FOUNDATION NEWS

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PRESIDENT'S MESSAGE

Research: An Investment in Our Future

Tim Garceau, President
Tri-State Turf Research Foundation

The Tri-State Turf Research Foundation and the many area superintendents who have benefited from studies we've supported, know that there can never be too much research. Let's face it, the business of managing turf for a living is as rewarding as it is fraught with obstacles that oftentimes only research can resolve. Whether it's in our day-to-day decision-making or when planning for the upcoming season, we all rely on information gathered through research.

That's why supporting the Tri-State Turf Research Foundation's efforts is so important. For the past 28 years, the foundation has led the charge in identifying challenges that face area superintendents—and working directly with researchers at universities in the Northeast to find viable solutions to the most pertinent and pressing turfgrass problems.

YOUR CONTRIBUTIONS AT WORK

The foundation currently has five research projects underway to provide area golf course superintendents with more effective solutions and environmentally safe options for addressing a variety of turfgrass ills and challenges.

Described in this issue, these projects seek solutions for everything from the annual bluegrass weevil and dollar spot to viable methods for prepping our greens safely for tournament play and reducing irrigation requirements on fairway turf. You will also find study details available on our website, www.tristateturf.org.

GIVE AND YOU SHALL RECEIVE

Each and every study is made possible with contributions from the Tri-State Turf Research Foundation's six affiliated associations *(see board members, page 20)* and from donations made by area clubs and vendors. I want to thank all of you who have contributed to the foundation's research efforts and encourage those who have not to seriously consider joining the foundation's list of supporters. *(See pages 10–11 for our list of 2017 contributors.)*

If contributing seems like more trouble—and expense—than it's worth, consider the turfgrass world without the benefit of research and the assistance it's provided in combating the many turf-threatening pests and problems we encounter: anthracnose, dollar spot, and the annual bluegrass weevil, to name just a few.

Think about how it's saved us thousands of dollars in unnecessary fertilizer and pesticide applications—and in the labor

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INSIDE THIS ISSUE

Rutgers Researchers Seek Magic Formula for Reducing Irrigation Requirements on Fairway Turf

As superintendents with creeping bentgrass fairways know well, drought stress due to lack of rainfall or reduced irrigation can wreak havoc on the health and welfare of the turf plant, causing decreases in leaf-water relations, membrane stability, and aesthetic qualities.

As temperatures rise from spring to summer, drought stress becomes increasingly problematic. This, combined with increasing interest in water conservation, particularly with water-use restrictions always looming, it becomes all the more clear that finding a viable method for reducing fairway turf irrigation inputs is essential.

With funding from the Tri-State Turf Research Foundation, Rutgers' Dr. Bingru Huang and graduate student Cathryn Chapman have embarked on research to evaluate the effectiveness of four plant-health products in reducing irrigation requirements and promoting ongoing turf health in creeping bentgrass fairways when there is a shortage of rainfall or irrigation. They are also investigating the ability of these plant-health products to aid post-drought recovery in creeping bentgrass turf.

In 2017, Dr. Huang and Chapman conducted two trials: one in spring/summer, from May to August, and a second in the fall, from September to November.

In both trials, the researchers tested products that include both commercial and experimental plant growth regulators, biostimulants, and fungicides. Each were evaluated under different levels of deficit irrigation to determine the amount of water savings associated with their use, as well as their ability to improve the turf's post-drought recovery once it is re-watered.

What follows are the methods, materials, and outcomes reached at the conclusion of the two trials.

TRIAL 1: SPRING/SUMMER

In the first trial, the researchers established the following materials and methods:

FIELD CONDITIONS

Creeping bentgrass (*Agrostis stolonifera* cv. L-93) field plots were used for the experiment. The plots were 0.91 x 0.91m and located at Rutgers Horticultural Farm II in New Brunswick, NJ. The study was carried out in an automated rainout shelter. Movement of the rainout shelter was triggered by a weather station, which closes and covers the plots at the beginning of a rain event and retracts back to an open position when the rain stops. This eliminates any unwanted rain events during deficit irrigation that could otherwise confound the results.

» The experiment was conducted from May 29 to August 1, 2017. Specifically, the pre-stress period lasted from May 29 to June 11, the water deficit period from June 12 to July 10, and the post-drought recovery period from July 11 to August 1.

» The turf site was managed according to fertility and pest management practices typically used on fairways in the New Jersey area during the growing season.

» Plots were well irrigated before any plant-health products were applied and before the deficit irrigation was initiated.

» Fertilizer was applied before the various water treatments were initiated but not applied during the period of stress.

» The field received 1 lb. N/1,000 sq. ft. (12-24-8 NPK) on May 4 for turf growth and establishment.

» In addition, the field received 1 lb. N/1,000 sq. ft. (16-0-8 Country Club Lebanon) on June 2.

» The field was mowed twice per week at fairway height, approximately 0.5 inches (1.2 cm).

CHEMICAL TREATMENTS AND EXPERIMENTAL DESIGN

Turf plots were subjected to three irrigation treatments designed to simulate water restriction scenarios in the spring/summer season as the temperature was rising:

1: Well-irrigated control. Plots were irrigated weekly to maintain soil water content at field capacity by replacing 100 percent of the water lost in evapotranspiration (ET).

2: Deficit irrigation. Plots were irrigated to replace 60 percent of the water lost in ET to simulate a moderate level of drought stress.

3: Drought stress. Irrigation was completely withheld to simulate severe drought stress.

After approximately 28 days of irrigation treatments, plots previously exposed to moderate or severe drought stress were re-watered by irrigating to achieve full soil capacity.

» The study was arranged in a split-plot design with the irrigation level (100 percent ET, 60 percent ET, or drought stress) as the main plot and chemical treatments as subplots.

» All subplots were replicated three times for well-irrigated conditions and four times each for 60 percent ET and drought-stressed plots.

» Treatments were randomized within each main plot.

» Four chemical treatments were evaluated, including Signature XTRA Stressgard (4 fl. ozs./1,000 sq. ft.), amino acid-based stress protectants (up to 20 mM), seaweed-extract-based biostimulants (6 fl. ozs./1,000 sq. ft.), and fungicides containing Acibenzolar (0.5 fl. ozs./1,000 sq. ft. and 0.125 fl. ozs./1,000 sq. ft.).

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» Each chemical treatment was applied on May 29 (two weeks prior to the initiation of the different irrigation treatments) and then every 14 days thereafter throughout the water-deficit period and during post-drought recovery.

» All products were applied with a pressurized backpack sprayer within a carrier volume of 2.0 gals./1,000 sq. ft.

ENVIRONMENTAL MONITORING

Lysimeters were installed in each treatment plot to estimate water loss due to evapotranspiration (ET) over a 24-hour period.

» Using a mass balance technique, the amount of water lost was used to calculate the approximate amount of water (in inches) to add back to the plots, taking into consideration their specific irrigation regimes.

» Twice a week, beginning on June 14, the calculated irrigation amounts were applied with a calibrated handheld hose to replace either 100 percent or 60 percent of the water loss. This regime was continued weekly for the duration of the water-deficit period.

» Starting on July 11, all plots were re-irrigated and watered regularly to field capacity to assess post-drought recovery for 22 days.

PHYSIOLOGICAL ANALYSIS

Throughout the experimental period, weekly measurements were taken to assess drought tolerance and the turf's ability to recover. The researchers examined:

1: Visual turf quality

2: Leaf hydration

3: Turf canopy measurements

On Visual Turf Quality

» Turf quality (TQ) was visually rated on a scale of 1 to 9, in which a rating of 1 was used to describe brown and desiccated turf and 9 was used to describe healthy green and dense turf.

» A rating of 6 was considered the minimal acceptable level.

» Each rating was based on many factors that influence turf quality, including density, texture, uniformity, and leaf color.

On Leaf Hydration

» Leaf hydration was measured during the water-deficit and recovery periods by evaluating the leaf relative water content (RWC).

» Leaf samples were taken from the turf canopy and fresh weight (FW) was measured using a mass balance.

» Samples were immediately placed in tubes with 40 ml of deionized water, placed in a cold room (4˚C/39.2˚F), and weighed again after 24 hours (turgid weight, TW).

» Samples were then dried in an oven at 80˚C/176˚F for three days and subsequently weighed to determine the dry weight (DW).

» Using the following formula, the RWC of the turf plant was calculated: [(FW-DW)/(TW-DW)]*100.

On Turf Canopy Measurements

» Turf canopy measurements were also taken by using a handheld multispectral radiometer (MSR). The MSR measures plant light reflectance characteristics (510-1700 nm) and determines the normalized difference vegetation index (NDVI). In simpler terms, the researchers used the MSR to determine variances in plant color, which are generally indicative of turf health.

» On sunny days, measurements were conducted between 11 a.m. and 3 p.m.

TRIAL 1 OBSERVATIONS

On Visual Turf Quality

» Visual turf quality ratings on plots receiving each of the four chemical treatments were not severely affected by the 60 percent ET replacement throughout the water deficit and typically maintained higher quality ratings for the duration of the study compared to the untreated control.

» Although turf quality declined under drought stress across all treatments, the values were generally higher for each chemical treatment than for the untreated control.

» None of the treatments, however, resulted in turf quality values that recovered to pre-stress levels when re-watered during post-drought recovery.

On Leaf Hydration

» Although leaf relative water content values declined as a result of deficit irrigation during many of the sampling dates, each of the four chemical treatments maintained higher RWC values than those for the untreated control.

» There were not many differences in RWC values for Signature XTRA Stressgard, the amino acid-based stress protectant, and the seaweed-extract-based biostimulant under drought stress compared to the untreated control.

» The RWC for fungicides containing Acibenzolar, however, was higher throughout the drought and recovery phases.

On Turf Canopy Measurements

» NDVI data, an indicator of the quantity of green leaves, corresponds well with the trend that was seen for TQ, in that each of the four chemical treatments were not severely affected by 60 percent ET replacement throughout water deficit, and typically maintained higher levels of

(continued on page 4)

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turf health for the duration of the study compared to the untreated control.

» Although NDVI values declined under drought stress across all treatments, the values were generally higher for the Signature XTRA Stressgard, the seaweed-extract-based biostimulant, and the fungicide containing Acibenzolar in comparison to the untreated control.

TRIAL 2: FALL

In the second trial, the researchers established the following materials and methods:

FIELD CONDITIONS

The second trial continued with the creeping bentgrass (*Agrostis stolonifera* cv. L-93) field plots established in Trial 1. The rainout shelter remained as well to protect the plots from rain events that could skew the research results.

» The experiment was conducted from September 5 to November 16, 2017. Specifically, the pre-stress period lasted from September 5 to September 18, the water deficit period from September 19 to November 6, and the post-drought recovery period from November 7 to November 16.

» The turf site was managed according to fertility and pest management practices typically used on fairways in the New Jersey area during the growing season.

» Plots were well irrigated before any plant-health products were applied and before the deficit irrigation was initiated.

» Fertilizer was applied before the various water treatments were initiated but not applied during the period of stress.

» The field received 1 lb. N/1,000 sq. ft. (16-4-8 Country Club Lebanon) on August 28 for growth and recovery.

» The field was mowed twice per week at fairway height, approximately 0.5 inches (1.2 cm).

CHEMICAL TREATMENTS AND EXPERIMENTAL DESIGN

Turf plots were subjected to two irrigation treatments:

1: Well-irrigated control. Plots were irrigated weekly to maintain soil water content at field capacity by replacing 100 percent of the water lost in evapotranspiration (ET).

2: Deficit irrigation. Plots were irrigated to replace 60 percent of the water lost in ET to simulate a moderate level of drought stress.

These irrigation treatments simulated water restriction scenarios in the fall season as temperatures are declining. Due to extensive damage to the drought-stressed, treated turfgrass after the summer cycle of this experiment, the researchers have elected not to include drought as a third irrigation treatment in order to allow the turfgrass on the trial site to fully recover.

» After approximately 28 days of irrigation treatments, plots previously exposed to moderate drought stress were re-watered by irrigating to achieve full soil capacity.

» Chemical treatments replicated the spring/summer trial. Each chemical treatment was applied on September 5 (two weeks prior to the initiation of the different irrigation treatments) and then every 14 days thereafter throughout the water deficit period and during post-drought recovery.

» All products were applied with a pressurized backpack sprayer within a carrier volume of 2.0 gals./1,000 sq. ft.

ENVIRONMENTAL MONITORING AND PHYSIOLOGICAL ANALYSIS

Turf performance was monitored and evaluated as described in the spring/summer trial.

TRIAL 2 OBSERVATIONS

On Visual Turf Quality

» Visual turf quality ratings on plots receiving each of the four chemical treatments were not severely affected by the 60 percent ET replacement throughout the water deficit.

» The Signature XTRA Stressgard, amino acid-based stress protectant, and the seaweed-extract-based biostimulant typically maintained higher quality levels for the duration of the study compared to the untreated control, despite minor fluctuations.

» The turf quality of the plots treated with the Acibenzolar fungicides was similar to the untreated control after 38 days of deficit irrigation.

On Leaf Hydration

» Leaf RWC values declined only slightly as a result of deficit irrigation, and all four chemical treatments were similar to the untreated control.

» There were some select sampling dates, however, where the treatments had higher RWC levels, which correspond to TQ and NDVI data.

On Turf Canopy Measurements

» NDVI data corresponds well with the trend that was seen for TQ and RWC, in that each of the four chemical treatments were not severely affected by a 60 percent ET replacement throughout the water deficit. They did, however, typically maintain similar turf health measurements for the duration of the study compared to the untreated control.

2018 CONCLUSIONS

» Overall, the four chemicals tested—Signature XTRA Stressgard, the amino acid-based stress protectant, the seaweed-extract-based biostimulant,

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and the Acibenzolar fungicide—seemed to improve drought tolerance during moderate drought stress (60 percent ET replacement) and during severe drought stress (complete water withholding) in the spring/summer trial *(Photos 1 and 2)*.

» Though researchers did observe similar positive effects from the chemical treatments in the fall when the turf was subjected to moderate drought stress (60 percent ET replacement), those effects were less pronounced. Unlike the spring/summer trial, when temperatures were rising during the course of the experiment, temperatures during the fall trial were consistently declining, affecting the outcome.

» Under the moderate level of drought stress, some treatments, compared to the untreated control, aided the turf in not only tolerating the deficit irrigation, but also in maintaining the aesthetic and physiological qualities of the turf plant.

» The researchers found, in fact, that they were better able to restore the turf's physiological qualities—turf quality, relative water content, and canopy health—to pre-stress levels during recovery.

With two field trials complete, Dr. Huang and Chapman plan to further investigate the four plant-health products' potential for aiding turfgrass managers in conserving water during periods of drought or water-use restrictions.

The actual amount of water savings determined for each product, however, may vary and should be further analyzed based on ET loss rates. The researchers will also continue to investigate the plant-health products' role in promoting post-drought recovery when normal watering conditions are restored.

Dr. Huang and Chapman will repeat the trial in 2018 to confirm the results for both the spring/summer and fall trials and provide final conclusions regarding the effects of specific chemical treatments. ▲

For further information, you can reach Dr. Huang at 848-932-6390 or at huang@sebs.rutgers.edu.

PHOTO 1

Taken at 24 days of deficit irrigation and drought in the spring trial.

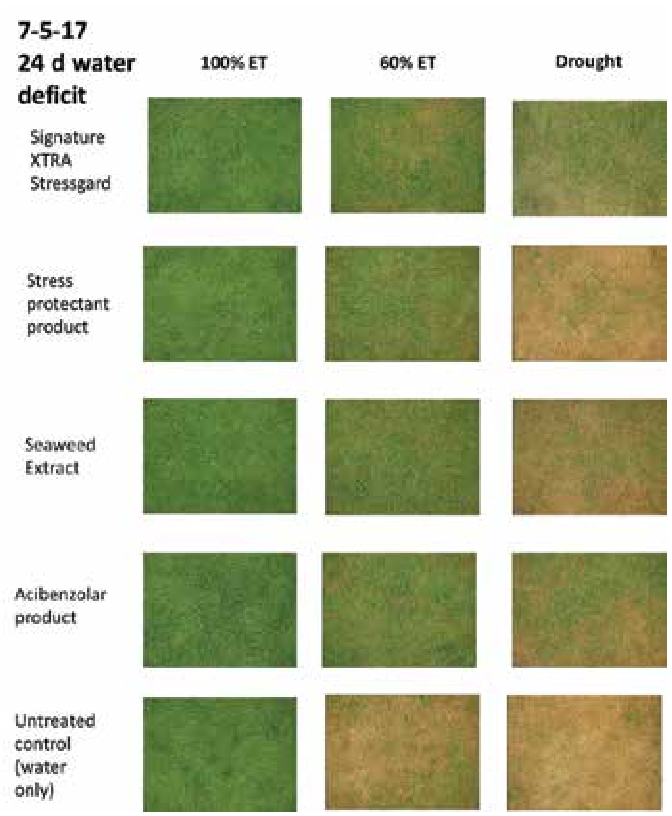
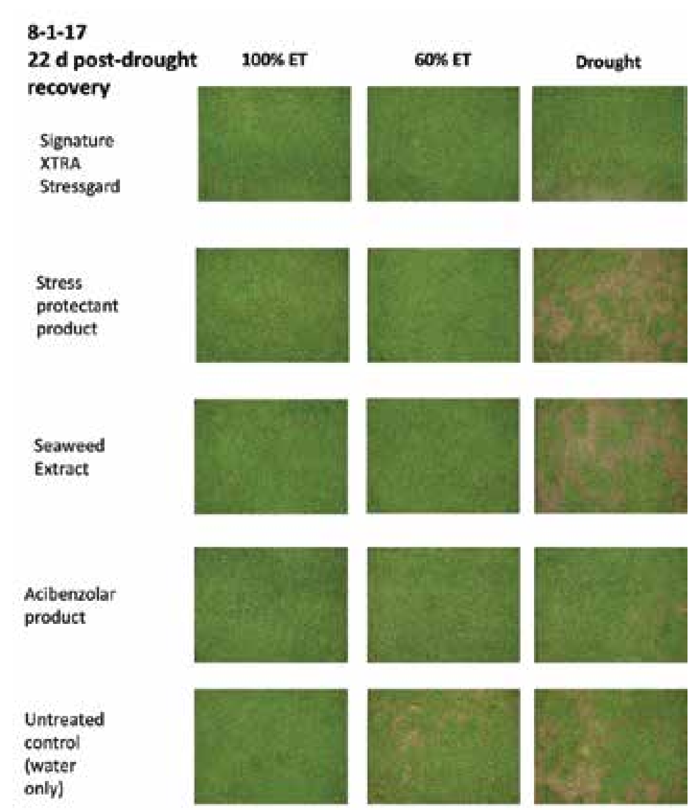


PHOTO 2

Taken during re-watering or recovery phase in the spring/summer trial.



Rutgers Researchers Continue Their Pursuit of Best Management Practices for Dollar Spot Control

Dollar spot disease, caused by the fungus *Sclerotinia homoeocarpa* F.T. Bennett, continues to plague 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 their third and final year of funding from the Tri-State Turf Research Foundation, Rutgers' Dr. Bruce Clarke, Dr. James Murphy, and graduate students James Hempfling and Kyle Genova continued research to aid in developing best management practices (BMPs) for the control of dollar spot disease on fairway turf.

In 2017, the researchers conducted two field trials designed to examine the role of bentgrass tolerance, disease predictive models, and fungicide timing in controlling this persistent and costly disease.

TRIAL 1: EXAMINING PREDICTORS OF DISEASE DEVELOPMENT ON BENTGRASS CULTIVARS

In the first trial, the researchers have two objectives:

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 weather-based models for predicting dollar spot epidemics on those cultivars and species.

THE CULTIVARS

The researchers continued in 2017 to examine six cultivars *(Figure 1)* 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 National Turfgrass Evaluation Program 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 are also assessing two weather-based models for predicting dollar spot epidemics on those cultivars and species. 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.

Quick Take on Dollar Spot Study Outcomes

» Dollar spot forecasting by a logistic regression model had good accuracy for highly susceptible cultivars during 2015, early 2016, and 2017.

» Moderate 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 four to five in 2017.

» In contrast, threshold-based fungicide applications on Independence creeping bentgrass produced moderate disease control and resulted in a total of six or seven applications during 2015 and six to nine applications during 2017, depending on the initial fungicide timing.

FIGURE 1
Bentgrass cultivars vary in their tolerance to dollar spot (clockwise from top left): 007, Declaration, Shark, Independence, Penncross, and Capri. Photo by *J. Hempfling*

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» **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 likelihood of an outbreak of the disease using a risk index of 20 percent.

TRIAL 1 OUTCOMES

» The onset of disease symptoms in highly susceptible cultivars (Independence and Penncross) occurred at 73 GDDs during 2015, 27 GDDs in 2016, and 92 GDDs in 2017.

» By contrast, the onset of disease symptoms in moderate- (007 and Shark) and low- (Declaration and Capri) susceptibility cultivars, occurred at 79 GDDs during 2015, 140 GDDs in 2016, and 112 GDDs in 2017.

» The logistic regression model accurately forecasted disease progress in susceptible cultivars throughout 2015, early 2016, and 2017 *(Figure 2)*.

» More specifically, the logistic regression model forecasted a 20-percent risk index of dollar spot onset in highly susceptible cultivars 7 days before symptoms first appeared in both 2015 and 2016 and 21 days before in 2017.

» By contrast, in moderate- and low-susceptibility cultivars, a 20-percent risk index occurred at 11 days before disease onset in 2015, 29 days before in 2016, and 28 days before symptoms appeared in 2017.

» In these moderate- and low-susceptibility cultivars, disease progress appears to be predicted better using a risk index greater than 20 percent in the logistic model. Further data analysis is needed to verify this hypothesis.

» The logistic regression model had good accuracy in forecasting disease on highly susceptible cultivars during the growing season in 2015 and 2017, and early in the season of 2016.

» Interestingly, disease recovery often occurred when the risk index declined sharply, though greater than 20 percent.

TRIAL 2: DETERMINING APPLICATION TIMING

In the second trial, the researchers have continued 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 presymptomatic fungicide applications may affect total fungicide use on each

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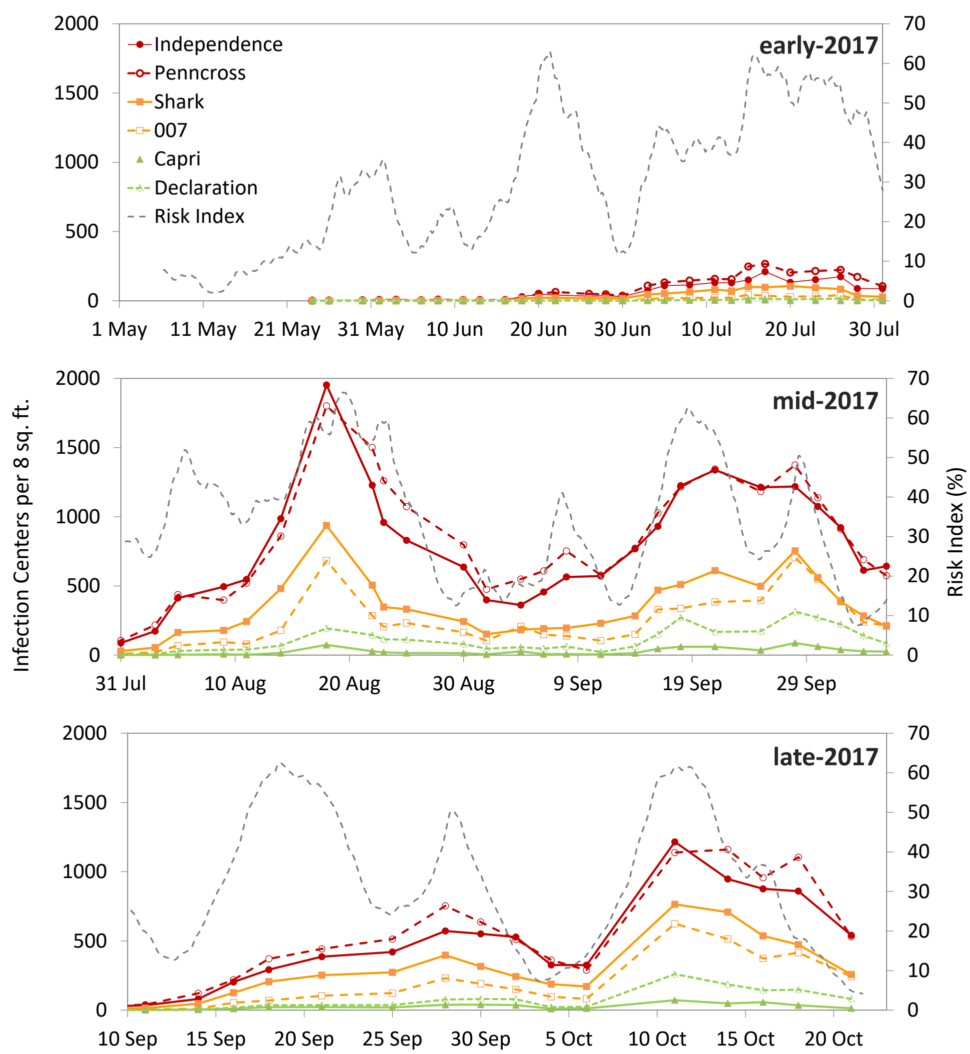

FIGURE 2

Number of dollar spot infection centers in high susceptibility (red lines), moderate susceptibility (orange lines), and low susceptibility (green lines) bentgrass cultivars, and dollar spot risk index (gray dotted line) calculated using a logistic regression model during 2017.

Rutgers Researchers Continue Their Pursuit of Best Management Practices for Dollar Spot Control

cultivar over a growing season when subsequent fungicide applications are 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 (highly susceptible).

2: Initial fungicide application timing. Eight initial fungicide timings were evaluated. The researchers timed these applications:

» At the first appearance of disease symptoms (threshold-based)

» 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.

» 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.

» Fungicide applications used Emerald 70WG (boscalid, BASF) at 0.18 ozs. per 1,000 sq. ft. from May 2015 to July 2017 OR a tank mix of Curalan (vinclozolin, BASF) at 1 oz. per 1,000 sq. ft. and Secure (fluazinam, Syngenta) at 0.5 fluid ozs. per 1,000 sq. ft. from August 2017 to November 2017.

» Threshold-based plots were monitored as often as daily for dollar spot incidence; fungicide was applied once a treatment reached one infection center per plot (8 sq. ft.).

» The number of applications to threshold- and logistic regression model-based plots were recorded each year.

TRIAL 2 OUTCOMES

Analysis of the data from 2015, 2016, and 2017 showed the following outcomes:

» Disease response to treatments was limited during 2016 due to unintended dollar spot suppression from the application of Medallion (fludioxonil, Syngenta) to control anthracnose.

» The most important factors influencing disease progress during 2015 and 2017 were the type of bentgrass cultivar and subsequent fungicide timing.

» In addition, the type of cultivar interacted with subsequent fungicide timing to influence not only the level of disease control, but also the total annual fungicide inputs during 2015.

» Subsequent fungicide applications based on both the logistic regression model and disease threshold produced excellent disease control (< 2 infection centers per plot) on Declaration plots.

» When only the logistic regression model was used to time applications, excellent disease control was attained on Independence plots.

» During 2015, three threshold-based applications were made to Declaration plots and six to seven applications were made to Independence plots depending of the timing of the initial fungicide application *(Table 1)*.

» In 2017, four to five threshold-based applications were made to Declarations plots, while six to nine applications were made to Independence plots depending of the timing of the initial fungicide application.

» Disease incidence was occasionally unacceptable on Independence plots that relied on the threshold model to determine application timing.

Next winter, Drs. Clarke and Murphy will share their final data analysis and report on the Best Management Practices for fairway dollar spot control. ▲

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

	DECLARATION		INDEPENDENCE	
	2015	2017	2015	2017
	Total Number of Fungicide Applications†			
CALENDAR	9	9	9	9
LOGISTIC	8 to 9	6 to 9	8 to 9	8 to 10
THRESHOLD	3	4 to 5	6 to 7	6 to 9

TABLE 1

Total number of fungicide applications used to control dollar spot based on bentgrass cultivar and subsequent fungicide timings during 2015 and 2017.

† A range in the total number of fungicide applications indicates that the total number depended on the timing of the initial fungicide application.

Two Research Teams Seek Solutions to ABW Insecticide Resistance

Resistance is a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendations for that pest species. – INSECTICIDE RESISTANCE ACTION COMMITTEE (IRAC)

The annual bluegrass weevil (ABW), technically known as *Listronotus maculicollis*, remains the most highly destructive and difficult-to-control insect pest of short-mown golf course turf in the Northeastern U.S. and Eastern Canada.

The trouble begins when young larvae tunnel the grass plant's stems causing 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.

Right now, chemical insecticides are the only effective option for ABW control, with turf managers typically applying insecticides over much of the short-mown areas of the golf course—sometimes 10 or more times during the season.

Overreliance on synthetic insecticides, particularly of the pyrethroid class, has led to the development of insecticide-resistant populations, some of which are already resistant to most of the currently available chemistries.

A recent survey conducted with turfgrass managers in the tri-state area who suspected ABW resistance on their courses, showed that insecticide resistance was, in fact, alive and well. Among the New Jersey courses surveyed, 28 percent reported resistant ABW populations; in Connecticut, 48 percent; and in Long Island, a significant 55 percent of the courses surveyed reported insecticide-resistant ABWs.

Still committed to supporting research that will aid superintendents in managing this formidable turfgrass pest, the Tri-State Turf Research Foundation is, once again, supporting two ABW studies. Researchers from Rutgers and Penn State universities are working together to put larvicides to the test in combating ABW insecticide resistance, while the University of Rhode Island team is examining the efficacy of wetting agents and newer chemistries in ABW control. Approaching ABW resistance from different angles, the two research teams hope to strike on the right formula for halting ABW devastation before it takes hold. Their reports follow.

REPORT 1

Are Larvicides the Answer to ABW Insecticide Resistance?

Researchers From Rutgers and Penn State Join Forces to Explore Sustainable ABW Management Alternatives

With ABW resistance now extending well beyond pyrethroids to many of the latest and greatest chemistries, it is becoming increasingly urgent that better tools be developed to assess and monitor ABW impact and to establish more effective and sustainable management practices. Even more essential is that the synthetic insecticides that have remained viable be protected by using them only when and where necessary.

With this in mind, the Tri-State Turf Research Foundation is supporting Rutgers' Dr. Albrecht Koppenhöfer and Penn State's Dr. Benjamin McGraw in exploring the viability of combining a regimen of diligent monitoring and scouting with well-timed larvicide applications in combating the mounting ABW insecticide resistance.

Since larval densities are a more precise predictor of damage potential than adult densities, concentrating management efforts more on larval control should allow for a much more informed decision on whether or not to apply an insecticide.

LARVICIDE SELECTION AND TIMING

Timing larvicide applications requires knowledge of population structure and a better understanding of the full potential—e.g., the efficacy and residual activity—of the available larvicides.

Currently, larvicides are applied to control either:

» The young larvae (1st instars; late- to past-bloom dogwood in spring) inside the plants through systemic activity (Acelepryn, Ference) *or*

» The medium-sized larvae (2nd to 3rd instars; full-bloom rhododendron in spring) once they have exited the plant (Provaunt, Conserve/MatchPoint, Dylox).

After several years of observations on pyrethroid-susceptible and pyrethroid-resistant ABW populations, the researchers suggest that:

» Ference is similarly effective whether applied against small- or medium-sized larvae.

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Special Thanks to Our 2017 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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Are Larvicides the Answer to ABW Insecticide Resistance?

» Dylox is often recommended as a "rescue" treatment for arresting further damage from late-instar (4th and 5th) larval feeding. However, it is not understood how effective this and other larvicides are against large larvae.

Why is it important to understand how effective larvicides are against the large larvae?

» First, if infestations are not recognized until large larvae are present, it is important to know which insecticides are most effective to prevent or minimize damage.

» Second, ABW larval populations are often spread over a wide range of stages so that early applications do not effectively control larvae that appear after the insecticide activity has worn off.

» The later an insecticide can be applied and still be effective against the large larvae, the greater the proportion of the larval population that can be controlled with that one application.

» Effective late applications, therefore, would reduce the need for multiple applications and, in turn, result in reduced costs, labor, and likelihood of insecticide resistance.

» Third, the later larvicides can be applied, the more the ABW larvae can be used to weaken the annual bluegrass turf and give preferred, and more ABW-tolerant grasses, like creeping bentgrass, an advantage.

GREENHOUSE AND FIELD TRIALS

The effect of larval stage/application timing on control of ABW larvae and speed of control was tested in several greenhouse (pots with annual bluegrass) and field (naturally infested fairway turf) experiments.

METHODOLOGY

Four commonly used larvicides were applied at standard rates:

1: Ference: active ingredient cyantraniliprole, rate 0.16 lbs. ai/acre

2: MatchPoint: spinosad, 0.4 lbs. ai/acre

3: Provaunt: indoxacarb, 0.225 lbs. ai/acre

4: Dylox: trichlorfon, 6 lbs. ai/acre

Applications were timed to target populations that consisted primarily of:

1: 2nd- and 3rd-stage larvae (average stage 2.5)

2: 3rd- and 4th-stage larvae (average stage 3.5)

3: 4th- and 5th-stage larvae (average stage 4.5)

» The first application was timed with the beginning of full-bloom hybrid Catawba rhododendron.

» The second and third applications were timed for about one and two weeks later.

» Generally, all treatments were evaluated for number/density of surviving larvae and pupae seven days after the last application.

» The speed of kill was estimated in one greenhouse experiment by evaluating treatments at two, four, and seven days after each application and in one field experiment by evaluating treatments seven days after each application.

OBSERVATIONS OF TIMING ON EFFICACY

Greenhouse data, overall, indicated that control tended to be higher against the youngest larvae (average stage 2.5) than the oldest larvae (average 4.5). However, data were too variable and/or mortality too high to allow for clear separation of effects on speed of kill and differences between products.

Two of the three field experiments provided good data with good development and densities of larval populations with similar timings at both sites.

» The average larval stages for the three application timings were 2.5, 3.4, and 3.9 for the first pyrethroid-susceptible population (Pine Brook Golf Course, Manalapan, NJ) and 2.7, 3.3, and 4.0 for the pyrethroid-resistant population (Preakness Hills Country Club, Wayne, NJ).

» At the second pyrethroid-susceptible site (Bucknell University Golf Course, PA), the ABW population behavior was unusual: Only two 4th-stage larvae recovered at the first application, and a slightly younger average was observed at the third application (3.4) than at the second application (3.6). The data at this site were also very inconsistent and different from those at the other sites and in previous studies. This may be a reflection of the very unusual population development; therefore, the researchers will not present these data here.

AT THE PYRETHROID-SUSCEPTIBLE SITE

Pine Brook Golf Club had by far the highest larval densities and the lowest variability in the data *(Figure 1, Susceptible)*.

» Ference was more effective in the first application (99%) than the second application (84%), and the least effective in the third application (65%).

» MatchPoint was more effective in the first (87%) and second (84%) applications than in the third application (68%).

» Provaunt was more effective in the first (83%) and second (83%) applications than in the third application (59%).

» Dylox was more effective in the second application (90%) than in the first (72%) and third applications (72%).

Because of the different effect of larval age at application of the different products, it was not possible to make general statements across products and timing.

Are Larvicides the Answer to ABW Insecticide Resistance?

AT THE PYRETHROID-RESISTANT SITE

At Preakness Hills Country Club, larval densities were considerably lower, and because of that, data were more variable and trends less clear *(Figure 1, Resistant)*.

» Ference was more effective in the first (89%) and second applications (80%) than in the third application (41%).

» The efficacy of MatchPoint (74-82%) and Provaunt (31-63%) did not differ significantly between application times.

» Dylox was more effective in the second (79%) than in the third application (35%), with the first application being intermediate in efficacy (50%).

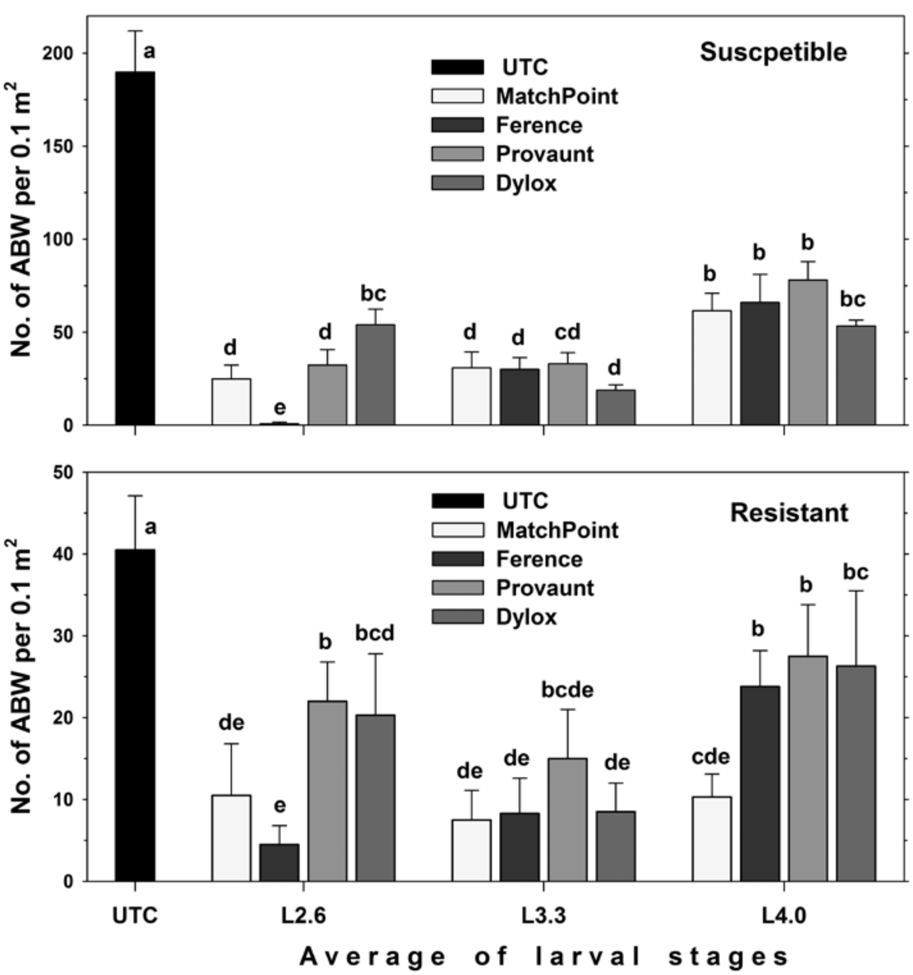
» Across all application times, MatchPoint and Ference were more effective than Provaunt with Dylox being intermediate in efficacy.

» And across all products, efficacy was higher in the first and second applications than in the third application.

Overall, Provaunt and Dylox efficacy, but not MatchPoint and Ference efficacy, tended to be lower against the resistant than the susceptible populations. The researchers point out that this is in line with their previous studies on the effect of resistance on these products.

FIGURE 1

Effect of application timing on efficacy of four larvicides for control of a pyrethroid-susceptible and a pyrethroid-resistant ABW population in golf course fairways. Larvicides were applied when larval stages averaged L2.6 (rhododendron start full bloom), L3.3 (rhododendron in late bloom), and L4.0 (past rhododendron bloom). Means within each graph with the same letters did not differ significantly.



OBSERVATIONS ON SPEED OF KILL

At the susceptible Pine Brook Golf Club site, the researchers also studied speed of kill by evaluating treatment effects seven days after treatment for each application time.

For the **first application** timing:

» Ference (99%), MatchPoint (87%), and Dylox (72%) provided exactly the same level of control as after the final evaluation two weeks later whereas Provaunt provided somewhat less control after seven days (67% vs. 83%).

» Ference was significantly more effective than the other products.

» MatchPoint was significantly more effective than Dylox and Provaunt.

For the **second application** timing:

» MatchPoint (78% vs. 84%) and Dylox (87% vs. 90%) provided the same level of control after seven days than at the final evaluation one week later.

» Ference (71% vs. 84%) and Provaunt (69% vs. 83%) provided somewhat less control after seven days.

» Dylox provided significantly higher control than the other three products.

IMPLICATIONS

The effect of larval stage on control of ABW larvae was tested in several greenhouse and field experiments in 2017. The commonly used larvicides—Ference, MatchPoint, Provaunt, and Dylox—were timed to target populations that consisted

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URI Investigates Viability of Wetting Agents in Battle Against ABW

Insecticide Resistance. No one understands that term better than superintendents who have spent the past several years battling ABW on their golf courses. With any turfgrass pest, there is a high risk of resistance developing when you have the following conditions:

1: The insect has a high rate of egg laying. (One ABW is capable of laying 500 eggs per sq. ft.)

2: The pest produces several generations per year. (ABW has 3-4 generations per year.)

3: The insect is subjected to repeated applications of the same insecticide or insecticide class (e.g., pyrethroids).

4: The course receives sprays based on calendar dates rather than on monitoring (not maximizing control of an ABW generation).

5: The entire course is being treated. (All insects on the course are under the selection pressure of the insecticide to develop resistance, and there are no untreated susceptible insects that can dilute the resistant insect gene pool.)

The ABW matches each of these resistance criteria. To make matters worse, this pest is subject to two types of resistance: cross resistance and multiple resistance:

1: In cross resistance, the insect becomes resistant to one pyrethroid insecticide, and since the mode of action of all of the pyrethroids is the same, the insect is also resistant to other pyrethroids, even though these products may have never been used against that particular population.

2: In multiple resistance, the insect becomes resistant to one class of insecticides (e.g., pyrethroids) and is also resistant to other classes of insecticides (e.g., neonicotinoids and anthranilic diamides), again, even if the insecticides have NEVER been used against them!

RESEARCH UPDATE: REPORT 1 (CONTINUED FROM PAGE 13)

Are Larvicides the Answer to ABW Insecticide Resistance?

primarily of 2nd- and 3rd-stage larvae (start full-bloom rhododendron), 3rd- and 4th-stage larvae (late-bloom rhododendron), and 4th- and 5th-stage larvae.

From the field experiments, the researchers noted…

» All four products seemed to remain effective when targeting slightly older larvae that seem to be primarily in the 3rd or 4th stage.

» The data suggest that Dylox may be more effective with 3rd- and 4th-stage larvae than at the start of full-bloom rhododendron.

» In general, however, the products tended to be less effective when the majority of the larvae were already in the 4th stage, i.e., about two weeks after the start of full-bloom rhododendron.

» Even in the 4th stage, Dylox provided 72-percent control, at least against the pyrethroid-susceptible population. This percentage of control would be enough to prevent significant damage on fairway turf with low to moderately high larval population densities, i.e., as many as 80 larvae per square foot on fairways.

» Provaunt and Ference applications, when timed with late-bloom rhododendron, appear to kill the larvae somewhat slower than the other products. When applied at the beginning of full-bloom rhododendron, this is not likely to play a role since damage does not typically start until more than one week later.

» When applied around late-bloom rhododendron, the time when ABW damage might start or could be impending, the slower rate of kill should be considered, particularly if higher larval densities are revealed by sampling. These data, however, need to be confirmed in 2018. ▲

For further information, you can reach Dr. Koppenhöfer at koppenhofer@aesop.rutgers.edu or Dr. McGraw at bam53@psu.edu.

Battling ABW Resistance

In greenhouse and field experiments with ABW populations from golf courses representing the full spectrum of pyrethroid-resistance (up to 343x bifenthrin resistance), Rutgers' Dr. Albrecht Koppenhöfer and Penn State's Dr. Benjamin McGraw found that:

» Against very resistant ABW populations (around 100x), only the larvicides Provaunt, Conserve, and Ference were still effective.

» Against highly resistant ABW populations (around 300x), only Conserve and Ference were still effective.

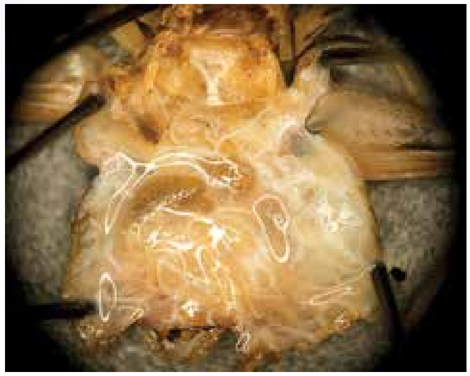
» It can be expected that overuse of any remaining effective synthetic insecticides will desensitize ABW to these compounds, as well.

URI Investigates Viability of Wetting Agents in Battle Against ABW

With the annual bluegrass weevil, we know from data compiled by Rutgers' Dr. Albrecht Koppenhöfer, and published in *Golf Course Management*, that ABW populations in some areas have developed cross *and/or* multiple resistance. This means that the arsenal to control a population of multiple-resistance ABW is very limited.

So what is the solution? Companies must continually develop insecticides with new modes of action that will be effective in putting the brakes on ABW. Until now, we have been one step ahead of the ABW, but new products are not coming down the pike as frequently as they once did.

In an attempt to aid superintendents in overcoming the mounting ABW insecticide resistance, the Tri-State Turf Research Foundation has provided ongoing support to University of Rhode Island's Dr. Steven Alm in continuing work he began in 2015 to evaluate and report on the efficacy of new controls for the ABW. At the same time, the foundation is supporting Dr. Alm and his team of researchers in their pursuit of alternate, nonchemical solutions to ABW. In 2017, the URI research team has focused a good part of their efforts on putting Silwet L-77 and other wetting agents to the test.



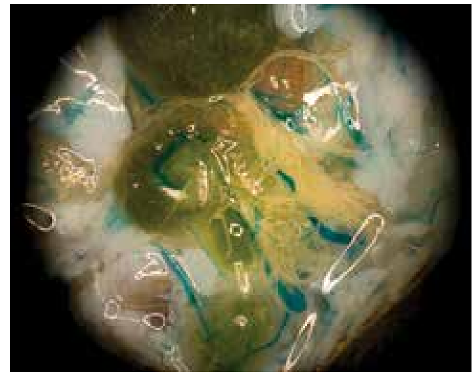


FIGURE 1

Trachea (silvery air tubes) untreated *(left)* and treated with Silwet and blue dye *(right)*.

SILWET LAB TRIALS AND OUTCOMES

To gain an understanding of Silwet's mechanism of control, the researchers tested the wetting agent on white grubs as well as crickets in the laboratory, combining the Silwet and water with a dye to determine where the product flows and precisely what the mechanism of control is.

ROLE OF CARRIER VOLUME OF WATER

The researchers were successful in killing the white grubs and crickets in a Petri dish with Silwet and water, noting that the key to control is not the Silwet, itself, but rather the carrier volume of water. The water has to be the equivalent of at least 4 gals. of water/1,000 sq. ft.

MODE OF ACTION

The researchers conducted trials to track the movement of Silwet through the treated insects to get a clearer picture of the surfactant's mode of action.

» *Figure 1 (left)* shows the silvery trachea (breathing tubes) used to bring oxygen to every cell in an untreated insect.

» *Figure 1 (right)* shows the trachea of an insect treated with Silwet and a blue dye. The trachea is filled with the blue dye, which indicates that the mode of action of the surfactants is more than likely suffocation.

WILL SILWET WORK IN THE FIELD?

The researchers are optimistic that Silwet L-77 will work in controlling ABW in the field for two reasons:

1: First, 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: Second, there are a number of different surfactants and oils that might not only work even better, but also be cheaper.

The researchers have experimented with other surfactants and oils—such as Civitas, which is already labeled for ABW—in the laboratory with similar results to Silwet L-77. The reason they have focused their efforts on Silwet L-77 is that it is one of the organosilicone surfactants 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 available.

2017 TRIALS ON NEW CHEMISTRIES

In addition to laboratory trials on Silwet and other wetting agents, Dr. Alm and his research team continued the field work they began in 2015 to evaluate the efficacy of new controls for ABW.

1: The First Field Trial conducted in 2017 evaluated three formulations: Ference, MatchPoint, and an experimental compound, A2390. On May 23, applications targeted 2nd-, 3rd-, 4th-, and 5th-instars with the following outcome:

» Ference, which is systemic, provided 81 percent control.

» MatchPoint provided 33 percent control, a surprise to the researchers since they had achieved excellent control with MatchPoint in 2016.

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Penn State Researchers Seek Just-the-Right Formula for Prepping Greens for Tournament Play

Putting greens are considered the most critical playing surface on the golf course. It's on the putting green, after all, that a large percentage of a player's strokes are taken. As a result, green speed and ball roll have become a top priority for golf course superintendents—and the many golfers who ask more often about green speed than they do about any other golf course condition.

In the past, research involving green speed and ball roll distance has been limited to examining *individual* cultural practices rather than focusing on a *specific set* of cultural practices that will produce a reasonable green speed and ball roll while lowering the stress caused to the turfgrass.

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.

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. At the same time, it would be helpful to understand the law of diminishing returns on these practices on increasing green speed at the expense of plant health.

Having completed their last year of a three-year study funded by the Tri-State Turf Research Foundation, Pennsylvania State University's Dr. John Kaminski and graduate research assistant Timothy Lulis are moving closer to developing the ideal formula for prepping greens for tournament play. Their objectives for the research have been 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 are working to identify ways to maximize tournament conditions without adding additional negative stress to plant health from practices that are not resulting in playability improvements.

COMMON PRACTICES TO ACHIEVE GREEN SPEED

In 2015, before initiating their field studies, Dr. Kaminski and Timothy Lulis investigated the influence of changes in mowing and cultural practices on green speed and plant health during golf course tournament preparations.

Two of the most commonly used practices to achieve faster green speeds leading up to the start of a tournament are:

» 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 *(Figure 1)*.

» 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 *(Figure 1)*. 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?

THREE YEARS OF TRIALS

To explore these practices, the researchers conducted three field trials in 2015 and two more in 2016 and 2017, each on putting greens established with a different turfgrass species at the Valentine Turfgrass Research Facility located in University Park, PA.

Results from the first year of the mowing height and frequency studies revealed a potential influence of mowing patterns on green speed. This prompted Dr. Kaminski and Timothy Lulis to examine in both

Penn State Researchers Seek Just-the-Right Formula for Prepping Greens for Tournament Play

their 2016 and 2017 trials how ball roll might be further influenced by:

» Mowing pattern & cultural practices

» Mowing frequency & brushing

The data that follows is from the researchers' work in 2016. Data from 2017 are still being analyzed.

MOWING PATTERN & CULTURAL PRACTICES

In 2016, 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 approximately 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.

» Height of cut for all treatments was 0.100".

ANALYZING MOWING PATTERN

To determine the effect of mowing patterns, individual plots were mowed according to the following schedule *(Figure 2)*:

» 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.

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

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

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 2 x 4 factorial in a randomized complete block design with three replications.

» Main effects consisted of four brushing treatments and two 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.

(continued on page 18)

Ball Roll Distance on a Creeping Bentgrass Putting Green

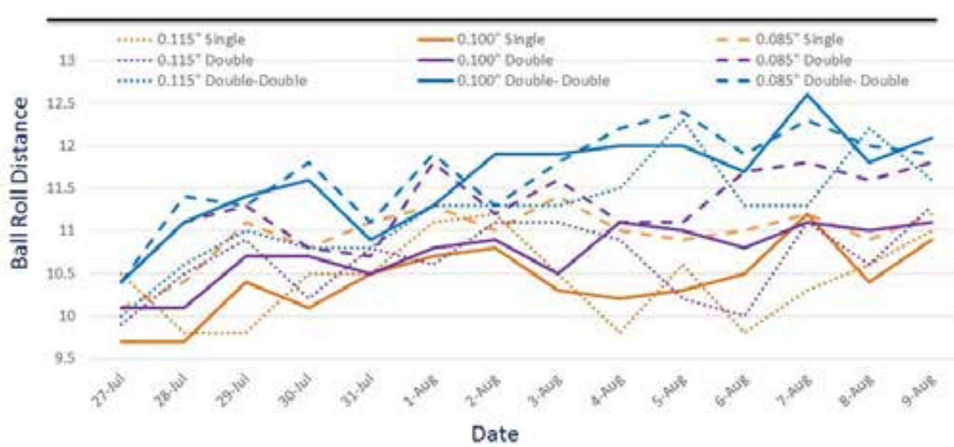

FIGURE 1

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.

Penn State Researchers Seek Just-the-Right Formula for Prepping Greens for Tournament Play

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.

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

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

ANALYZING BRUSHING

Brushing treatments included *(Figure 3)*:

» 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 & 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 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:

» 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 OBSERVATIONS

Data from the *mowing pattern & cultural practices* and *mowing frequency & brushing* experiments in 2017 are currently being analyzed. Analysis of the 2016 data reveals the following:

ABOUT MOWING PATTERN & CULTURAL PRACTICES

There was a significant difference in ball roll distance on five of twelve rating dates *(Figure 2)*. On those rating dates:

» Plots mowed with either a double cut or crosscut consistently had among the greatest ball roll distance.

» Plots mowed with a single cut were consistently among the plots with the lowest ball roll distance.

MORNING BALL ROLL DISTANCE IN 2016 AS AFFECTED BY MOWING PATTERN ON A CREEPING BENTGRASS PUTTING GREEN

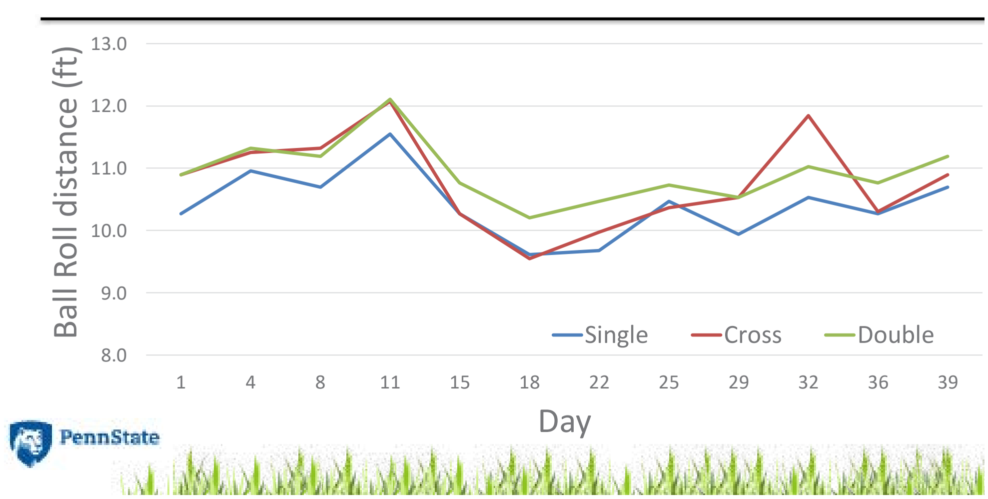

FIGURE 2

Penn State Researchers Seek Just-the-Right Formula for Prepping Greens for Tournament Play

» Nitrogen and PGR produced few significant differences on any rating dates. This data suggests that spoon-feeding fertility programs and growth regulator management have little effect on ball roll distance.

ABOUT MOWING FREQUENCY & BRUSHING

Out of 12 rating dates, nine dates had significant differences in ball roll distance *(Figure 3)*. On all nine dates that were statistically significant, plots mowed with:

» No brush & double cut had among the greatest ball roll distance.

» Soft brush & double cut OR no brush & single cut had among the greatest ball roll distance on five and four of the statistically significant rating dates, respectively.

» Stiff brush & single cut had the lowest ball roll distance on nine of nine statistically significant rating dates.

» Rotary brush & single cut OR stiff brush & double cut had among the lowest ball roll distance on five and four statistically significant rating dates, respectively.

IN SUMMARY

The researchers have concluded the following after analyzing the 2016 data:

» Nitrogen and PGRs had virtually no effect on ball roll distance.

» Brushing programs actually reduced ball roll distance with the stiffest brush causing the largest reduction in speed.

» Mowing patterns created only minor differences in ball roll distance.

» As demonstrated in previous data, increasing mowing frequency will increase ball roll distance.

Next year, Dr. Kaminski and his research team will present a comprehensive data analysis summing up all the parameters of this study. ▲

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

Morning Ball Roll Distance in 2016 as Affected by Brush on a Creeping Bentgrass Putting Green

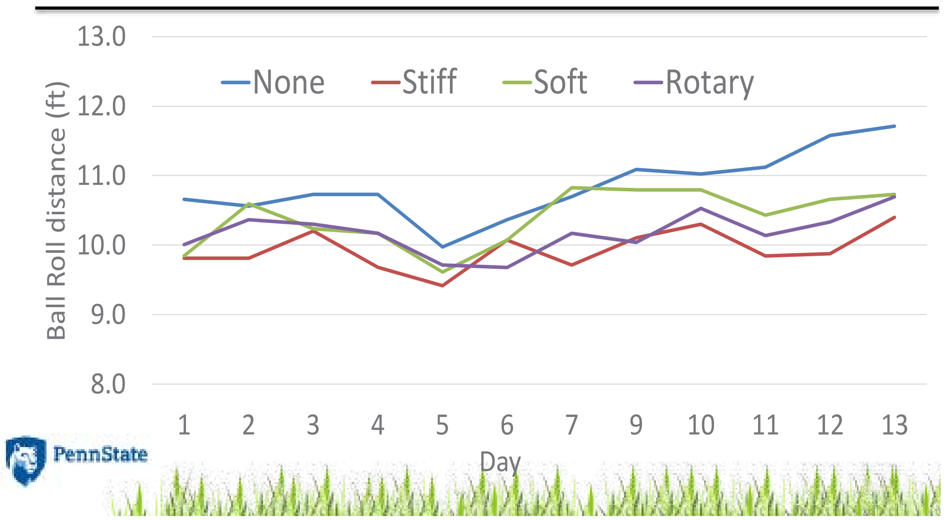

FIGURE 3

Research: An Investment in Our Future

to apply them. For the cost of treating fewer than nine greens one time with plant protectants, you could support research for a year that has the potential to reduce or even eliminate your need to make that application. But without your help in funding this kind of research, we will never know.

As the science of golf course management becomes increasingly complex and environmental concerns and additional government restrictions and controls seem inevitable, the value of the Tri-State's work becomes all the more apparent—and imperative.

So please help us help you! Add your name to the list of fellow contributors with your $250 donation. There is no more valuable way to contribute to your future success as a turfgrass manager.

If you do not have a contribution invoice, please feel free to contact Susan O'Dowd at MGA Headquarters. She would be happy to send you one.

A JOB WELL DONE

In closing, I would like to thank Tony Girardi for the time and effort he devoted as president to furthering the foundation's mission of building better golf and a safer environment through turfgrass research. Special thanks, also, to longtime board members Matt Ceplo and Les Kennedy, who have completed their terms on the board. Their wisdom, vision, and energy will be hard to replace.

As the new president, I look forward to furthering the foundation's many worthwhile efforts and endeavors, and with your support, I know that's possible.

Tim Garceau, President
Tri-State Turf Research Foundation

URI Investigates Viability of Wetting Agents in Battle Against ABW

» An experimental compound, A2390, provided 65 percent control *(Figure 2)*.

2: The Second Field Trial conducted in 2017 tested a numbered compound, which the researchers report performed quite well. Though the company is not ready to release the product information yet, there is at least one promising new product in the pipeline for ABW control.

3: The Third Field Trial was conducted with Silwet: 16 treatments were replicated 6 times, equaling 96 treated plots. Unfortunately, these plots did not develop enough ABW pressure to show any statistical differences, a disappointing outcome given the effort put into conducting this trial.

PLANS FOR 2018

In 2018, Dr. Alm and his research team will work to:

» Determine the correct concentration of surfactant and water and how long that concentration needs to be maintained in the crown/thatch zone to cause mortality of ABW in the field.

» Find the rate of Silwet that offers optimal control while avoiding phytotoxicity, which proved a problem in 2016 when Silwet was applied at higher rates, e.g., 9 fl. ozs.

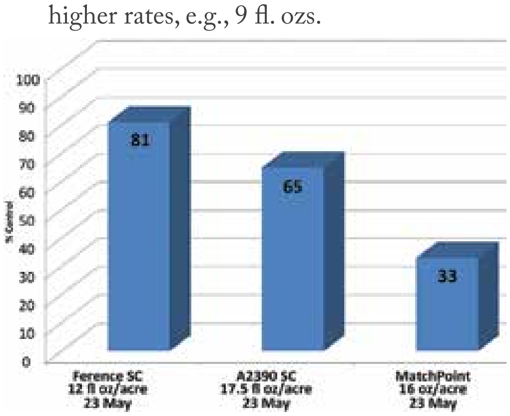

FIGURE 2

Ference, A2390, and MatchPoint applied May 23, 2017 for control of first-generation larvae. Rated June 5, 2017.

» Check soil moisture levels using Time Domain Reflectometry (TDR). TDR measures water content of soil by measuring the conductivity between two metal probes.

» Include Civitas (88.8 percent mineral oil), which is currently labeled for ABW, in further trials.

If anyone with a "good" ABW population would be willing to have Silwet and Civitas trials conducted on their course, please be sure to contact Dr. Alm at stevealm@uri.edu. ▲

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

Why Is ABW so Difficult to Manage?

The answer is fecundity. The ABW, compared to other insects, has a tremendously high rate of fecundity or egg laying capacity. The pest can lay 500 eggs per square foot, which means that even if you achieve 80 percent control on one square foot of turf, you are killing 400 larvae with a sizable 100 larvae per square foot left. Each of those 100 larvae can kill 12 *Poa* plants. That means 1,200 plants per square foot would die, and if you have only 1,200 plants in that square foot, you are going to end up with a patch of bare ground!

By contrast, researchers testing insecticides on white grubs and other insects (larvae of Japanese and oriental beetles, European and Northern masked chafers, etc.) have been happy to get 70 percent control of white grubs. But with thresholds of just 8 grubs per square foot, 70 percent control (kill of 6 grubs) was acceptable.

The rub? The ABW remains one of the most persistent and troublesome turfgrass pests plaguing golf course turf.

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