE FIELD CLUB
John Bradley Jr.

RIDGEWOOD COUNTRY CLUB/CT
David Kerr, CGCS

RIDGEWOOD COUNTRY CLUB/NJ
Todd Raisch, CGCS

ROCKAWAY HUNTING CLUB
Nick Brodziak

ROCKLAND COUNTRY CLUB
Matthew Ceplo, CGCS

ROCKRIMMON COUNTRY CLUB
Anthony Girardi, CGCS

ROCKVILLE LINKS COUNTRY CLUB
Luke Knutson

ROLLING HILLS COUNTRY CLUB
Glenn Perry, CGCS

ROUND HILL CLUB
Sean Foley

ROXITICUS GOLF CLUB
Justin Dorman

SANDS POINT GOLF CLUB
Pat Ryan

SCARSDALE GOLF CLUB
Matthew Severino

SEAWANE GOLF & COUNTRY CLUB
Brian Benedict

SHINNECOCK HILLS GOLF CLUB
Jonathan Jennings, CGCS

SILVERMINE GOLF CLUB
Lawrence Pakkala, CGCS

SILVER SPRING COUNTRY CLUB
Peter Rappoccio, CGCS

SIWANOY COUNTRY CLUB
Steven McGlone

SLEEPY HOLLOW COUNTRY CLUB
Thomas Leahy, CGCS

SOMERSET HILLS COUNTRY CLUB
Ryan Tuxhorn

SOUTHAMPTON GOLF CLUB
Jim Choinski

SOUTHWARD HO COUNTRY CLUB
James Stewart

SPOOK ROCK GOLF CLUB
Daniel Madar

SPRING BROOK COUNTRY CLUB
Robert Carey

SPRING LAKE GOLF CLUB/NJ
Joshua Reiger

ST. ANDREW'S GOLF CLUB
Robert Milar

SUNNINGDALE COUNTRY CLUB
Sean Cain, CGCS

TAMARACK COUNTRY CLUB
Jeffrey Scott, CGCS

TAVISTOCK COUNTRY CLUB
Victor Frederico

THE APAWAMIS CLUB
William Perlee

THE BRIDGE
Gregg Stanley, CGCS

THE MILBROOK CLUB
Doug Snyder

THE PATTERSON CLUB
Jason Meersman

THE STANWICH CLUB
Scott Niven, CGCS

THE TUXEDO CLUB
Casey Klossner

TWIN HILLS COUNTRY CLUB
Michael McDermott

UPPER MONTCLAIR COUNTRY CLUB
Michael Brunelle

WACCABUC COUNTRY CLUB
Douglas George

WEE BURN COUNTRY CLUB
Douglas Drugo

WESTCHESTER COUNTRY CLUB
David Dudones

WEST POINT GOLF COURSE
Steven Whipple

WETHERSFIELD COUNTRY CLUB
Allen Woodward

WHEATLEY HILLS GOLF CLUB
Ben Orlowski III

WHIPPOORWILL CLUB
Paul Gonzalez, CGCS

WILLOW RIDGE COUNTRY CLUB/NY
Bert Dickinson, CGCS

WINGED FOOT GOLF CLUB
Stephen Rabideau, CGCS

WINTONBURY HILLS GOLF COURSE
Mark Mansur

WOODMERE CLUB
Timothy Benedict, CGCS

WOODSIDE ACRES
Ryan VonSteenburg

WOODWAY COUNTRY CLUB
Jamie Kapes

WYKAGYL COUNTRY CLUB
Daniel Rogers

CORPORATE CONTRIBUTORS

ALL PRO HORTICULTURE, INC.
John Seib

AQUATROLS, INC.
Kevin Collins

COOMBS SOD FARM, LLC
John Coombs

DELEA SOD FAMRS, INC.
Richard DeLea

DRYJECT NORTHEAST, LLC
Steve Jordan

GRASS ROOTS, INC.
Keith Kubik

GRIGG BROS. FOLIAR FERTILIZERS
Gordon Kauffman

JAMES CARRIERE & SONS, INC.
William Carriere

METRO TURF SPECIALISTS
Scott Apgar

NASSAU SUFFOLK TURF SERVICES
Bob Mele

OCEAN ORGANICS
Doug Middleton

PLANT FOOD COMPANY, INC.
Tom Weinert

STORR TRACTOR CO.
Richard Krok

SYNGENTA
Lee Kozsey
Dennis DeSanctis

THE TERRE COMPANY OF NJ, INC.
Robert Schreiner

TURF PRODUCTS CORP.
John Ferry

WESTCHESTER TURF SUPPLY, INC.
Dave Lippman

WILFRED MACDONALD, INC.
William Luthin

Putting Syringing to the Test Against Summer Bentgrass Decline

Rutgers Researchers Seek Practical Measures for Stopping SBD Before It Starts

Creeping bentgrass *(Agrostis stolonifera)* is a cool-season grass widely used on putting greens because of its highly desirable turf characteristics. During spring and fall, this grass species grows vigorously. During summer months, however, creeping bentgrass turf frequently shows signs of stress. Commonly referred to as summer bentgrass decline (SBD), this syndrome is a major concern of superintendents growing creeping bentgrass greens across the country.

Many factors could contribute to SBD, but heat stress has proved the primary culprit in the decline in turf quality and physiological activities of creeping bentgrass.

While the telltale sign of bentgrass decline is a thinning turf canopy and leaf chlorosis, this is preceded by physiological damage that typically begins as new root production slows, root dieback occurs, and shoot growth declines. Root dieback inhibits water and nutrient uptake that eventually limits shoot growth and causes leaf senescence.

Heat stress also induces the closure of stomata (apertures on leaf epidermal cells), which restricts air exchange and limits transpirational cooling from the leaf surface. Prolonged stomatal closure will increase leaf temperature substantially and also restrict inward carbon dioxide diffusion required for photosynthesis and carbohydrate production.

Once visual decline of bentgrass turf becomes apparent, much of the damage is done. Therefore, management techniques that prevent physiological damage prior to visual decline in turf quality appear to be more effective than curative tactics once visual signs become obvious.

Hoping to help superintendents avoid the ill effects of summer bentgrass decline, the Tri-State Turf Research Foundation is supporting Dr. Bingru Huang and her research team from Rutgers University in their work to identify best management practices for preventing SBD from taking hold on bentgrass putting greens.

In their first of two years of foundation-funded work, the researchers have begun to examine how proper application and timing of syringing might play a role in sparing these greens from undue stress and decline.

THE UNCERTAIN ROLE OF SYRINGING IN SBD

Syringing is a commonly used management tactic for avoiding SBD and lowering leaf and canopy temperature on creeping bentgrass putting greens. As you know, syringing involves applying a small volume of "fine mist" water primarily to moisten the leaves and accelerate evaporative cooling by drawing excess heat away from the turfgrass canopy.

THE PROBLEM: Reports from superintendents and results from preliminary research have shown mixed results (positive, negative, or neutral) in the effectiveness of turfgrass syringing.

POSSIBLE CAUSE: Variations in application techniques, frequency, and interacting environmental conditions.

» While syringing may lower leaf temperature, the duration of the effects and long-term physiological effects on high-value turf stands are not clear.

» Improper syringing—applying water too frequently or at the wrong time of day—may actually accelerate turfgrass decline by increasing disease incidence due to prolonged leaf and thatch wetness.

» Ineffective syringing is a waste of valuable resources: time, labor, and water.

Despite wide utilization of syringing for cooling putting greens throughout the Northeast, limited scientific information is available regarding proper frequency, duration, environmental thresholds, and the subsequent physiological effects on creeping bentgrass during the summer.

THE STUDY FOCUS

Dr. Huang and her team began their multi-year research trials at the Rutgers University turfgrass research farm in New Brunswick, NJ. They also conducted onsite trials at Hominy Hill Golf Course in Colts Neck, NJ, and at Baltusrol Golf Club in Springfield, NJ, to evaluate the effectiveness of syringing for two golf courses with different management and growing conditions.

Using thermography (thermal imaging), the researchers set out to determine the true effectiveness of syringing on SBD mitigation. They examined:

» the minimum air temperature threshold above which syringing should be initiated

» the maximum air temperature threshold above which syringing is no longer effective for mitigating SBD

» the duration of evaporative cooling after syringing is performed as affected by air temperature and wind speed

» the syringing frequency most effective in maintaining a constant rate of evaporative cooling from leaves

» the physiological effects prompting turfgrass heat tolerance as affected by different syringing techniques

Putting Syringing to the Test Against Summer Bentgrass Decline

THE METHODOLOGY

The trials at Rutgers were conducted on a 2-year-old creeping bentgrass (cv. Penncross) stand built according to USGA specifications, maintained well—watered and fertilized (0.1 lb. N/1,000 sq. ft./10 days)—and under a preventive pest control regimen typically used on golf course greens.

The weather conditions during the 2015 season were characterized by a substantial increase in daytime air temperatures throughout August that spanned into the first two weeks of September.

On hot days during August:

» Syringing treatments were applied when the ambient air temperature (not heat index) reached 85˚, 90˚, or 95˚ F (main plots).

» Reapplications occurred every one or two hours (subplots).

» Approximately 0.03 – 0.05 inches of water were applied per syringing event.

» All treatments were compared to untreated plots not receiving syringing.

» Coinciding with thermal images (one per minute), soil water content and canopy density were measured prior to the first syringing and following the final syringing within a given day of measurements.

OBSERVATIONS

The research team observed the following:

ON CANOPY TEMPERATURE REDUCTION…

» Thermal imagery collected on the hottest days of August revealed that applying syringing at either 85˚ or 90˚ F threshold (air temperature did not reach 95˚ F threshold during 2015) can reduce canopy temperature by 6 to 10 degrees compared to plots not syringed.

For example, syringing applied at the 85˚ F threshold reached at 11 a.m. lowered canopy temperature by 6 degrees, and the repeated application one hour later lowered canopy temperature by 9 degrees.

ON DURATION OF COOLING EFFECTS…

The duration of the cooling effects post-syringing is dependent on wind speeds.

» The beneficial effects of syringing for effectively lowering canopy temperature may last 15 to 20 minutes on days that are calm or have no wind.

» When winds are between 5 to 10 mph, evaporational cooling lasts only 10 to 15 minutes.

» Syringing when the 90˚ F threshold was reached at 2 p.m. produced similar reductions in canopy temperature and interacting wind effects as those noted for 85˚ F thresholds.

Due to the observed effects of repeated syringing on soil moisture content (discussed in the following paragraphs), the 90˚ F threshold was utilized for the onsite golf course trials.

CANOPY TEMPERATURE REDUCTION ON NATIVE VS. SAND-BASED GREENS…

The researchers also evaluated the role sand-based vs. native (push-up) green types might play in the duration of canopy temperature reduction following syringing. They looked at non-syringed and syringed areas of a native green in Colts Neck, NJ, and a USGA-spec green in New Brunswick, NJ, and found little difference in canopy temperature between the two types of greens.

THE EFFECTS OF TEMPERATURE THRESHOLDS ON SOIL MOISTURE…

An important consideration to note regarding the 85˚ and 90˚ F thresholds is the ultimate effect on soil moisture throughout the afternoon hours.

» The average soil moisture content for the sand-based USGA-spec green in New Brunswick, NJ, prior to syringing initiation on a given day was 12 to 14 percent and would decline by 2 to 3 percent for non-syringed areas. The green was then lightly irrigated in the early morning hours to replace water lost due to evapotranspiration (ET).

» By contrast, turf stands syringed at the 85˚ F threshold and subsequently syringed every hour throughout the afternoon had a 3- to 4-percent increase in soil moisture; when syringed every two hours, soil moisture increased by only 1 to 2 percent.

» Delaying the first syringing event until the 90˚ F threshold was reached resulted in a less than 1 percent increase in soil moisture when followed by hourly syringing; when syringed every two hours, researchers noted a slight reduction in soil moisture.

Therefore, the 2015 results suggest that if a turfgrass manager initiates syringing at the 85˚ F threshold, irrigation amounts will need to be decreased to compensate for water added during the daytime.

Syringing at the 85˚ F threshold may also prompt a more aggressive disease management protocol as stands are wetter going into the nighttime hours, though this would need to be confirmed in subsequent research trials.

CONCLUSIONS TO-DATE

Overall, the first year of research during 2015 shows that:

» Syringing is effective in lowering canopy temperature when initiated at either 85˚ or 90˚ F threshold; though initiating at a lower air temperature can lead to increases in soil moisture content following repeated applications.

(continued on page 20)

Rutgers Research Team Delves Deeper Into Best Management Practices for Anthracnose Control

Latest Results Focus on the Role Soil pH Plays in Anthracnose Severity on Poa Putting Greens

Caused by the fungus *Colletotrichum cereale,* anthracnose disease continues to plague annual bluegrass *(Poa annua)* putting greens—particularly those that have been subjected to intense maintenance practices, such as decreased mowing heights, reduced irrigation, and minimal nitrogen fertilization to increase green speeds. The disease infects leaf, crown, stolon, or root tissues of the grass plant, resulting in foliar blight or basal (stem) rot.

As the disease's prevalence soared in the mid-'90s, Rutgers' Dr. James Murphy and Dr. Bruce Clarke began to scrutinize the role cultural practices might play in anthracnose severity on annual bluegrass turf.

With prior funding from the Tri-State Turf Research Foundation, the Rutgers research team determined that sand topdressing and both granular and soluble nitrogen fertilization play a significant role in suppressing anthracnose activity.

In 2012, the foundation agreed to provide an additional three years of support to the Rutgers research team in their quest to delve deeper into best management practices (BMPs) for anthracnose control and, ultimately, a more viable solution to this turf-threatening disease.

THE TRIALS AND OUTCOMES: 2012 TO 2015

Drs. Murphy and Clarke, along with a team of graduate students, devoted the past three years to conducting trials that examined the impact of the following factors on anthracnose development and severity:

1. Nitrogen (N) source
2. Potassium (K) fertilization
3. Soil pH
4. Sand topdressing
5. The effect of combining BMPs on fungicide efficacy and turf quality

Prior to 2012, their team conducted trials that examined the impact of:

6. N rate and timing
7. Mowing, rolling, and foot traffic
8. Plant growth regulators
9. Irrigation
10. Cultivation practices on anthracnose development and severity

The research team's trials have indicated that nitrogen fertilization is among the most influential cultural practices affecting anthracnose severity in annual bluegrass putting greens. N-deficient turf proved to be not only more susceptible to anthracnose, but also less capable of recuperating from disease damage. Also notably influential in suppressing anthracnose activity were increasing mowing height and sand topdressing frequency, as well as maintaining suitable potassium levels.

Other practices the researchers studied—such as foot traffic, irrigation, lightweight rolling, and the application of plant growth regulators—have also been shown to have an impact on anthracnose severity but to a lesser degree.

In addition, the research team found strong evidence that soil pH influences anthracnose severity. Because many years of treatment are required to achieve large changes in soil pH, the researchers devoted a fourth year to examining lime and sulfur effects on soil pH and anthracnose severity. What follows are the outcomes of the trials they had initiated at the end of 2011.

SOIL pH'S ROLE IN ANTHRACNOSE SEVERITY

Knowing that annual bluegrass is generally considered to be intolerant of low pH, Drs. Murphy and Clarke set out, in December 2011, to:

1. quantify the response of annual bluegrass over a range of soil pH
2. establish a critical level for optimum growth and turf quality
3. determine the effect, if any, of soil pH on anthracnose severity

METHODOLOGY

Over the course of four years, the research team experimented by applying:

» limestone and sulfur treatments (on December 12, 2011 and again on April 1, 2014) to increase and decrease soil pH, respectively

» two gypsum treatments to assess the effect of calcium nutrition on annual bluegrass turf without a large increase in soil pH

The researchers then focused on monitoring the pH of the 0" to 2.5" depth zone (mat layer composed of thatch and topdressing sand) since this is where the vast majority of annual bluegrass roots are located.

OBSERVATIONS

» By September 2014, almost three years after the initial application of limestone and sulfur treatments, the pH of the mat layer within the soil profile ranged from 5.35 to 6.52.

Rutgers Research Team Delves Deeper Into Best Management Practices for Anthracnose Control

» Soil pH increased very gradually over this three-year period, which is not surprising since neutralization of soil acidity by limestone is a slow process and is highly dependent on the particle size of the lime (small particle = more rapid reaction).

» It was surprising, however, that after two applications of limestone treatments (applied two years apart) the pH of the mat layer has not reached or exceeded 7.0.

» During 2015, treatments with a soil pH of greater than 6.0 had less than 10-percent anthracnose severity through mid-July compared to turf plots with lower soil pHs, which had up to 37-percent disease severity by July 17.

» Disease severity increased in all treatments as the 2015 season progressed, but anthracnose remained most severe on plots with a pH of less than 6.0.

» Analysis of soil pH with disease data over the entire season indicated a critical soil pH value between 6.0 and 6.5; turf grown at lower soil pH had more severe anthracnose.

» Calcium (gypsum) applications alone had little effect on anthracnose severity in 2015, while comparative rates of limestone (= quantity of calcium) significantly decreased disease severity throughout the season.

THE TAKEAWAY: Observations of turf quality and color indicate that a soil pH of 6.0 to 6.5 will enable the maintenance of healthy annual bluegrass putting green turf.

RECOMMENDATIONS

Based on their findings, Drs. Murphy and Clarke recommend:

» Routine (annual) soil testing of the turfgrass root zone should be conducted to ensure that soil pH does not become too acidic for annual bluegrass. Because soil pH can vary substantially during the growing season, the researchers emphasize that sampling be done at the same time each year. Soil pH, for instance, tends to be much lower during dry periods (summer) than during periods of rainfall (spring and fall) when the pH will increase.

» If limestone is required, the quantity applied should be based on a target pH of 6.0 and the buffering capacity of the soil (lime requirement index). Excessive applications of limestone may increase the risk of summer patch disease.

FUTURE PLANS

It is well known that summer patch disease can become more intense at soil pH values near neutral (7.0) or above. Because the greatest pH achieved in the trial was only 6.5, the researchers are planning to reapply treatments to develop a broader range of soil pH levels.

Their objective in 2016: to better understand the response of annual bluegrass at pH levels above 6.5.

For further information on the researchers' trials, you can reach Dr. Murphy at Murphy@aesop.rutgers.edu or Dr. Clarke at Clarke@aesop.rutgers.edu.

SIDEBAR

Rutgers' BMPs for Anthracnose Control

During the course of their trials to uncover a more viable solution to the turf-threatening anthracnose disease, Rutgers' Dr. James Murphy, Dr. Bruce Clarke, and their team of researchers have organized their findings into a working outline of Best Management Practices for controlling anthracnose on annual bluegrass putting green turf.

Here are their latest recommendations:

NITROGEN

» Nitrogen should be applied to maintain vigor of the putting green turf without overfertilizing. Annual "summer" soluble-N rates of approximately 2.4 to 3.6 lbs. N/1,000 sq. ft. should be applied to reduce anthracnose incidence and severity. A rate at the higher end of the range will be needed if N rates have been low historically.

» Beginning soluble-N programs earlier in the year (April or May) at 0.4 to 0.8 lbs. of N/1,000 sq. ft. per month can build up nitrogen in the turf heading into summer, which can result in decreased anthracnose severity.

» Any granular-N fertilization should be applied in the spring at rates of 1 to 3 lbs./1,000 sq. ft. to reduce disease severity. A rate at the higher end of the range will be needed if N rates have been low historically.

POTASSIUM

» Potassium should be applied to maintain sufficient levels of soil K (>100 lbs./acre Mehlich III; >50 ppm).

» Soluble-K applications made at a 1:¾ N:K_2O ratio every 14 days will be effective at reducing anthracnose severity.

(continued on page 16)

Rutgers' BMPs for Anthracnose Control

MOWING AND ROLLING

» Avoid mowing below 0.125", if feasible, when using fixed-head mowers; a slightly lower bench setting might be feasible for flex units. Raising the cutting height as high as 0.140" will provide even greater suppression of anthracnose. Slight increases in mowing height can significantly reduce the severity of this disease. Therefore, using solid rollers versus grooved rollers, at the same bench height setting, may also be helpful.

» Roll and/or increase mowing frequency to maintain ball roll distances (green speed) at higher mowing heights. Rolling and double-cutting increase ball roll but will not increase disease severity.

» Rolling every other day can result in slightly decreased anthracnose severity, regardless of roller type.

SOIL pH

» Test the turfgrass root zone annually to ensure that soil pH does not become too acidic.

» If limestone is required, base the quantity of limestone to be applied on a target pH of 6.0 and the buffering capacity of the soil (lime requirement index).

PLANT GROWTH REGULATORS

» Routine trinexapac-ethyl (Primo MAXX) use, even at high rates and short intervals, will not increase—and may even reduce—anthracnose severity by improving plant health, as well as turf tolerance to low mowing.

» Mefluidide (Embark) and ethephon (Proxy) can be used to suppress seed-head formation in annual bluegrass turf without increasing anthracnose.

» Mefluidide or ethephon applied in March or April at label rates with subsequent applications of trinexapac-ethyl at 0.1 to 0.2 fl. ozs./1,000 sq. ft. every 7 to 14 days throughout the spring and summer will provide the best turf quality and may reduce anthracnose.

IRRIGATION

» Increased anthracnose can result when annual bluegrass is consistently subjected to wilt stress or excessively wet conditions.

» Irrigating to replace 60 to 80 percent of potential evapotranspiration, combined with hand watering to avoid wilt stress, has the dual benefit of providing a quality playing surface while avoiding conditions favorable for anthracnose.

TOPDRESSING AND FOOT TRAFFIC

» Biweekly sand topdressing in the summer with up to 100 lbs./1,000 sq. ft. provides a protective layer of sand around the crown. This slightly raises the effective height of cut, reducing the incidence of anthracnose.

» Topdressing in the spring at 400 to 800 lbs./1,000 sq. ft. is more effective than fall applications in reducing anthracnose severity.

NOTE: These rates do not take into account the quantity of sand that would be needed to fill coring holes. If coring is done at the same time as topdressing, more sand would be needed. The precise amount will depend on the diameter and spacing of coring holes.

» Anthracnose does not appear to be affected by different sand incorporation techniques, so methods that best incorporate sand should be selected to minimize turf injury and wear on mowing equipment.

» Foot traffic (similar to rolling) appears to reduce anthracnose, regardless of sand topdressing. The benefits of sand topdressing (better wear tolerance and decreased disease) are also seen in areas that receive daily foot traffic.

CULTIVATION PRACTICES

» It is not necessary to avoid the use of verticutting or other cultivation practices (e.g., aerification, scarification, grooming) when disease is present, since wounding from these practices has not been shown to increase anthracnose severity. It is a good idea, however, to apply fungicides close to the time of any cultivation practice when there is active disease.

FUNGICIDE MANAGEMENT

» Avoid the sequential use of any fungicide chemistry. Tank-mix or alternate fungicides with different modes of action to enhance efficacy and reduce the potential that resistant strains of the anthracnose pathogen will develop.

» Develop fungicide programs that focus on the strengths (efficacy) of fungicide chemistries, and time their application to optimize the control of all major diseases on the site.

» Use as many different fungicide chemistries with proven efficacy against anthracnose as are practical during the growing season to enhance anthracnose control and reduce the potential for fungicide resistance.

Included on this list: the QoI, DMI, Nitrile (chlorothalonil), benzimidazole, dicarboximide (iprodione), phosphonate, antibiotic (polyoxin-D), SDHI (penthiopyrad), and phenylpyrrole fungicides.

For further information on the BMPs, you can reach Dr. Murphy at Murphy@aesop.rutgers.edu or Dr. Clarke at Clarke@aesop.rutgers.edu.

Seeking Just-the-Right Formula for Prepping Greens for Tournament Play

Penn State Researchers Analyze Impact of Management Practices on Putting Green Playability and Plant Health

Whether preparing for a member/guest or a major tournament, golf course superintendents' prime concern is to produce consistently fast and smooth greens while endeavoring to maintain high-quality turf. Because players ask more often about green speed than they do about any other golf course condition (Nikolai, 2005), it's only natural that superintendents focus on green speed and how to best achieve it.

To date, research involving green speed has focused mostly on quantifying *individual* cultural practices on ball roll distance, rather than focusing on *a specific set* of cultural practices. Additionally, the goal of most research focused on ball roll distance has been to identify cultural practices that maintain a reasonable ball roll distance while lowering the stress caused to turfgrass through standard cultural practices, such as mowing frequently at a low height of cut (Gilhuly, 2006; Soller, 2013).

The reality is that when turfgrass managers are preparing greens for a tournament, they're faced with integrating *a variety* of cultural practices into a program to develop the best possible playing surface for a short period of time.

Some of the components of a tournament preparation program may include adjustments to height and frequency of cut, lightweight rolling, topdressing, grooming, or vertical mowing. Additional factors include adjustments in fertility and irrigation regimes (Nikolai, 2005; Zontec, 1997).

Integrating all of these potential cultural practices into an effective program that produces the required greens conditions for a short time period is the goal of a tournament preparation program. It only follows, then, that quantifying and comparing the effects of all of these tournament prep practices, collectively, on the playability of greens would provide a great resource to golf course managers looking to maximize speeds with the least possible negative impact on plant health.

While previous research has shown that a number of factors improve green speed, little research is available that investigates the influence of *multiple* factors on increasing speeds. There is also limited information on the law of diminishing returns of these practices as it relates to increasing green speed at the expense of plant health.

With three years of funding from the Tri-State Turf Research Foundation, Pennsylvania State University Associate Professor of Turfgrass Management Dr. John Kaminski and graduate research assistant Timothy Lulis hope to uncover the ideal formula for prepping greens for tournament play. They plan to:

1. Explore the influence of various cultural and chemical practices on golf course putting green playability
2. Examine the impact of these cultural practices on turfgrass quality
3. Correlate the influence of various cultural programs with green speed from data collected from golf course superintendents

Ultimately, the researchers' goal is to identify ways to maximize tournament conditions without adding additional negative stress to plant health from practices that are not resulting in playability improvements.

THE FOCUS IN 2015

In year one of their research, Dr. Kaminski and Timothy Lulis focused their efforts on the two most commonly used practices to achieve faster green speeds: lowering height of cut and adjusting mowing frequency as management practices are intensified leading up to the start of a tournament.

ABOUT HEIGHT OF CUT

» Research has indicated that a decrease in mowing height by .031" can be expected to produce a gain in ball roll of six inches (Richards, 2008).

» As mowing height is lowered further, however, increases in ball roll distances diminish.

» Reducing mowing heights from 0.156" to 0.125" may increase ball roll by as much as six inches, while an additional increase of six inches in ball roll would require dropping the mower height twice the previous increment to 0.063" (Nikolai, 2005).

ABOUT MOWING FREQUENCY

Most research on frequency of mowing and ball roll distance has focused on identifying procedures that reduce the frequency of mowing while maintaining an acceptable green speed. Turfgrass managers subscribe to a variety of mowing frequencies in an effort to increase speed. Some of these include:

» single mowing in the morning

» single mowing in the morning and evening

» integrating double cutting into either or both morning and evening mowing events

Double cutting while maintaining a consistent height of cut has been shown to increase ball roll distance (Nikolai, 2004).

There are many unknowns, however, relating to the timing of these increased

Seeking Just-the-Right Formula for Prepping Greens for Tournament Play

mowing frequencies on green speed and plant health. How long, for instance, do these practices need to be implemented prior to the start of an event before any additional benefits are noticed?

TRIAL SITES

In 2015, the researchers conducted three studies on putting greens they established at the Valentine Turfgrass Research Facility located in University Park, PA.

THE FIRST EXPERIMENT was conducted on a stand of 100-percent annual bluegrass (*Poa annua* L.)

» Soil at the site is typical of a highly modified pushup-style putting green and consists of a sandy loam with 2.5-percent organic matter and a pH of 7.0.

THE SECOND EXPERIMENT was conducted on a stand of 98-percent "Penn A-4" creeping bentgrass (*Agrostis stolonifera* L.) with 2-percent annual bluegrass.

» The green was constructed to USGA putting green specifications in 2012 and, at the start of the study, had 0.9 percent organic matter and a pH of 7.5.

THE THIRD EXPERIMENT was conducted on a stand established on 90-percent fine fescue (*Festuca rubra* L.) and 10-percent colonial bentgrass (*Agrostris capillaris* L.).

» The 2-year-old putting green was constructed with a 4" layer of USGA-specification root-zone mix overlying a loamy sand-constructed root-zone.

» At the initiation of the experiment, the soil had 1.6-percent organic matter and a pH of 7.5.

METHODOLOGY

All studies were arranged as a 3 x 3 factorial arranged as a randomized complete block design with three replications.

» Main effects consisted of three mowing heights and three mowing frequencies.

» All mowing was done using three John Deere E-Cut 220s with an 11-bladed reel and a 2.0-mm bed knife.

» Irrigation was applied as needed to prevent wilt.

» Preventive fungicide treatments were applied on a 14-day schedule.

» Sites consisting of creeping bentgrass and annual bluegrass received fertilizer applications of 0.1 lbs. N/1,000 sq. ft. every two weeks.

ANALYZING HEIGHT OF CUT

The three mowing heights were varied according to turfgrass species:

» In experiments conducted on annual bluegrass and creeping bentgrass, putting green heights of cut were 0.115", 0.100", and 0.085".

» In experiments conducted on fine fescue, heights of cut were 0.157", 0.177", and 0.197".

» Mower heights of cut and quality of cut were checked daily and adjusted as needed.

ANALYZING MOWING FREQUENCY

To determine the effect of mowing frequency, individual plots were mowed according to the following schedule:

» Single-cut treatments involved one single pass with the mower.

» Double-cut treatments consisted of two passes of the mower along the same line.

» Double double-cut treatments consisted of a double cut in the morning and again in the afternoon.

» All mowing treatments were initiated at 6:30 a.m.

» Double double-cut treatments were mowed at both 6:30 a.m. and 3:30 p.m.

THE DATA COLLECTION

The researchers collected the following data three times daily for the 14-day duration of each experiment:

» Air temperature and relative humidity

» Ball roll distance using a USGA Stimpmeter

» Putting green trueness using a Greenstester

» Soil moisture at 1.5" and 3.0" using a Fieldscout TDR 300 meter

» NDVI (digital value of the density of "greenness" in a plant) using a Fieldscout CM 1000 meter

» Surface firmness using a Fieldscount TruFirm True Firmness Meter

» Ball roll physics characteristics using the Sphero Turf Research app from Turf Informatics and a Sphero robotic ball.

The first set of data was collected immediately after the morning mowing. Then the researchers collected data two more times during the day:

» Before the afternoon mowing, data collections were made to ascertain air temperature, relative humidity, ball roll distance, putting green trueness, and ball roll physics

» Following afternoon mowing treatments, data again were collected to ascertain ball roll distance, putting green trueness, and ball roll physics on the experimental plots that received the afternoon mowing.

Seeking Just-the-Right Formula for Prepping Greens for Tournament Play

VISUAL EVALUATIONS

» Each experimental putting green was monitored using an Intri-Corp Hawk-Eye infrared camera. Images were captured every 10 minutes for the duration of each experiment.

» Regular visual evaluations of color and quality, as well as plot photos were taken.

» Turfgrass quality and color were also visually assessed on a scale of 1 to 9, where 1 = entire plot brown or dead and 9 = optimum greenness and/or density.

PRELIMINARY RESULTS

For this leg of their study, the researchers analyzed the results of the experiment conducted on creeping bentgrass. As you might expect, they found that height of cut and mowing frequency have a significant influence on ball roll distances. Among all treatments and rating dates, ball roll distance ranged from 9.2 to 12.8 feet.

» On the first date of the trial, ball roll distance ranged from 9.3 to 10.2 feet.

» When ball roll distance was at its maximum (11 days after treatments were initiated), it ranged from 10.1 to 12.8 feet.

EFFECT OF VARIED HEIGHTS OF CUT AND MOWING FREQUENCY ON BALL ROLL

» Plots mowed to a height of cut of 0.085", four times daily (double double-cut), had the longest ball roll distance on all evaluation days.

» Plots mowed at 0.115", once per day (single-cut), had the shortest ball roll distance on 12 of 14 days.

» When comparing the ball roll distance of the varying heights of cut within plots mowed twice per day, turf mowed at 0.115", 0.100", and 0.085" were among the slowest on 100 percent, 64 percent, and 21 percent of the rating dates, respectively.

EFFECT OF MOWING FOUR TIMES PER DAY ON BALL ROLL

When comparing mowing heights on plots that were mowed four times per day (double double-cut), differences in ball roll distance were observed:

» Plots mowed at the highest cut (0.115") had the shortest ball roll distance among all treatments on 11 of 14 dates.

» Conversely, plots mowed at 0.100" and 0.085" had the longest ball roll distance among all treatments on 11 and 14 of the 14 ratings dates, respectively.

THE TAKEAWAY: These results suggest that when creeping bentgrass is mowed four times per day, lowering the mowing heights from 0.100" to 0.085" resulted in an increase in ball roll distance on only 3 of 14 rating dates. Although not analyzed yet, preliminary observations indicate a visible decline in plant health among these treatments.

THE RESEARCH TEAM'S REFLECTIONS

As expected, as height of cut was lowered and mowing frequency increased, ball roll distance increased.

Unclear, however, is why plots mowed twice per day generally had shorter ball roll distances than those that were mowed only once at the same respective heights. It is likely that mowing patterns influence ball roll distance more than what was previously thought.

In this study, plots that were mowed twice were mowed down and back on the same line. Based on the ball roll distance in these treatments, it is possible that mowing on the same line resulted in a change in the position of the grass blades that negatively influenced ball roll distance. The influence of these mowing patterns will be the subject of a future study.

It has been reported that the average golfer is unable to detect changes in greens speed less than six inches (Nikolai, 2005). Although not statistically significant, differences in ball roll distance of 0.5 feet may be of interest as it relates to decreases in plant health.

The influence of these treatments on plant health, however, remains unclear. Data collected in this study are currently being evaluated to shed light on these effects. All treatments will be repeated in 2016 and data pulled for final analyses and interpretation.

For further information on Dr. Kaminski's research, you can reach him at jek156@psu.edu.

REASEARCH UPDATE (CONTINUED FROM PAGE 13)

Putting Syringing to the Test Against Summer Bentgrass Decline

» Beneficial cooling effects diminished more quickly than expected, as only small differences were noted between treatments after 20 minutes post-syringing.

» Different syringing treatments didn't seem to make a significant difference in overall turfgrass quality, which the researchers surmise is due to the fact that all sites are maintained under well-irrigated conditions.

IN THE YEAR AHEAD

With golf courses seeking to increase ball roll distances on putting greens through deficit irrigation (gradual reduction in daily irrigation based on ET loss) practices, the researchers plan, in 2016, to look at whether syringing can effectively delay symptoms of summer stress on greens imposed with combined heat and deficit-irrigation stresses.

The current hypothesis is that turfgrass stands may benefit more from a combination of irrigation and syringing under deficit irrigation conditions rather than relatively brief periods of syringing under well-irrigated conditions.

In addition, the researchers plan to compare the effects of the combination of syringing and fans to syringing alone for canopy cooling.

For further information on the researchers' trials, you can contact Dr. Huang at Huang@aesop.rutgers.edu.

PRESIDENT'S MESSAGE (CONTINUED FROM PAGE 1)

Where Would We Be Without Research?

superintendents who maintain the club's most important resource and for the golfers who enjoy fine course conditions.

If you're a superintendent and have just forgotten to contribute or put it off for another time, that time has come. Please don't delay in showing your support for the Tri-State's research efforts by sending your contribution today. It truly is such a small price to pay for the many benefits you'll receive in return.

AS MY TERM COMES TO A CLOSE

As my term as president comes to a close, I want to thank everyone who has contributed to our efforts. I also want to thank current and past board members who, without their support, this great organization would not be possible.

True to the old adage "give and you shall receive," I feel I have received just as much in my time on the Tri-State board as I have given. I have thoroughly enjoyed my term as president and am pleased to leave the foundation in good hands, with Tony Girardi our new president. I look forward to a bright future for this worthy organization and endeavor. After all, with your support, anything is possible!

FOUNDATION NEWS is published
by the Tri-State Turf Research Foundation
49 Knollwood Road, Elmsford, NY 10523-2819
TEL: 914-347-4653 FAX: 914-347-3437