FOUNDATION NEWS

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PRESIDENT'S MESSAGE

Tri-State Continues Commitment to Supporting Area Supers With All-New Research, Member Survey, and Website

Tim Garceau, President
Tri-State Turf Research Foundation

Some things never change. The Tri-State Turf Research Foundation's mission is one of them. After 29 years, the foundation still holds true to its vision of "building better golf and a safer environment through turfgrass research." And its success has been undeniable.

Why? Because the foundation is, and always has been, committed to identifying and funding research projects pertinent to the needs of tri-state-area superintendents.

INSIDE THIS ISSUE

Directing the foundation's activities is our Board of Directors, which is made up of three representatives from each of six affiliated associations: the MetGCSA, New Jersey GCSA, Connecticut AGCS, Long Island GCSA, Hudson Valley GCSA, and the MGA. Take a look at the back page of this issue of *Foundation News,* and you will see the representatives from your association. It's these reps who determine which research is most beneficial.

The selection process is rigorous. Study proposals are reviewed and then voted on once a year at the foundation's Annual Meeting. Foundation board members realize that there is little to no margin for error in course management today, particularly with many courses tightening their belts as they attempt to build up membership and golfer participation despite weather extremes that can render the course unplayable. Superintendents cannot afford to hunt and peck for solutions. They need solid answers based on solid research.

As most area superintendents know, the foundation draws the research it funds from top universities right here in the Northeast: Cornell, Rutgers, University of Connecticut, University of Massachusetts, University of Rhode Island, and Penn State. And the results of that research have helped area superintendents battle numerous, often deadly, turfgrass diseases and pests over the years—summer patch, anthracnose, and the annual bluegrass weevil to name a few.

RESEARCH TO THE RESCUE

As you read through this issue, you will see that we are continuing our ongoing commitment to supporting research pertinent to area superintendents by funding two new studies this year:

1: Drs. James Murphy and Bingru Huang from Rutgers University will be conducting a three-year study to evaluate plant-health products' effectiveness in controlling summer decline of annual bluegrass, a perennial problem for the many golf courses with predominantly *Poa* turf.

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Rutgers Researchers Close in on Best Management Practices for Dollar Spot Control

Dollar spot disease, caused by the fungus *Clarireedia jacksonii* Salgado, Beirn, Clarke and Crouch sp. nov. (previously known as *Sclerotinia homoeocarpa* F.T. Bennett) on cool-season turf, continues to plague golf course turf around 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 final year of funding from the Tri-State Turf Research Foundation, Rutgers' Dr. Bruce Clarke, Dr. James Murphy, and graduate student James Hempfling worked to summarize the data from their three years of research, which focused on uncovering best management practices (BMPs) for the control of dollar spot disease on fairway turf.

Starting in 2015, 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.

Over the course of their three-year study, the researchers saw a notable improvement in the newer bentgrass cultivars' ability to resist dollar spot. That, combined with the use of weather-based models to predict the disease, did allow for opportunities to more efficiently manage dollar spot on golf courses. However, the extent to which the cultivar's susceptibility affects fungicide inputs or the performance of the disease predictive models, calls for further investigation.

Here is a look at how their two trials unfolded during the last year of their study, which concluded in 2017.

TRIAL 1: EXAMINING PREDICTORS OF DISEASE DEVELOPMENT

In the first trial, the researchers had 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

From 2015 through 2017, the researchers evaluated disease incidence on six bentgrass cultivars *(Figure 1),* ranging from high to low susceptibility to dollar spot. These cultivars were:

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 also assessed two weather-based models for predicting dollar spot epidemics on those cultivars and species. The models:

- » **Growing Degree Day (GDD) Model** *developed by Ryan et al. (2012) to predict the first occurrence of dollar spot symptoms in the spring.* This model uses a base air temperature of 15° C (59° F) and a start date of April 1.
- » **Logistic Regression Model** *developed by Smith et al. (2018) 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.

QUANTIFYING DOLLAR SPOT EPIDEMICS

Five trial runs (five blocks each) were used to quantify dollar spot epidemics through each growing season, April to November *(Figure 2).* The use of multiple trial runs enabled monitoring of disease progress through most of each season.

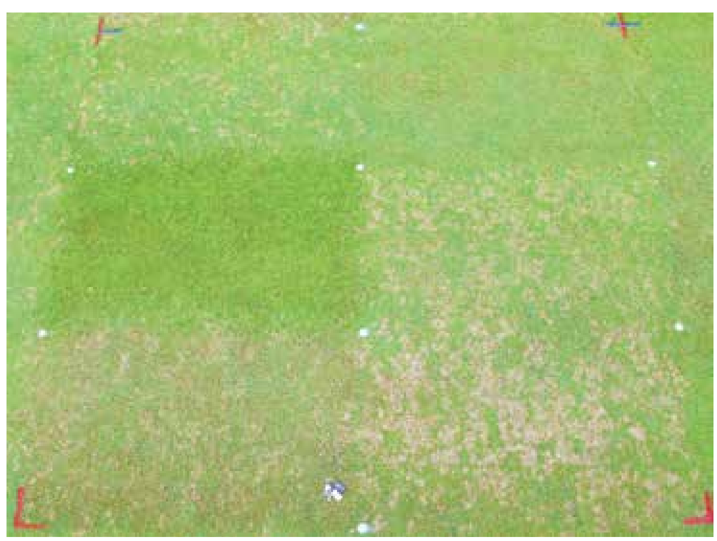

FIGURE 1
Bentgrass cultivars vary in tolerance to dollar spot (clockwise from top left): 007, Declaration, Shark, Independence, Penncross and Capri.
Photo by J. Hempfling

Rutgers Researchers Close in on Best Management Practices for Dollar Spot Control

» When determining a cultivar's response to disease, the researchers looked at both disease *counts* and *diameter*, which were summarized as the Area Under the Disease Progress Curve (AUDPC).

» When it came to *infection center counts*, the cultivars that proved most to least susceptible to dollar spot were Independence, Penncross, Shark, and 007, with Declaration and Capri on par with the lowest susceptibility ranking.

» When evaluating the AUDPC of *infection center diameter*, the cultivars with the greatest to smallest diameters were Penncross, Independence, Shark, and 007, with Declaration and Capri again ranked similarly, having the smallest diameters.

TRIAL 1 OUTCOMES

» The *onset of disease symptoms in low-susceptibility cultivars* was delayed by 4 to 27 days.

» Regarding prediction of disease onset, the 20-percent risk index for the Logistic Regression Model was reached before disease onset; however, the time between each event varied between years. The researchers will further assess the Logistic Regression Model's ability to predict disease onset in spring. The GDD Model was not reliable at predicting disease onset.

» *Forecasting disease during the middle of the growing season* with the Logistic Regression Model was reasonably accurate on highly susceptible cultivars.

» Forecasting disease progress on less-susceptible cultivars also appeared possible with the Logistic Regression Model. To improve prediction accuracy, however, the researchers felt it might help to have a greater risk index and/or take into account the change of the risk index over time.

» *Recovery from disease* was often observed when the risk index declined, although not lower than the 20-percent risk index currently recommended for triggering a fungicide application.

The researchers are continuing further analysis of the Logistic Regression Model and disease progress data.

(continued on page 4)

FIGURE 2
The study was duplicated in five runs that were released from (left) or maintained under (right) fungicide control to facilitate season-long evaluation of dollar spot epiphytotics.

SIDEBAR

Dollar Spot Study Outcomes at a Glance

Interpretation of the Logistic Regression Model relative to disease progress is ongoing. What follows are preliminary observations worthy of reporting:

» Dollar spot forecasting with a Logistic Regression Model had good accuracy during the middle of the growing season for *highly susceptible cultivars* during 2015, 2016, and 2017.

» Disease forecasting on *low-susceptibility cultivars* may also be possible using the Logistic Regression Model; however, a greater risk index and/or an assessment of the change of the risk index over time may be needed to improve model accuracy.

» 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.

» Threshold-based fungicide applications on Declaration *(low susceptibility)* creeping bentgrass produced excellent disease control and required only one to five fungicide applications depending on the year and initial fungicide timing.

» In contrast, threshold-based fungicide applications on Independence *(highly susceptible)* creeping bentgrass produced moderate disease control and required four to nine applications depending on the year and initial fungicide timing.

Rutgers Researchers Close in on Best Management Practices for Dollar Spot Control

TRIAL 2: DETERMINING APPLICATION TIMING

In the second trial, the researchers continued to:

1: *Evaluate the effect of presymptomatic (initial) fungicide application timing on dollar spot incidence and disease progression on two bentgrass cultivars with low or high susceptibility to dollar spot.*

2: *Determine the extent to which the timing of initial fungicide applications may affect total fungicide use on each 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 *(model-based)*

» 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 two subsequent fungicide timings on the Logistic Regression Model or a disease threshold (>1 standard-size infection center per plot) to assess long-term effects of initial fungicide timings.

QUANTIFYING FUNGICIDE APPLICATIONS

The number of fungicide applications made varied, depending on the type of bentgrass cultivar, the disease threshold, and the Logistic Regression Model's disease risk assessment.

» One to five *threshold-based* applications were made on the *low-susceptibility cultivar* (Declaration), while four to nine threshold-based applications were made on the *high-susceptibility cultivar* (Independence) *(Table 3)*. The number of applications varied with the year and initial timing of the fungicide application.

» Using the *model-based timing*, six to nine applications were made on the *low-susceptibility cultivar* and seven to ten sprays were made on the highly susceptible cultivar. The number of applications varied with the year and initial timing of the fungicide application.

» Nine applications were made per year for the *calendar-based* program.

TRIAL 2 OUTCOMES

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

» Initial fungicide timing had no effect on season-long AUDPC during any trial year.

» Differences in disease control during disease onset were small and short-lived among initial timings.

» Threshold- or calendar-based initial timings provided adequate disease control with one to three fewer annual applications of fungicides compared to earlier initial timings (data not shown).

» Initial fungicide timings made between 2 and 24 days before disease onset produced better disease control during the first outbreak compared to timings that were made more than 24 days before, less than two days before, or after disease onset.

	DECLARATION			INDEPENDENCE		
	2015	2016	2017	2015	2016	2017
	Total Number of Fungicide Applications†					
CALENDAR	9	9	9	9	9	9
LOGISTIC MODEL	8 to 9	7 to 8	6 to 9	8 to 9	7 to 8	8 to 10
THRESHOLD	3	1	4 to 5	6 to 7	4 to 5	6 to 9

TABLE 3

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

Rutgers Researchers Close in on Best Management Practices for Dollar Spot Control

» The type of bentgrass cultivar, subsequent fungicide timing, and the interaction of these two factors explained the majority of the variance in season-long disease activity (AUDPC) during the three years of the study.

» Excellent disease control was achieved on the *low-susceptibility cultivar* (Declaration) with little or no difference between model- and threshold-based subsequent fungicide timings.

» By contrast, only the model-based subsequent fungicide applications were consistently effective in controlling disease on the *high-susceptibility cultivar* (Independence) *(Table 4)*.

» Threshold-based fungicide applications on the high-susceptibility cultivar had a greater number of days with unacceptable disease control than the threshold-based program with the *low-susceptibility cultivar*.

CONCLUSION

The research confirmed that:

» Fungicide inputs are needed for all bentgrass cultivars, but the total number of applications varies with the cultivar's susceptibility to dollar spot.

» The weather-based Logistic Regression Model reduces fungicide inputs but to a lesser extent than the cultivar-susceptibility factor.

» The study evaluated only the extremes in cultivar susceptibility. Assessment of cultivars with intermediate susceptibility is needed to provide golf course superintendents with the most effective and economical recommendations for control options.

» Threshold-based applications on a *low-susceptibility cultivar* can produce excellent disease control and a large savings in fungicide inputs.

» Logistic Regression Model-based or calendar-based applications were required for good disease control on a *high-susceptibility cultivar*, with model-based applications providing a modest savings in fungicide inputs. ▲

For further information, you can reach Dr. Murphy at Jamurphy@Rutgers.edu or Dr. Clarke at Bruce.Clarke@Rutgers.edu.

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CULTIVAR	SUBSEQUENT FUNGICIDE TIMING	2015 SEASON LONG	2016 SEASON LONG
	AUDPC†		
Declaration	Logistic	3.2 a††	0.3 a
Independence	Threshold	34.3 b	3.2 a
Declaration	Logistic	35.6 b	21.2 a
Independence	Threshold	127.5 c	161.7 b

TABLE 4

Interaction means for the area under the disease progress curve (AUDPC) response to cultivar and subsequent fungicide application timing on creeping bentgrass fairway turf in North Brunswick, NJ during 2015 and 2016.

† The area under the disease progress curve for the observation dates of 19 May to 25 Nov. 2015 (*n*=47) and 14 May to 23 Nov. 2016 (*n*=43).

†† Within columns, means followed by the same letter are not significantly different according to $LSD_{(0.05)}$

Rutgers Researchers Pinpoint Plant Health Products' Role in Reducing Irrigation Requirements for Fairway Turf

Superintendents are all too familiar with the damaging effects that drought due to lack of rainfall or reduced irrigation can have on the health and welfare of their creeping bentgrass fairways.

As temperatures rise from spring to summer, drought stress becomes increasingly problematic, causing decreases in leaf-water relations, membrane stability, and aesthetic qualities. Because of this and the increasing interest in water conservation, particularly with water-use restrictions always looming, it became all the more clear that finding a viable method for reducing fairway turf irrigation inputs was essential.

With their final year of funding from the Tri-State Turf Research Foundation, Rutgers' Dr. Bingru Huang and Ph.D. graduate student Cathryn Chapman continued their research to find a viable solution to this enduring problem. They have worked to evaluate the effectiveness of different 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. The products tested included both commercial and experimental plant growth regulators and fungicides, and each has been evaluated under different levels of deficit irrigation to determine the amount of water savings associated with their use. In addition, the study examined the ability of these plant-health products to aid post-drought recovery once fairways were rewatered to field capacity.

In 2018, Dr. Huang and Chapman conducted two trials: one in spring/summer, from May to July, and a second in the fall, from September to November. This study was a follow-up to their 2017 spring/summer and fall trials.

What follows is a brief recap of the researchers' work, along with the 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 and located at Rutgers Horticultural Farm II in New Brunswick, NJ. Use of a rainout shelter eliminated any unwanted rain events during the deficit irrigation.

» The experiment was conducted from May 15 to July 16, 2018. Specifically, the pre-stress period lasted from May 15 to May 28; the water deficit period lasted from May 29 to June 25; and the post-drought recovery period lasted from June 26 to July 16.

» The turf site was managed following typical practices of fertility and pest management for fairways in the New Jersey area during the growing season.

» The plots were maintained under well-irrigated conditions prior to plant-health product application and initiation of deficit irrigation.

» Plots were mowed twice a 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 to evapotranspiration (ET).

2: Deficit irrigation: Plots were irrigated to replace 60 percent of the water lost to 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 rewatered by irrigating to achieve full soil capacity.

» Three chemical treatments were evaluated, including Signature XTRA Stressgard, fungicides containing acibenzolar, and water as the untreated control.

» Each chemical treatment was applied on May 15 (two weeks prior to the initiation of the different irrigation treatments) and then every 14 days throughout the water deficit period and during post-drought recovery.

ENVIRONMENTAL MONITORING

Lysimeters (91.79 in2) were installed in each treatment plot to estimate water loss due to evapotranspiration (ET) over a 24-hour period.

» Twice per week, the calculated irrigation amounts were applied to replace either 100 percent or 60 percent of the water loss beginning on June 1, and continued weekly for the duration of the water deficit period.

» On June 26, all plots were re-irrigated and watered regularly to field capacity to assess post-drought recovery for 21 days.

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Special Thanks to Our 2018 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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Rutgers Researchers Pinpoint Plant Health Products' Role in Reducing Irrigation Requirements for Fairway Turf

PHYSIOLOGICAL ANALYSIS

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

1: Visual Turf quality
Turf quality (TQ) was visually rated on a scale of 1 to 9. 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.

2: Leaf Hydration
In addition to visual turf quality ratings, leaf hydration was measured during the water-deficit and recovery periods by evaluating the leaf relative water content (RWC).

3: Turf Canopy Measurements
Turf canopy measurements were also taken by using a handheld multispectral radiometer (MSR). In simple terms, the researchers used the MSR to determine variances in plant color, which are generally indicative of turf health.

TRIAL 1 OBSERVATIONS

On Visual Turf Quality

» Visual turf quality ratings for Signature XTRA Stressgard were generally higher than the untreated control throughout water deficit and drought stress and even had significant differences on select sampling dates for both irrigation regimens.

» TQ ratings were similar during the drought recovery period. However, during post-drought stress recovery, where water was completely withheld, ratings for the Signature XTRA Stressgard were consistently higher than the untreated control.

» The acibenzolar product performed higher than the untreated control on some select dates during water deficit and toward the end of drought stress, but it was similar to the untreated control for both 60 percent ET replacement and drought stress, as well as during post-drought rewatering after deficit irrigation or completely withholding water.

» TQ ratings, however, were consistently higher under the recovery period for both irrigation regimens compared to the untreated control.

On Leaf Hydration

» Under both deficit irrigation and drought stress, relative water content (RWC) values across all treatments declined, although to a much greater extent under the severe drought stress in comparison to the moderate water deficit.

» There were no significant differences among the treatments; although RWC values for Signature XTRA Stressgard and the acibenzolar product were higher than the untreated control on select sampling dates during drought stress.

» The similarity in RWC values under 60 percent ET replacement may indicate that plant-water relations were maintained to the same extent across all treatments, which was also shown by the ability to recover to pre-stress levels upon rewatering.

ON TURF CANOPY MEASUREMENTS

» The normalized difference vegetation index (NDVI) data, an indicator of green canopy density, corresponded well with TQ data, showing significant differences during both 60 percent ET replacement and drought stress for Signature XTRA Stressgard, and under 60 percent ET replacement for the acibenzolar product in comparison to the untreated control on select sampling dates.

» In addition, both chemical treatments performed consistently better than the untreated control during post-drought rewatering, with significant differences noted for the Signature XTRA Stressgard treatment across all sampling dates during recovery.

TRIAL 2: FALL

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

FIELD CONDITIONS

The fall trial continued with the creeping bentgrass (*Agrostis stolonifera* cv. L-93) field plots that were established in the spring/summer trial, and the same rainout shelter was used to eliminate unwanted rain events.

» The experiment was conducted from September 4 to November 1, 2018. Specifically, the pre-stress period lasted from September 4 to September 17, the water deficit period from September 18 to October 18, and the post-drought recovery period from October 19 to November 1.

» The turf site was managed in a manner similar to the spring/summer trial.

CHEMICAL TREATMENTS AND EXPERIMENTAL DESIGN

In the second trial, the turf plots were subjected to only two irrigation treatments:

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

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

(continued on page 10)

Rutgers Researchers Pinpoint Plant Health Products' Role in Reducing Irrigation Requirements for Fairway Turf

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

» After approximately 31 days of irrigation treatments, plots previously exposed to moderate drought stress were rewatered by irrigating to achieve full soil capacity.

» Each chemical treatment was applied on September 4, two weeks prior to the initiation of the different irrigation treatments as described for the spring/summer trial. Treatments were then applied approximately every 14 days throughout the water deficit and post-drought recovery periods.

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 were higher for Signature XTRA Stressgard compared to the untreated control for most sampling dates during water deficit (60 percent ET replacement) and rewatering, with significant differences seen during the rewatering/recovery period.

» The acibenzolar product performed similarly to the untreated control during 60 percent ET replacement, but it consistently exhibited higher turf quality ratings during the rewatering/recovery period.

On Leaf Hydration

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

» There were select sampling dates, however, where the treatments had higher RWC levels, specifically during the recovery period.

On Turf Canopy Measurements

» NDVI data corresponded well with the trend that was seen for TQ. Although during the water deficit period the chemical treatments performed similarly to the untreated control, both Signature XTRA Stressgard and the acibenzolar product had significantly higher NDVI values during the recovery period compared to the untreated control.

TRIAL 1 AND 2 CONCLUSIONS

» Overall, both Signature XTRA Stressgard and the acibenzolar product seemed to improve drought stress tolerance due to either a severe (complete water withholding during the spring/summer 2018 trial) or a moderate (60 percent ET replacement) drought stress during both trials.

» The spring/summer 2018 trial showed that both chemical treatments were most effective in promoting severe drought stress tolerance and post-drought recovery, as indicated by greater TQ and NDVI values compared to the untreated control. This was also observed in the 2017 study, which may indicate that such chemical treatments can provide much-needed aid in long-term drought stress survival and recovery.

» The positive effects on the physiological parameters that were analyzed in 2018 were consistent to findings from the 2017 trial. Although in 2017, during the 60 percent ET replacement, more significant and pronounced differences were seen in the turf treated with both Signature XTRA Stressgard and the acibenzolar product than in the untreated control.

» Similar positive effects of chemical treatments were observed with 60 percent ET replacement and rewatering during the recovery period in the fall 2018 trial. Specifically, both chemical treatments were more effective than the untreated control, showing greater or more rapid recovery in turf quality, relative water content, and canopy health. This was consistent with the results from the fall 2017 trial for both Signature XTRA Stressgard and the acibenzolar product

» Additionally, under the moderate level of drought stress, chemical treatments compared to the untreated control were able to tolerate these levels of deficit irrigation while still maintaining aesthetic and physiological qualities. In both the spring/summer and fall trials in 2017 and 2018, the chemical treatments were also successful in returning the turf plots to pre-stress levels during recovery in terms of turf quality, relative water content, and canopy health.

FINAL TAKEAWAY

The findings in this study indicate that these plant-health products influence water use and conservation during periods of limited water availability due to lack of rainfall. In addition, the use of these products can aid in promoting more rapid post-drought recovery when normal watering conditions are restored.▲

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

New Research Targets Summer Decline on Annual Bluegrass Greens

Poa annua it seems, is here to stay… particularly on putting greens, where it has become a dominant grass on many golf courses. Various measures have been taken to control *Poa* as a weed, including application of plant growth regulators, herbicides, and fumigants, but we have come to realize that complete eradication of this grass species is difficult at best.

One of the major limitations of growing *Poa* is summer decline in turf quality and root growth due to its poor heat tolerance. Management strategies that enhance *Poa* tolerance to heat stress will greatly benefit superintendents who choose to use *Poa* as a desirable turfgrass or who maintain *Poa*/Bentgrass greens.

In recent years, there has been increased interest throughout the golf course management industry in the use of plant-health products that protect turfgrass from stress damages, including various formulations of plant growth regulators (PGRs), biostimulants, and stress protectants, as well as newly developed fungicide products with value-added plant-health benefits.

Many golf courses use plant-health products on a regular basis, particularly on creeping bentgrass putting greens, to combat summer stress. There is increasing evidence supporting the positive effects of foliar applications of PGRs, biostimulants, and fungicides in promoting turfgrass abiotic stress tolerance in various turfgrass species. However, the physiological mechanisms controlling *Poa* summer decline and effective plant health products for promoting *Poa* stress tolerance are not well documented.

In hope of uncovering an effective method for controlling *Poa* summer decline, the Tri-State Turfgrass Research Foundation has granted Rutgers University's Dr. Bingru Huang and Dr. James Murphy funding for a three-year study that will delve into the physiological factors associated with *Poa* summer decline and the potential of plant-health products and application rates required to enhance *Poa* tolerance to heat stress.

THE OBJECTIVES

More specifically, during the course of their trials, the researchers will:

1: Determine physiological factors associated with *Poa* responses to heat stress and summer decline.

2: Identify effective plant-health products and application rates for controlling *Poa* summer decline or improving heat tolerance.

3: Test the effectiveness of plant-health products for promoting summer performance of annual bluegrass on putting green conditions.

EXPERIMENTAL PLAN QUICK TAKE

The project consists of three experiments:

1: Controlled-environment trial (CET): This trial will provide information on physiological mechanisms and will screen different plant-health products for their effectiveness in promoting heat tolerance in *Poa*.

2: Farm field trials: The products and rates identified as most effective in the CET will be tested on *Poa* plots managed as putting greens at Rutgers research farm.

3: Golf course trials: The same products and rates will be tested next on *Poa*/Bent mixture greens at a golf course to determine the real-world effectiveness of those products.

Dr. Huang and Dr. Murphy are beginning their research by analyzing *Poa* sod planted in pots and filled with sand, simulating sand-based putting greens. They will subject the sod to heat stress and a series of plant-health product treatments, including biostiumlants, plant growth regulators, and fungicides claimed to have plant health benefits. The chemical treatments will be compared to the untreated control with equivalent amounts of water or nitrogen.

The researchers will then conduct a physiological analysis of the *Poa's* heat tolerance. At the conclusion of the study's first year, the researchers will identify the products that show the most promise in the control of *Poa* summer decline and bring those products out into the field for further testing in years two and three of the study. The study will conclude in 2021.▲

For further information, you can reach Dr. Bingru Huang at huang@sebs.rutgers.edu or Dr. James Murphy at Jamurphy@NJAES.Rutgers.edu.

New Study to Investigate Manganese as Viable Summer Patch Control

University of Connecticut Researchers Put Manganese Fertilizers to the Test

Summer patch, caused by *Magnaporthiopsis poae*, is a serious disease affecting Kentucky bluegrass, annual bluegrass, and fine fescues on golf course turf areas that range from fairways to putting greens. A fair amount is known about the environmental factors that predispose turfgrasses to summer patch and cultural practices that can help minimize the disease. However, summer patch continues to be problematic for superintendents throughout the Northeast.

At sites where the disease is a perennial challenge, a combination of cultural and chemical controls are often required to maintain acceptable control. Where fungicides are used, three to four preventive applications at high label rates are typically recommended.

This type of fungicide use, however, may not be practical, particularly where large acreages make the cost prohibitive, or where pesticide use is restricted under state or municipal law. Moreover, fungicides may fail to control summer patch when appropriate cultural practices are not implemented and when environmental conditions favoring disease are optimal.

In an attempt to find a reliable and cost-effective method for controlling this devastating disease, the Tri-State Turf Research Foundation has granted the University of Connecticut's Dr. John Inguagiato and Dr. Thomas Morris funding for a two-year investigation of manganese's role in controlling summer patch on Kentucky bluegrass turf.

According to the researchers, manganese (Mn) has already proved effective in suppressing take-all patch in turfgrass. Manganese, after all, is used by plants in the production of lignin and phenolics, which are compounds synthesized by the plant to produce physical and chemical barriers to resist fungal infections. Preliminary field studies have indicated that manganese shows promise in suppressing summer patch as well *(Figure 1)*. Data from these early studies, however, do not adequately address interactions that exist between soil types, soil pH, and their influence on soil-available Mn.

More research is needed, therefore, to determine optimal rates of Mn fertilization to suppress summer patch in turfgrass. It is likely that Mn requirements will vary based on soil organic matter content and soil pH. During their study, the researchers intend to identify optimal Mn application rates to suppress summer patch on different soils amended to acidic or basic pH.

Moreover, the researchers plan to establish critical Mn values to manage summer patch based on a soil Mn availability index for Kentucky bluegrass turf. This index has already been used to predict the likelihood that Mn fertilization will suppress take-all patch disease on bentgrass.

THE OBJECTIVES

More specifically, during the course of the study, the researchers will:

1: Evaluate the effect of Mn fertilization on the severity of summer patch.

2: Identify optimal Mn fertilization rates for suppression of summer patch.

3: Characterize how optimal Mn fertilization rate varies across soil type and pH for summer patch suppression.

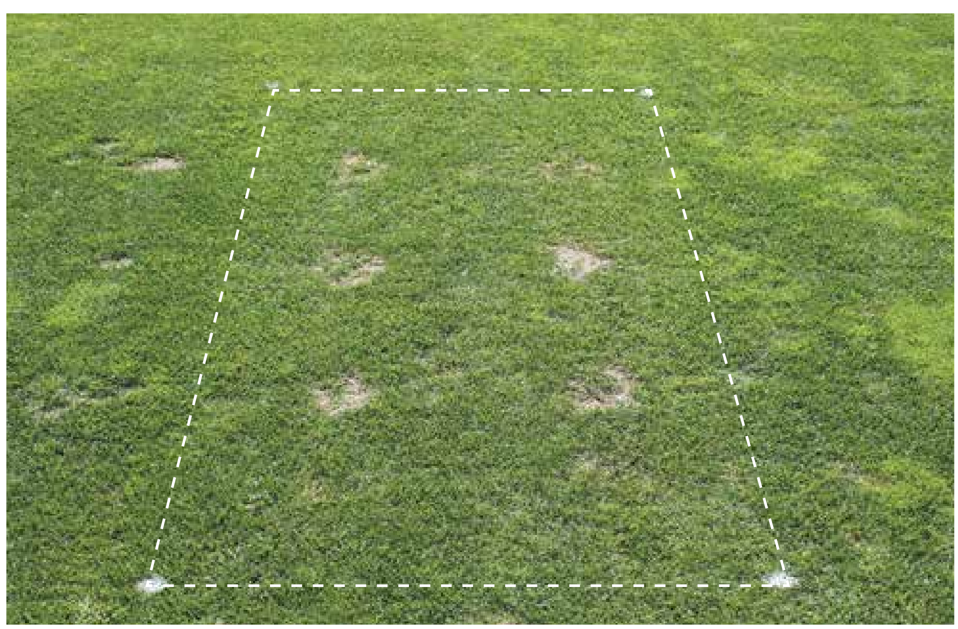
4: Determine a critical value for soil responsiveness to manganese fertilization of turfgrass across soil types using the Mn+2 availability index.

METHODOLOGY QUICK TAKE

The researchers will collect various data throughout the duration of the study to characterize the soils studied and assess treatment effects on turf growth and disease severity.

FIGURE 1

Summer patch symptoms apparent in 6 inoculation points in a Kentucky bluegrass turf not receiving Mn fertilization in plot on the left; compared to similarly maintained turf receiving 3.0 lbs Mn / acre monthly from May to September in plot to the right (p. 13). Photos taken September 6, 2013.



New Study to Investigate Manganese as Viable Summer Patch Control

» Soils differing in organic matter (i.e., sand amended with peat and a sandy loam) will be collected for use in the study. They will be amended with lime or sulfur to adjust pH to levels known to influence Mn availability, and seeded with Kentucky bluegrass.

» Mn will be applied at rates ranging from none to 8.0 lbs. per acre to turf grown in soils with all the above combinations of pH and organic matter.

» Soil extractable Mn will be determined before the start and conclusion of the study.

» The Mn Availability Index will be calculated using total extractable Mn and pH measurements.

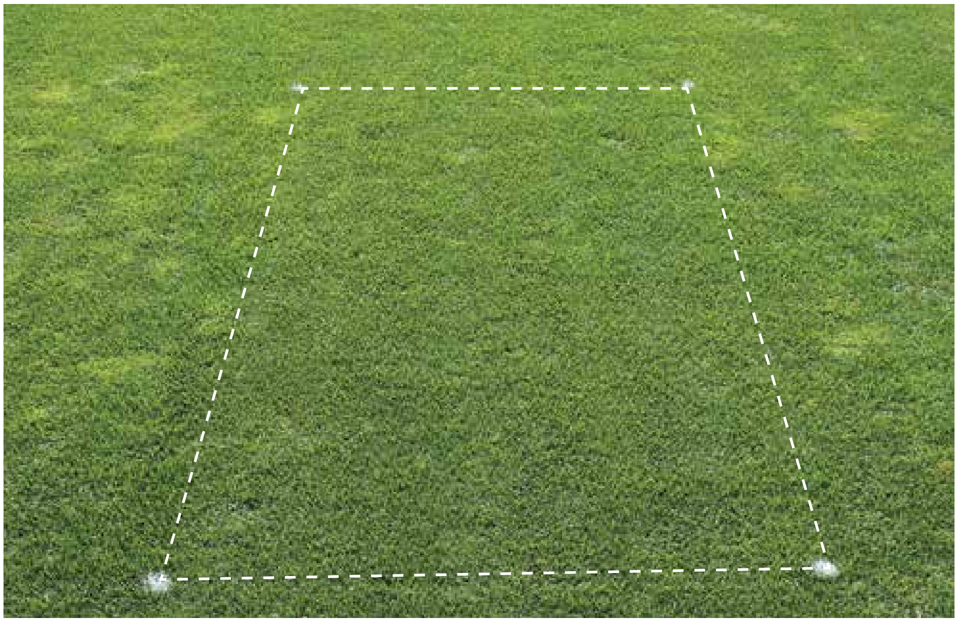
» Foliar Mn will be determined from clippings collected from plants periodically throughout the study to assess the relative amount of Mn uptake under various soil conditions and fertility rates.

» Summer patch severity will be assessed using digital image analysis to characterize symptoms associated with yellowing and loss of density.

» Lignin concentration of roots will also be determined at the conclusion of the study to assess the role of Mn availability on the accumulation of lignin as a possible mechanism for control of summer patch in Kentucky bluegrass.

Dr. Inguagiato and Dr. Morris are beginning their research with a greenhouse/growth chamber study at UConn's Floriculture Greenhouse Facility in Storrs, CT. Working in a controlled environment, the researchers will begin their assessment of the potential interactions between soil type, soil pH, and Mn fertilization rate on summer patch severity in Kentucky bluegrass. By the end of year one of the study, the UConn researchers expect to shed light on the effect of Mn treatments on summer patch development.▲

For further information, you can reach Dr. Inguagiato at john.inguagiato@uconn.edu or Dr. Morris at thomas.morris@uconn.edu.



Tri-State Continues Commitment to Supporting Area Supers With All-New Research, Member Survey, and Website

2: In hope of providing a viable alternative to costly fungicide applications to control summer patch disease, Drs. John Inguagiato and Thomas Morris from the University of Connecticut are conducting a two-year study to determine the efficacy of manganese fertilization in suppressing summer patch on Kentucky bluegrass.

At the same time, the foundation has two valuable studies from Rutgers coming to a close. Drs. Bruce Clarke and James Murphy and graduate student James Hempfling have spent the past three years working to develop best management practices for dollar spot control on fairways. And Dr. Bingru Huang and graduate student Cathryn Chapman have examined plant-health products' role in reducing irrigation requirements for fairway turf, providing valuable insight into how best to promote ongoing turf health in creeping bentgrass fairways when there is a shortage of rainfall or irrigation.

SURVEY PINPOINTS RESEARCH NEEDS

As part of the Tri-State's effort to support area golf course superintendents' success in managing their golf courses, this past year the foundation produced a survey designed to explore the needs of area superintendents. The survey was well received and has guided the Tri-State in funding research most pertinent to area superintendents' turfgrass challenges. The latest survey, for instance, pinpointed a need for research to address what is commonly known as bacterial wilt or etiolation. As a result, we are in the midst of reviewing a proposal to help superintendents combat this problem. In the meantime, feel free to reach out to anyone on the board with suggestions, comments, or questions.

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Tri-State Continues Commitment to Supporting Area Supers With All-New Research, Member Survey, and Website

A GOOD WEB TO GET CAUGHT IN

With an eye toward broadening the Tri-State's reach, the foundation is also in the process of developing a new website that will better communicate the foundation's mission and contributions to the turf industry. *Foundation News* will be archived on the website and available to anyone interested in accessing one of our past research reports.

Also interesting are the monthly Superintendent Spotlights that are posted on the site. They were developed several years ago as an avenue for publicizing the work of both the Tri-State and the golf course superintendent. Written by a Tri-State board member, they highlight an aspect of golf course maintenance—anything from aeration to weather-related challenges.

To go beyond the superintendent audience and attract public attention to the spotlight, the MGA agreed to run a "teaser" for the spotlight in its bi-monthly online E-Revision Newsletter, which publishes handicap revisions. Beneath the teaser is a link to the Tri-State website: www.turfstateturf.org. This communication reaches nearly 100,000 area golfers every month, providing them with a quick link to timely educational information about the turfgrass management industry.

Last but not least, the new-and-improved website will now provide Tri-State Turf Research Foundation contributors with the ability to donate online. Watch for the new site's launch sometime this spring, and be sure to log on to submit your donations. It's your support that allows the foundation to tackle those troublesome turf maladies and issues affecting our golf courses!

STEP UP AND MAKE A DIFFERENCE

Every study is made possible by the contributions the Tri-State Turf Research Foundation has received from its six affiliated associations 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. It is my hope that everyone will see the value in supporting the foundation's work to support research pertinent to area superintendents' turfgrass challenges.

Though everyone benefits from the research the Tri-State supports, only about 25 percent of our area clubs send in a contribution. This is far too few to fund the research necessary to keep pace with our industry's evolving needs. So please find a way to add your name to the list of contributors (see pages 7–8 for our list of 2018 contributors), and encourage those who have not yet contributed to join the foundation in supporting research that will help us thrive now and into the future.

By now, you should have received information on how to make your $250 annual contribution. If not, please take a moment to contact Susan O'Dowd at MGA Headquarters for a personalized invoice.

In closing, I hope that you find the information provided in this issue of *Foundation News* useful and that you have a better understanding of the Tri-State Turf Research Foundation's work and mission.

Best wishes for a trouble-free 2019, and know that should difficulties arise the foundation will be here to provide the research necessary to help find practical and environmentally safe solutions to your turfgrass challenges.

Tim Garceau, President
Tri-State Turf Research Foundation

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