FOUNDATION NEWS

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PRESIDENT'S MESSAGE

Building Better Golf and a Safer Environment

Tony Girardi, CGCS, President
Tri-State Turf Research Foundation

During our annual board meeting last January, it was suggested that I survey the boards of each of our five affiliated superintendent associations to find out how they felt about the Tri-State Turf Research Foundation's current efforts and how we might better satisfy their members' future research needs.

Those gracious enough to share their thoughts over the past year, naturally, had varying needs, but also, I found, had a fair number of questions about the foundation.

INSIDE THIS ISSUE

Having attended a professional development seminar recently that focused on enhancing our ability to communicate *what* we, as superintendents, do, *how* we do it, and *why* we do what we do, I thought it might be appropriate to review the very same topics as they apply to the Tri-State Turf Research Foundation.

Sure, we have hit on some of these topics in the past in our president's messages, but I feel the time is right to, once again, highlight our mission and impressive three-decade history.

WHAT DO WE DO?

Established in 1990, the Tri-State Turf Research Foundation is concerned with finding environmentally safe controls for turfgrass pests and problems common to tri-state area golf courses.

Working directly with researchers at universities in the Northeast—Cornell, Rutgers, University of Connecticut, University of Massachusetts, University of Rhode Island, and most recently, Penn State—the foundation strives to identify and fund research projects pertinent to the needs of area superintendents.

By now, most area turfgrass professionals know the foundation's work: Dr. Noel Jackson's breakthrough study on summer patch at URI; UMass's Dr. Pat Vittum's tireless work over decades studying the control of the annual bluegrass weevil; URI's Dr. Steven Alm's and Rutgers' Dr. Albrecht Koppenhöffer's search for sustainable controls for insecticide-resistant ABW; Drs. James Murphy and Bruce Clarke's outstanding work at Rutgers to establish BMPs for anthracnose control and now dollar spot, and the list goes on.

Every year, the list of foundation-funded research grows with one goal in mind: Building better golf and a safer environment through turfgrass research.

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URI Researchers Continue to Do Battle With the ABW

As golf course superintendents across the Northeast and Mid-Atlantic regions well know, the annual bluegrass weevil (ABW) continues to rank among the most highly destructive, difficult-to-control insect pests of short-mown golf course turf (greens, collars, approaches, fairways, tee boxes).

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 the newer chemistries being developed as well.

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 by continuing to fund the University of Rhode Island's Dr. Steven Alm and his team of researchers in their endeavor to uncover a reliable way to stop the ABW in its tracks.

TRIALS IN 2016

This past season, Dr. Alm continued the work he began in 2015 to evaluate and report on the efficacy of new controls for the ABW.

IN TRIAL 1

The first trial the researchers conducted in 2016 evaluated two formulations of Ference (cyantraniliprole) and Conserve SC:

» On May 9, the researchers timed applications for late overwintering-adult control.

» On June 2, applications were timed for third-, fourth-, and fifth-instar control.

The outcome: Both formulations and applications proved effective for control of the ABW *(Figure 1)*. It is encouraging that Ference provides a wide application window to prevent turf damage.

IN TRIAL 2

The researchers conducted a second trial that compared Matchpoint and Ference at two different timings:

» The May 17 applications were timed for first-, second-, and third-instar control.

» The June 2 applications were targeted at controlling fourth- and fifth-instars.

The outcome: Both treatments and timings provided excellent control *(Figure 2)*. Also encouraging is that Matchpoint, like Ference, appears to have a fairly wide window of application.

IN TRIALS 3 AND 4

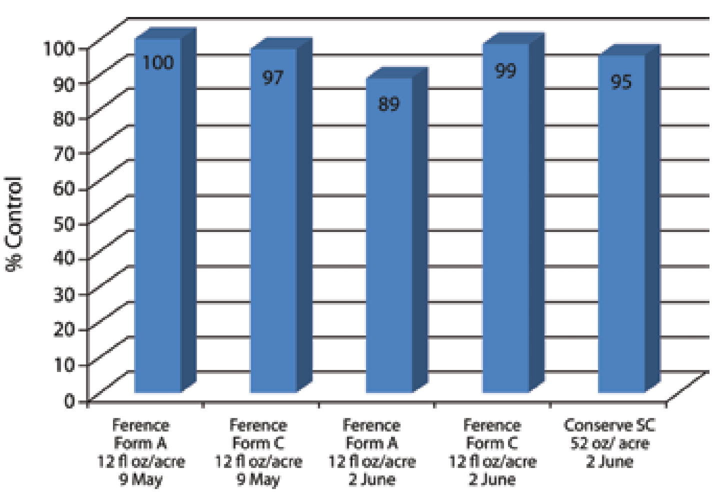
After several inconclusive trials with Silwet L-77 conducted in 2015, the researchers decided to conduct further tests to determine whether the surfactant could work together with various insecticides or on its own to control the ABW.

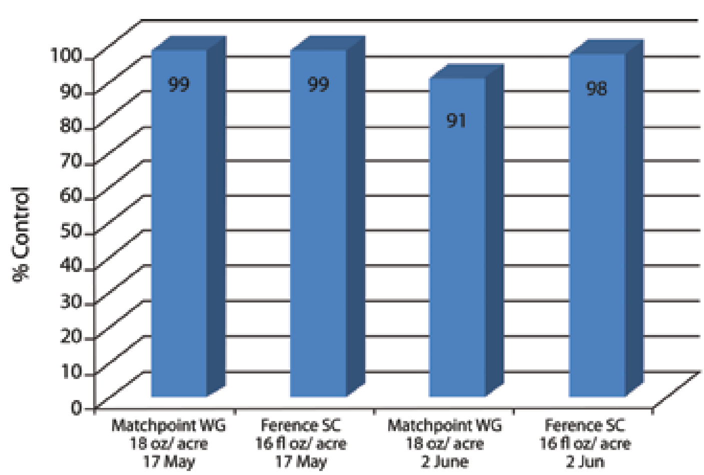
In 2016, the researchers conducted a third trial to compare the Silwet L-77 surfactant and Ference *(Figure 3)*.

» The Silwet treatments were applied in 8 gallons of water per 1,000 sq. ft.

» The Ference treatment was applied in 1 gallon of water per 1,000 sq. ft.

» In their June 2 trial, the researchers applied 5 fl. ozs. of Silwet on third-, fourth-, and fifth-instars and were very encouraged by the surfactant's level of control and that the application did not appear to cause any phytotoxicity *(Figure 4, page 4)*.





URI Researchers Continue to Do Battle With the ABW

» On May 23, the researchers pushed the application rate of Silwet to 9 fl. ozs. This rate did cause some phytotoxicity *(Figure 5, page 4)*.

With this in mind, on July 13, the researchers conducted a fourth trial to examine Silwet phytotoxicity when applying rates of 5, 6, 7, and 8 fl. ozs. per 1,000 sq. ft. They waited until one week after the treatment to evaluate each rate's efficacy. They discovered that only the 8 fl. oz. application caused significant phytotoxicity *(Figure 6, page 4)*.

The outcomes: The researchers confirmed that the application of 8 gallons of water per 1,000 sq. ft. is not a desirable application rate. However, there may be opportunities during or after a rainfall where the researchers could take advantage of saturated soils, which would allow control with wetting agents. We will continue research along these lines in 2017.

IN TRIAL 5

The researchers also conducted a fifth trial in 2016 using grubGONE! G, which happens to be labeled for the annual bluegrass weevil. The active ingredients in this product are:

» *Bacillus thuringiensis* subspecies *gallariae*

» Stain SDS-502 fermentation solids

» Spores

» Insecticidal toxins

» On June 2, the researchers applied grubGONE! G on third-, fourth-, and fifth-instars at a rate of 2.5 lbs. per 1,000 sq. ft.

The outcome: The researchers achieved 69 percent control. Dr. Alm and his team feel the results are encouraging, but they acknowledge that this is a very limited sample size. The highest label rate is 3 lbs. 7 ozs. per 1,000 sq. ft.

MANAGING RESISTANCE

The Colorado potato beetle is notorious for developing resistance to insecticides. At one point in the 1990s, resistance was so prevalent that at least one Rhode Island potato grower had to resort to using propane torches mounted on a boom sprayer rig to singe larvae on potato plants for control. What does the Colorado potato beetle have to do with the annual bluegrass weevil? In two words, insecticide resistance.

Insecticide resistance is more likely to develop in insects that possess the enzymes able to detoxify insecticides. The Colorado potato beetle feeds on plants in the nightshade family, which are chockfull of toxic compounds. It is likely, therefore, that these beetles are predisposed to detoxifying many other chemicals, including synthetic insecticides.

Previous research conducted in the URI team's lab has shown that the ABW possesses three groups of enzymes that are able to detoxify the synthetic pyrethroids and other insecticides:

» cytochrome P450s

» glutathione stransferases

» carboxylesterases

Resistance is also more likely to develop in insects that:

» produce several generations per year

» have a high rate of egg laying

It just so happens that the ABW falls into both of these categories

The "prescription" for minimizing the chances of developing chemical resistance? Noting the work of Dr. Andrei Alyokhin, an entomologist at the University of Maine, who has worked his entire career trying to combat resistance in the Colorado potato beetle, Dr. Alm offers this recommendation: "Do not follow an insecticide with any other insecticides that have similar chemistry within the same season."

Though, no doubt, challenging to incorporate into your own ABW management practices, Dr. Alm feels Dr. Alyokhin's recommendation is worthy of consideration.

COURSE SAMPLING

One observation the researchers have made in their travels to various courses is that the ABW populations can vary significantly from one fairway to the next. They recommend, therefore, that turfgrass managers step up their sampling practices

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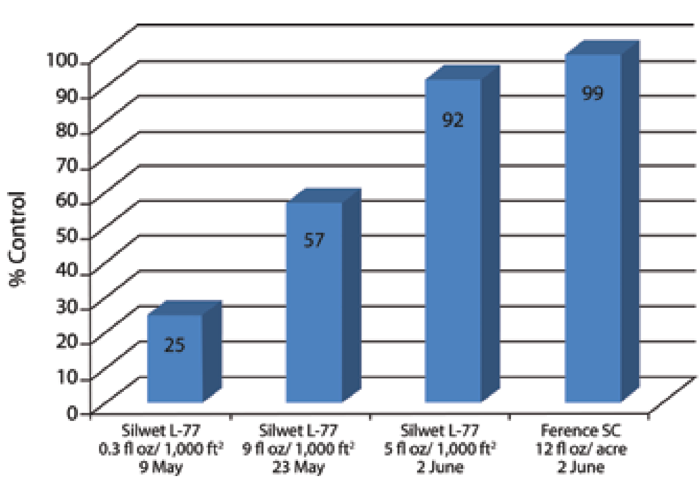

FIGURE 1 (LEFT)

Ference (two formulations A and C) and Conserve at two different application dates for ABW control.

FIGURE 2 (MIDDLE)

Matchpoint and Ference at two different application dates for ABW control.

FIGURE 3 (RIGHT)

Silwet L-77 and Ference at three different application dates for ABW control.

URI Researchers Continue to Do Battle With the ABW

FIGURE 4 (TOP)

5 fl. ozs. of Silwet L-77 applied June 2 in the equivalent of 8 gallons of water per 1,000 sq. ft.

FIGURE 5 (MIDDLE)

9 fl. ozs. of Silwet L-77 applied May 23 in the equivalent of 8 gallons of water per 1,000 sq. ft.

FIGURE 6 (BOTTOM)

8 fl. ozs. of Silwet L-77 applied July 13 in the equivalent of 8 gallons of water per 1,000 sq. ft.

to better time applications for second- and third-generation ABW adults and larvae. Developing more reliable and accurate sampling practices will help to reduce the number of insecticide applications and slow the rate of resistance development… the turfgrass manager's ultimate goal.

CONCLUSIONS AND FUTURE PLANS

Dr. Alm and his team of researchers have identified three application rates of Silwet L-77 that do not cause phytotoxicity and are economical enough to warrant further research. At the same time, they discovered that the key to control is not the Silwet, itself, but rather the carrier volume of water.

» The researchers were able to achieve 100 percent mortality of adult weevils in Petri dishes in 24 hours with a water carrier rate equivalent to 4 gallons per 1,000 sq. ft. and very reasonable rates of Silwet L-77. When the same rate of Silwet L-77 was used in a Petri dish with the equivalent of 2 gallons of water per 1,000 sq. ft., control dropped to almost nothing.

» The researchers have repeated these laboratory experiments many times with populations of weevils from several different golf courses, and they have achieved the same result.

» The mode of action is believed to be suffocation via drowning. This is based on the movement of water into the spiracles (openings to the tracheal system) or penetration of the cuticle from other studies that have shown control of other insects and mites with Silwet L-77.

» When the researchers took the trials outside the Petri dish, adding a known number of weevils to turfgrass plugs, they did not get the same level of control, probably due to the "wicking" action of water away from the treatment zone.

The researchers are hopeful for two reasons that they can get their current method of control to work:

1: One is that it would be almost, if not certainly, impossible for the ABW to develop resistance to drowning or mortality due to penetration of the cuticle.

2: The other reason to be optimistic is that there are many different surfactants and oils that may work even better and might even be cheaper.

The researchers have tried other oils and surfactants in the laboratory with similar results to Silwet L-77. The reason they are sitting tight with Silwet L-77 for now is that it is one of the organosilicone surfactants that are thought to cause a greater reduction in surface tension than both nonionic surfactants and crop oil concentrates. This makes them the most potent surfactants and super-penetrants currently available (Mullin et al. 2015).

Looking ahead to 2017, Dr. Alm and his team will conduct field trials in which they will:

» Check soil moisture levels before adding treatments.

» Add water before treatments in an effort to simulate the Petri dish levels of moisture.

» Apply treatments at different timings to see if they can achieve a greater level of control with ABW adults and larvae.

Reference: Mullin, C. A., J. Chen, J. D. Fine, M. T. Frazier, J. L. Frazier. 2015. The formulation makes the honey bee poison. Pesticide Biochem. and Physiol. 120: 27-35.

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

Rutgers Researchers Forge Ahead in Their Pursuit of BMPs for Dollar Spot Control

Dollar spot, caused by the fungus *Sclerotinia homoeocarpa* F.T. Bennett, continues to be 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.

In an attempt, therefore, to develop a viable and cost-effective method of control for dollar spot disease, the Tri-State Turf Research Foundation last year agreed to support Rutgers' Dr. Bruce Clarke, Dr. James Murphy, and graduate student James Hempfling in their pursuit of best management practices (BMPs) for dollar spot control on fairway turf.

In their second year of a four-year study, the researchers conducted two field trials in 2016, examining the role of bentgrass tolerance, disease predictive models, and fungicide timing in controlling this costly disease.

TRIAL 1: EXAMINING PREDICTORS OF DISEASE DEVELOPMENT ON BENTGRASS CULTIVARS

The researchers had two objectives in the first trial:

1: *Evaluate dollar spot incidence and disease progress on six bentgrasses that vary in tolerance to dollar spot disease.*

2: *Assess the reliability of two existing weather-based models for predicting dollar spot epidemics on those cultivars and species.*

THE CULTIVARS

The researchers continued in 2016 to examine six cultivars *(see photo below)* for disease incidence, monitoring them every two to five days. These cultivars 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

THE WEATHER-BASED PREDICTIVE MODELS

Drs. Clarke and Murphy also assessed two weather-based models for predicting dollar spot epidemics on those cultivars and species.

(continued on page 6)

SIDEBAR

Dollar Spot Study Outcomes At-a-Glance

» Dollar spot forecasting by a logistic regression model had good accuracy for highly susceptible cultivars during 2015 but overpredicted during 2016.

» Good to excellent, season-long disease control was achieved when subsequent fungicide timing was based on a threshold program. But total fungicide inputs and the level of disease control depended on the cultivar and, to a lesser extent, the initial fungicide timing.

» Fungicide applications on Declaration creeping bentgrass that were threshold-based produced excellent disease control and resulted in only three fungicide applications during 2015 and only one in 2016, regardless of the initial fungicide application date.

» In contrast, threshold-based fungicide applications on Independence creeping bentgrass resulted in a total of six or seven applications during 2015 and four or five applications during 2016, depending on the initial fungicide timing.

Bentgrass cultivars vary in their tolerance to dollar spot (clockwise from top left): 007, Declaration, Shark, Independence, Penncross, and Capri. Photo by *J. Hempfling*

Rutgers Researchers Forge Ahead in Their Pursuit of BMPs for Dollar Spot Control

The models:

» **Growing Degree Day (GDD) Model** *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 15° C (59° F) and a start date of April 1.

» **Logistic Regression Model** *to forecast the development of dollar spot epidemics throughout the growing season.* This model uses air temperature and relative humidity to predict the onset of the disease.

TRIAL 1 OUTCOMES

» The GDD model provided an accurate prediction of the onset of disease symptoms in highly susceptible cultivars during 2015 but not in 2016.

» In both 2015 and 2016, the logistic regression model forecasted a high risk of dollar spot one week before symptoms first appeared in highly susceptible cultivars.

» While the logistic regression model had good accuracy in forecasting disease during the growing season in 2015 on highly susceptible cultivars, in 2016 the model overpredicted *(Figures 1 and 2).*

» In tolerant cultivars, disease forecasting has not been at all accurate.

TRIAL 2: DETERMINING APPLICATION TIMING

In the second trial, the researchers set out to:

1: *Evaluate the effect of presymptomatic (initial) fungicide applications on dollar spot incidence and disease progression on both a susceptible and a more tolerant bentgrass cultivar.*

2: *Determine the extent that subsequent fungicide applications affect total fungicide use over a growing season when based on either a disease threshold or a predictive model.*

Treatments in this trial examined three factors:

1: Bentgrass tolerance to dollar spot. The researchers applied all possible combinations of initial and subsequent fungicide timings on both Declaration (more tolerant) and Independence (susceptible).

2: Initial fungicide application timing. The researchers timed these applications:

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

» On May 20 (calendar-based)

» As the logistic regression model reached a 20-percent risk index

» At a GDD range of 20-30, 30-40, 40-50, 50-60, or 60-70 (base temperature 15° C (59° F) starting April 1).

3: Subsequent fungicide application timing. The researchers based subsequent fungicide timing on the logistic regression model, a disease threshold, or they withheld fungicide applications to assess long-term effects of initial fungicide timings.

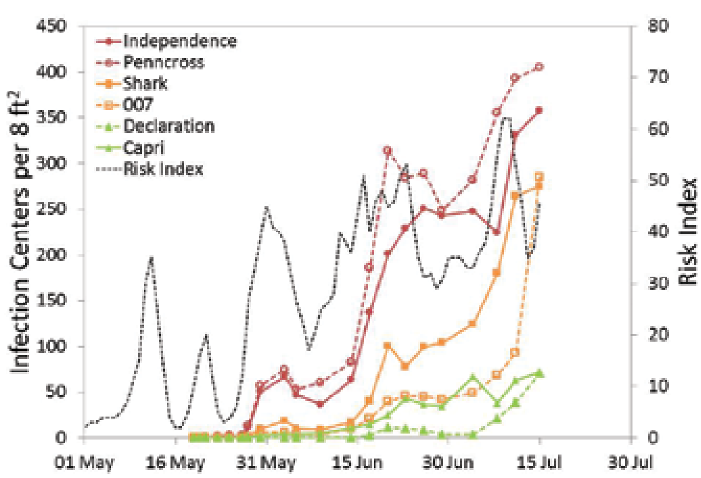

FIGURE 1

Number of dollar spot infection centers in highly susceptible (red lines), moderately susceptible (orange lines), and more tolerant (green lines) bentgrass cultivars and dollar spot risk index (black line) calculated using a logistic regression model during 2015.

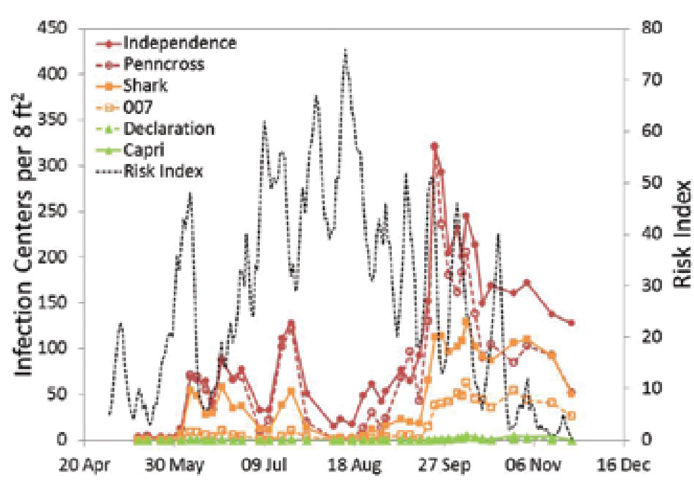

FIGURE 2

Number of dollar spot infection centers in highly susceptible (red lines), moderately susceptible (orange lines), and more tolerant (green lines) bentgrass cultivars and dollar spot risk index (black line) calculated using a logistic regression model during 2016.

Rutgers Researchers Forge Ahead in Their Pursuit of BMPs for Dollar Spot Control

» All possible combinations of initial and subsequent fungicide timings were applied on both cultivars.

» A calendar-based program of fungicide applied every 21 days also was included for comparison.

» All fungicide applications used Emerald 70WG (boscalid, BASF) at 0.18 ozs. per 1,000 sq. ft.

» Threshold-based plots were monitored as often as daily for dollar spot incidence.

» The number of applications to threshold- and model-based plots were recorded.

TRIAL 2 OUTCOMES

Analysis of the data from both 2015 and 2016 yielded the following outcomes:

» The initial fungicide application had minimal impact on long-term (May through November) control of dollar spot during 2015.

» Conversely, the factors of 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 logistic regression model or the calendar-based program.

» Depending on the initial fungicide timing, the logistic regression model reduced fungicide inputs by up to one application during 2015 and by one or two applications during 2016. Compare that to the calendar-based program, which for the past two years has led to nine applications *(Table 1)*.

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

» Subsequent fungicide applications on Declaration plots that were based on a threshold program produced excellent disease control and resulted in only three applications in 2015 and one fungicide application in 2016, regardless of the initial fungicide application date.

» In contrast, the threshold schedule for subsequent applications on Independence plots resulted in a total of six or seven applications during 2015 and four or five applications during 2016, depending on the initial fungicide timing *(Table 1)*.

» Moreover, disease incidence occasionally surpassed the target threshold value on Independence plots and reached levels (up to nine infection centers per 8 sq. ft.) during the growing season that may not be acceptable at some golf courses.

WHAT'S AHEAD

Drs. Clarke and Murphy will continue both field trials in 2017, and they plan to evaluate the impact of other cultural practices on dollar spot with the goal of developing best management practices for the control of this disease in the future.

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

	2015						2016					
	Declaration			Independence			Declaration			Independence		
	Subsequent Fungicide Timing						Subsequent Fungicide Timing					
Initial Fungicide Timing	Calendar	Logistic Model	Threshold	Calendar	Logistic Model	Threshold	Calendar	Logistic Model	Threshold	Calendar	Logistic Model	Threshold
	Total Number of Fungicide Applications											
20-30 GDD	-	9	3	-	9	7	-	8	1	-	8	5
30-40 GDD	-	9	3	-	9	7	-	7	1	-	7	4
40-50 GDD	-	8	3	-	9	7	-	7	1	-	7	5
50-60 GDD	-	8	3	-	8	6	-	7	1	-	7	4
60-70 GDD	-	8	3	-	8	6	-	7	1	-	7	5
Logistic	-	8	3	-	9	7	-	8	1	-	8	4
Threshold	-	8	3	-	8	6	-	0	1	-	8	5
Calendar	9	8	3	9	8	6	9	7	1	9	7	4

TABLE 1

Total number of fungicide applications used to control dollar spot based on bentgrass cultivar and initial and subsequent fungicide timings during 2015 and 2016.

Special Thanks to Our 2016 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.

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Douglas George

WATERTOWN GOLF CLUB
Paul Bonini, CGCS

WEE BURN COUNTRY CLUB
Douglas Drugo

WESTCHESTER COUNTRY CLUB
David Dudones

WEST POINT GOLF COURSE
Steven Whipple

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Allen Woodward

WHIPPOORWILL CLUB
Paul Gonzalez, CGCS

WINGED FOOT GOLF CLUB
Stephen Rabideau, CGCS

WOODWAY COUNTRY CLUB
Jamie Kapes

WYKAGYL COUNTRY CLUB
Daniel Rogers

CORPORATE CONTRIBUTORS

AQUATROLS
Kevin Collins

DELEA SOD FARMS
Richard DeLea

GRASS ROOTS TURF PRODUCTS
Keith Kubik

GREENPRO MATERIALS
Wes Perrine

GRIGG BROTHERS FOLIAR FERTILIZERS
Dr. Gordon Kauffman III

METRO TURF SPECIALISTS
Scott Apgar

NASSAU SUFFOLK TURF SERVICES
Bob Mele

NEW ENGLAND SPECIALTY SOILS
Edward Downing

OCEAN ORGANICS
Doug Middleton

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Syringing Shows Promise in Rutgers' Battle Against Summer Bentgrass Decline

Summer Bentgrass Decline (SBD). As superintendents with creeping bentgrass *(Agrostis stolonifera)* putting greens are well aware, SBD is a force to be reckoned with. During spring and fall, this grass species grows vigorously. During summer months, however, creeping bentgrass turf frequently shows signs of stress, a major concern among superintendents across the country.

There are several factors at play, but high temperatures have proved the primary culprit in the decline in turf quality. Also distressing to the turf, however, are low mowing heights, which stymie the plant's ability to acquire water located deeper within the soil, and damage from heavy foot traffic.

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.

Unfortunately, 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.

To avoid the ill effects of SBD during periods of high heat stress, most superintendents supplement turf with additional irrigation. This is generally accomplished by syringing, or hand-watering, which as you know, 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.

With the support of the Tri-State Turf Research Foundation, Dr. Huang and her research team have made great strides in pinpointing the most effective method of syringing in combating SBD.

With their final year of funding complete, what follows are the results of their trials, as well as practical advice for superintendents seeking to develop a more reliable formula for syringing practices to lower turfgrass canopy temperatures and prevent SBD.

STUDY FOCUS

In 2015, Dr. Huang and her team conducted a series of syringing trials at the Rutgers University turfgrass research farm in New Brunswick, NJ, and at two golf courses with different management and growing conditions: Hominy Hill Golf Course in Colts Neck, NJ, and Baltusrol Golf Club in Springfield, NJ.

In 2016, trials were continued onsite at Hominy Hill Golf Course to delve further into the effectiveness of syringing practices typically implemented by managers of golf course greens.

More specifically, the researchers are seeking to determine:

» the temperature at which syringing should be initiated

» the temperature at which syringing is no longer effective for mitigating SBD

» the duration of evaporative cooling after syringing is performed

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

THE METHODOLOGY

The trials in 2016 were conducted on the same turfgrass stand as in 2015: creeping bentgrass cv. Penncross, grown on greens built according to USGA specifications.

During 2016, daytime temperatures increased in the beginning of August and

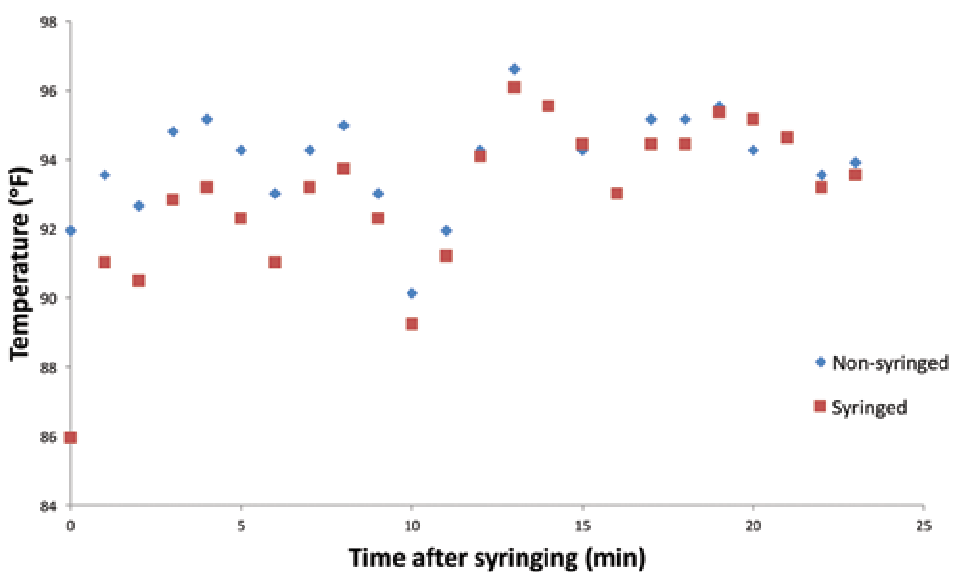

FIGURE 1

Canopy temperature of turf syringed when air temperature increased to 85° F compared to non-syringed turf.

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remained high throughout the month and into the first half of September. Thermal images were collected on days when air temperatures reached 85˚ and 90˚ F.

In August, the researchers:

» applied syringing treatments when the ambient air temperature reached 85˚ or 90˚ F

» made reapplications every hour

» applied approximately 0.03 to 0.05 inches of water per syringing event

» collected data at the 85˚ and 90˚ F thresholds, as in 2015, because these temperatures marked the highest temperatures occurring in the day

» compared all plots that received the syringing treatment to untreated plots that were not syringed

» took thermal images (one per minute) and measured soil water content and canopy density prior to the first syringing treatment and following the final syringing treatment at each site

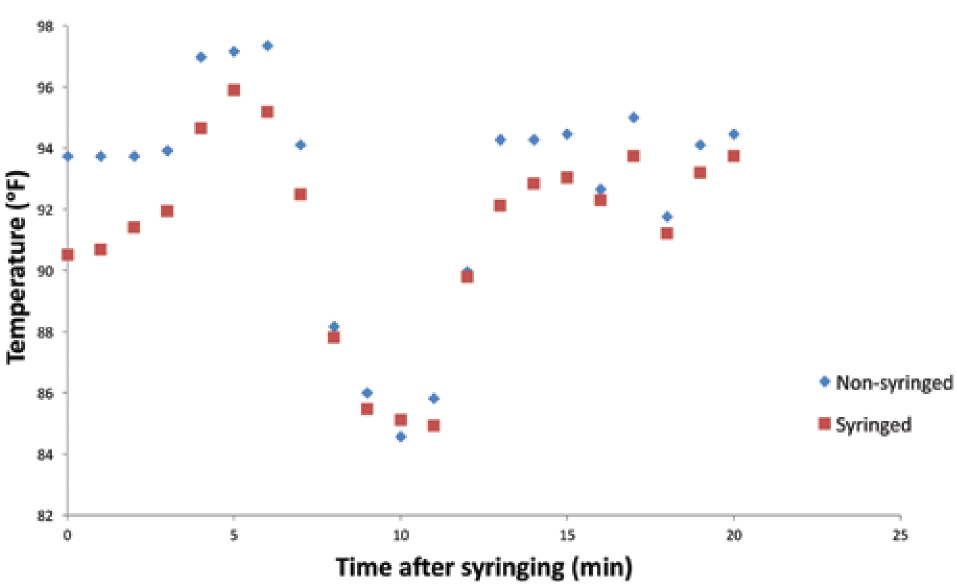

FIGURE 2

Canopy temperature of turf syringed when air temperature increased to 90° F compared to non-syringed turf.

ON CANOPY TEMPERATURE REDUCTION...

Applying syringing as air temperatures increased to 85˚ and 90˚ F reduced canopy temperature by 4 to 11 degrees compared to plots not syringed in the 2016 trial. This is similar to the 6- to 10-degree reduction seen in the 2015 trial.

For example, on a typical August day:

» When air temperature reached 85˚ F around 11 a.m., the syringing treatment applied reduced the canopy temperature by 4 degrees *(Figure 1)*.

» When air temperature increased to 90˚ F at 2 p.m., the canopy temperature decreased by 6 degrees when syringed *(Figure 2)*.

» When the same treatment was applied one and two hours later, the canopy temperature was reduced by 6 degrees in both instances.

ON DURATION OF CANOPY COOLING EFFECTS...

The researchers also discovered that wind speed affected canopy cooling rates similarly in both trials.

» In 2016, evaporative cooling effects on canopies lasted 10 to 15 minutes or less when wind speeds were 10 to15 mph, with more pronounced cooling effects.

» When wind speeds were between 5 to 10 mph, cooling effects lasted up to 15 minutes; though the effects were less drastic.

» In 2015, wind speeds did not top 10 mph, and when winds were 5 to 10 mph, cooling effects also lasted for 10 to 15 minutes.

» When winds were calm in both years, cooling effects lasted from 15 to 20 minutes.

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

In 2016, the researchers continued to evaluate 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. This seems to confirm that cooling effects may not be based on whether the site is native or sand-based.

(continued on page 15)

Prepping Greens for Tournament Play

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

Green speed and how to best achieve it is probably the number one preoccupation of today's golf course superintendent. And it's no wonder since golfers ask more often about green speed than they do about any other golf course condition (Nikolai, 2005).

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 have been hard at work developing the ideal formula for prepping greens for tournament play. Their objectives for this research are 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 superintendents

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

TRIALS IN 2015

In 2015, Dr. Kaminski and Timothy Lulis focused their efforts on the two most commonly used practices to achieve faster green speeds leading up to the start of a tournament:

» lowering height of cut

» adjusting mowing frequency

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 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?

To explore these practices, the researchers conducted three trials, each on putting greens established with a different turfgrass species at the Valentine Turfgrass Research Facility located in University Park, PA.

Prepping Greens for Tournament Play

The first trial 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 trial 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 trial 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.

In 2016, the researchers repeated all three trials, which examined the effects of lowering height of cut & adjusting mowing frequency on green speed and plant health.

THE METHODOLOGY

All studies were arranged as a 3 x 3 factorial in 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.

ANALYZING HEIGHT OF CUT

The three mowing heights were varied according to turfgrass species:

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

» In trials conducted on fine fescue, heights of cut were 0.165", 0.175", and 0.185".

» 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. at 3:30 p.m.

TRIALS IN 2016

Preliminary results from the first year of the mowing height & frequency studies revealed the potential influence of mowing pattern on green speed. This prompted Dr. Kaminski and Timothy Lulis to examine in 2016 how ball roll might be further influenced by:

» Mowing pattern & cultural practices

» Mowing frequency & brushing

MOWING PATTERN & CULTURAL PRACTICES

The researchers focused this leg of the study on how mowing pattern, in combination with nitrogen and trinexapac-ethyl, might affect green speed.

» The study was conducted on a stand of 98-percent "Penn A-4" creeping bentgrass with approx. 2-percent annual bluegrass.

» The green was constructed with a sand-based root zone in 2003 and, at the start of the study, had 1.2-percent organic matter and a pH of 7.2.

THE METHODOLOGY

The study was arranged as a randomized complete split-plot design with three replications.

» Main plots consisted of three mowing patterns with split-plots consisting of four fertilizer/plant growth regulator (PGR) regimes.

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

ANALYZING MOWING PATTERN

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

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

» Double-cut pattern consisted of two passes of the mower up and along the same line.

» Crisscross pattern involved mowing the individual plots twice at opposite angles.

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

ANALYZING CULTURAL PRACTICES

» The trial involved four fertilizer/PGR treatments that consisted of:

- Urea (0.1 lbs. N/1,000 sq. ft., every two weeks)
- Trinexepac-ethyl (0.125 fl. ozs. /1,000 sq. ft., every two weeks)
- Urea (0.1 lbs. N/1,000 sq. ft., every two weeks) + Trinexepac-ethyl (0.125 fl. ozs. /1,000 sq. ft., every two weeks)
- An untreated control receiving no fertilizer or PGR applications

(continued on page 14)

Prepping Greens for Tournament Play

» Height of cut for all treatments was 0.100".

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

MOWING FREQUENCY & BRUSHING

The researchers conducted a final study on the effects of mowing frequency & brushing on green speed.

» The study was conducted on a stand of 98-percent "Penn A-4" creeping bentgrass with approximately 2-percent annual bluegrass.

» The green was constructed to USGA putting green specifications in 2005 and, at the start of the study, had 1.4-percent organic matter and a pH of 7.3.

THE METHODOLOGY

The study was arranged as a 3 x 4 factorial in a randomized complete block design with three replications.

» Main effects consisted of four brushing treatments and three mowing frequencies.

» Height of cut for all treatments was 0.100".

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

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. at 3:30 p.m.

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

ANALYZING BRUSHING

Brushing treatments included:

» a powered rotary brush

» a soft bristle push brush

» a stiff bristled push brush

» an untreated control (i.e., no brush)

Brush components and equipment were supplied by John Deere. All brushes were mounted to the mowers as per manufacturer specifications.

DATA COLLECTION

The researchers collected data one to three times per week for the duration of the 10-week mowing pattern and cultural practices study. For all other experiments, data was collected twice daily for the 14-day duration of each study.

The data gathered included:

» Air temperature and relative humidity

» Ball roll distance using a USGA Stimpmeter

» Putting green trueness using a Greenstester

» Soil moisture (SM) 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 TCM 500 meter

» Chlorophyll content using a Fieldscout CM 1000 meter

» Surface firmness using a Fieldscout 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:

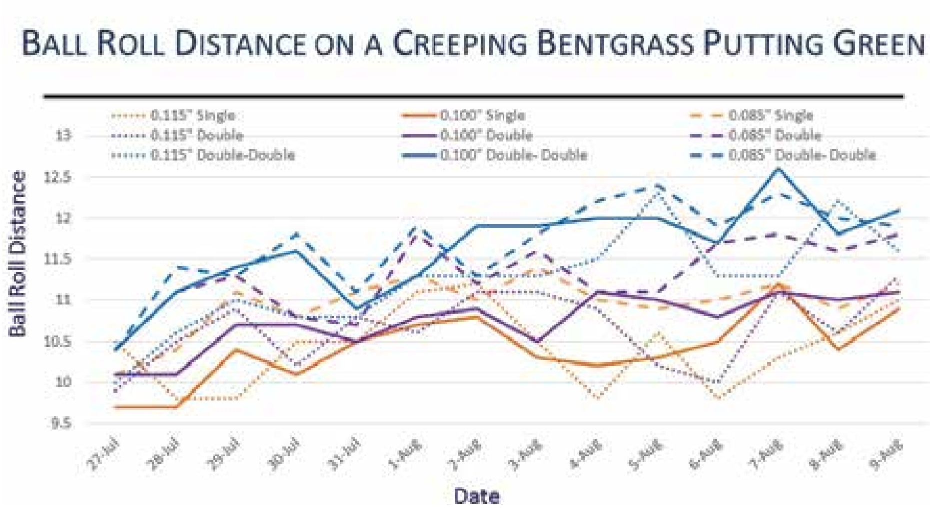

FIGURE 1

Ball roll distance as influenced by mowing height and mowing frequency on a creeping bentgrass putting green subjected to intense management during a simulated tournament.

Prepping Greens for Tournament Play

» 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.

» 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.

» All data were subjected to analysis of variance, and means were separated at $P \leq 0.05$ according to Fisher's Protected least significant difference test.

RESULTS AND NEXT STEPS

Data from *all three mowing height and mowing frequency* studies are currently being analyzed. A summary of data from the bentgrass study is presented in *Figure 1*. As expected, mowing height had a large impact on ball roll distance throughout the study.

Data collected in 2016 is currently being combined with the data gathered in 2015 and analyzed for significant differences among treatments, as well as to determine any treatment interactions.

Analyses for data obtained from the *mowing pattern & cultural practices and mowing frequency & brushing* trials are currently being assessed. These studies will be repeated again in 2017. On completion, data will be combined and analyzed to determine the main effects of each treatment and to identify any potential interactions among treatments.

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

Syringing Shows Promise in Rutgers' Battle Against Summer Bentgrass Decline

THE EFFECTS OF TEMPERATURE ON SOIL MOISTURE...

Prior to syringing on a given day in the 2016 trial, the average soil moisture content of the native soil turf stands ranged from 19 to 20 percent and declined by 2 to 3 percent on non-syringed plots.

» When syringing was applied every hour through the afternoon, soil moisture content increased by 3 to 4 percent.

» In 2015, the USGA-spec green in New Brunswick, NJ, had a soil moisture content ranging from 12 to 14 percent, which in non-syringed plots, decreased by 2 to 3 percent.

» Plots syringed every hour throughout the afternoon had a 3- to 4-percent increase in soil moisture content.

The data generated at the native sites in Colts Neck, NJ, in 2016 coincide with the data generated at the same site in 2015. These data suggest that syringing every hour when air temperatures reach 85° and 90° F allows soil moisture to be maintained in sand-based or native soil root zones during hot summer days.

IN SUMMARY

Results from the 2015 and 2016 trial years suggest that syringing may have beneficial effects on reducing internal temperatures of turf canopies during periods of high temperature stress.

» Data from both 2015 and 2016 trials demonstrated that syringing can reduce canopy temperature up to 11 degrees when applied at air temperatures of 85° and 90° F.

» The effects of evaporative cooling can last 15 to 20 minutes post-syringing.

» The level and duration of canopy temperature reduction varied with wind speed and soil moisture content.

» When wind speeds were low, from 5 to 10 mph, evaporative cooling effects lasted longer than when wind speeds ranged from 10 to 15 mph, but cooling effects were less pronounced.

» Syringing not only keeps the canopy cool, but also maintains soil moisture.

» Syringing on drier days or soils can be more effective than under moist or humid conditions.

The researchers recommend that turfgrass managers:

» Apply syringing treatments in the morning, when air temperature increases to 85° F, and then continue syringing hourly into the afternoon.

» Avoid syringing on moist soils or on humid days, as it can lead to an increase in disease incidence. Many pathogens commonly detected in the summer months are most aggressive when temperatures are high and when soil moisture is ample.

» Measure soil moisture content before deciding to syringe, taking into account when the stand was last well irrigated. Not all greens, after all, will be exposed to the same conditions.

With careful management, syringing may be a valuable practice, helping managers to maintain greener, healthier turf by mitigating heat stress in times when temperatures are highest.

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

Building Better Golf and a Safer Environment

HOW DO WE DO IT?

Orchestrating the foundation's activities is a Board of Directors made up of three representatives from each of the six affiliated associations: the MetGCSA, New Jersey GCSA, Connecticut AGCS, Long Island GCSA, Hudson Valley GCSA, and the MGA. If you take a look at the back page of this issue of *Foundation News*, you will see the representatives from your association.

Collectively, the six associations raise approximately $50K each year to support local universities and their research—that's generally three to five studies per year.

How do we decide what universities get the funding? The short answer is that the vetting process for these studies is rigorous. The Tri-State board accepts research proposals throughout the year that are then presented at the Annual Meeting every January. Board members spend a good deal of time discussing the merits of each proposal, finally voting on those that we feel will benefit the majority of superintendents in our region. But our job doesn't end there. Once committed to funding a project, we monitor that research, making sure to get timely updates so findings can be disseminated to area superintendents.

WHY DO WE DO WHAT WE DO?

The Tri-State Turf Research Foundation exists to support research. Research that is critical in preserving not only the quality of golf turf, but also the vitality and integrity of the game of golf.

Because of Tri-State-funded research, golf course superintendents have found environmentally safe control options for numerous turf-threatening pests and problems. We've saved thousands of dollars in unwarranted fertilizer and pesticide applications and avoided added labor costs and environmental liabilities. Beyond that, research has led to advances in turfgrass management practices that have guided us in providing top conditions for the countless people who enjoy playing golf.

The studies supported by the Tri-State are made possible with the contributions of the foundation's six affiliated associations along with donations from area clubs and vendors *(see list on pages 8–9)*.

As the science of golf course management becomes increasingly complex and environmental concerns and controls continue to escalate, the reason the Tri-State does what it does becomes all the more apparent—and essential.

WHAT CAN *YOU* DO?

To ensure that we can continue to do what we do, and do it well, we need just one simple thing from you: *your support*. An annual contribution of $250 to the Tri-State Turf Research Foundation's efforts is truly a small price to pay for the many benefits you receive in return—research that will undoubtedly shed a favorable light on your turf management practices and offer you the tools needed to meet new turf challenges and concerns head-on.

I look forward to the Tri-State's ongoing success, which with your support, is every bit possible!

FOUNDATION NEWS STAFF

EDITOR Ken Lochridge
MANAGING EDITOR Pandora Wojick

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49 Knollwood Road, Elmsford, NY 10523-2819
TEL: 914-347-4653 FAX: 914-347-3437