TURFGRASS & ORNAMENTAL FIELD DAY

South Farm Research Center
Columbia, MO

July 21, 2015

Faculty
Dr. Bruce Barrett – Entomology
Dr. Brad Fresenburg – Turfgrass Research & Extension
Dr. Richard Houseman – Entomology
Dr. Lee Miller – Turfgrass Pathology
Dr. Manjula Nathan – Soil Testing/Nutrient Management
Dr. David Trinklein – Floriculture
Dr. Xi Xiong – Turfgrass Management & Physiology

Research Specialists
Daniel Earlywine – Turfgrass Pathology

Graduate Research Assistants
Naba Amgain
Maxwell Gilley
John Koehler
Xiaowei Pan
Michael Patterson
Kyle Robertson
Enzhan Song

Find us on the web:
turf.missouri.edu
turf.missouri.edu/stat
turfpath.missouri.edu
motoc.org

Brought to you by:
MoTOC
Missouri Turfgrass & Ornamental Council
We would like to express our gratitude to our industry sponsors for their incredible support of the Mizzou Turfgrass & Ornamental Programs. Without this assistance, we would not be able to build upon our programs, nor be able to function at the research and extension level that this great state of Missouri needs and deserves. We would also like to thank our wonderful colleagues at the MU Agronomy Research Center at Bradform Farm and those at South Farms for assisting us with the logistics and set up of this event.

We have listed our contributors on the first page of this booklet to signify our appreciation of their support. While we strive to make this list as comprehensive as possible, please let me or another faculty member know if your organization should be on this list. If an error has occurred, please accept our sincere apology, and we will correct it in the future.

In addition to our program sponsors, I'd also like to thank our numerous sponsors and vendors at this 2015 field day. These companies are also listed and recognized on these opening pages, because their participation and support has played an integral part in facilitating this event.

Inside this booklet, we hope you will find valuable research and insights that you can bring back to your operation to make it more successful. Whether your operation is a lawn, landscape, golf course, sod farm, nursery, athletic field, (etc.), we would like to assist with your plant health issues. If there is a concern you feel needs to be covered more fully, please don't hesitate to let us know, or email me at turfpath@missouri.edu or phone at (573) 882-5623. Please enjoy your day of discussion, learning and camaraderie, and we hope you take something back that is useful.

Sincerely,

Dr. Lee Miller
Extension Turfgrass Pathologist
University of Missouri
Division of Plant Sciences
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<td>Capital Sand Company*</td>
<td>MO-KAN Chapter (STMA) **</td>
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<th>Sponsors</th>
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<td>19 1/2 Spoede Lane, Creve Coeur, MO 63141</td>
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<td>GR Robinson Seed &amp; Service Co</td>
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## July 21, 2015 Schedule of Events

<table>
<thead>
<tr>
<th>Time</th>
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<tr>
<td>7:30 – 8:30 a.m.</td>
<td>Registration, coffee/donuts and exhibitors</td>
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<tr>
<td>8:30 – 9:00 a.m.</td>
<td><strong>Welcome &amp; Introduction:</strong> Dr. Lee Miller, Turfgrass Pathology</td>
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<td><strong>Welcome &amp; Program Update:</strong> Dr. Jim English, Director of Division of Plant Sciences,</td>
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<td><strong>Welcome &amp; MOTOC Update:</strong> Gabe Huffington, MOTOC President</td>
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<tr>
<td>9:00 – 10:20 a.m.</td>
<td><strong>Morning Session 1: Visit 4 of 5 topics</strong></td>
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<td>Presentations last 10 minutes; 10 minute Q&amp;A/Transit time</td>
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<tr>
<td>![Stop 1]</td>
<td><strong>Billbug Control on Zoysiagrass Turf</strong></td>
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<td>Michael Patterson - M.S. Program, Dr. Bruce Barrett – Professor: Entomology &amp; Dr. Xi Xiong – Assistant Professor: Turfgrass Science</td>
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<tr>
<td>![Stop 2]</td>
<td><strong>Dealing with Problem Patches on Warm &amp; Cool Season Grasses</strong></td>
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<td>Dr. Lee Miller – Assistant Professor: Turfgrass Pathology</td>
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<td>![Stop 3]</td>
<td><strong>New Tools for Disease Control on Golf Putting Greens</strong></td>
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<td>Daniel Earlywine, M.S. – Turfgrass Pathology</td>
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<td>![Stop 4]</td>
<td><strong>Ornamental Diseases: Sample types, diagnoses and common pathogens</strong></td>
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<td>Patricia Hosack, M.S. - MU Plant Diagnostic Clinic Director</td>
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<td>![Stop 5]</td>
<td><strong>Soil, Plant, and Nematology Diagnostic Services Available at the University of Missouri for the Turfgrass, Lawn Care, and Landscape Industries</strong></td>
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<td>Dr. Manjula Nathan – Associate Professor: Nutrient Management &amp; Amanda Howland – Director of MU Plant Nematology Laboratory</td>
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<td>10:20 – 11:40 a.m.</td>
<td><strong>Morning Session 2: Visit 3 of 4 topics</strong></td>
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<td>![Stop 6]</td>
<td><strong>Don’t Forget to Calibrate That Sprayer...</strong></td>
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<td>Dr. Brad Fresenburg, Assistant Professor: Turfgrass Science</td>
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<td>![Stop 7]</td>
<td><strong>What’s New with Emerald Ash Borer?</strong></td>
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<td>Collin Wamsley - State Entomologist: Missouri Department of Agriculture</td>
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<td>![Stop 8]</td>
<td><strong>Wet Weather Woes</strong></td>
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<td>Dr. David Trinklein – Associate Professor: Horticulture</td>
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<td>![Stop 9]</td>
<td><strong>Why Bee Concerned About Insect Pollinators?</strong></td>
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<td>Dr. Richard Houseman – Associate Professor: Entomology &amp; Dr. Bruce Barrett – Professor: Entomology</td>
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<td>![Stop 10]</td>
<td><strong>Evaluation of Pylex® for Control of Zoysiagrass in Cool Season Turf</strong></td>
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<td>Steve Song, Ph.D. student &amp; Dr. Xi Xiong – Assistant Professor: Turfgrass Science</td>
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<tr>
<td>11:40 - 12:00 p.m.</td>
<td><strong>Exhibitor Demonstrations</strong></td>
</tr>
<tr>
<td>12:00 – 12:45 p.m.</td>
<td>Lunch, Exhibitors</td>
</tr>
<tr>
<td>1:30 p.m. Tee Off</td>
<td>Lobenstein Scholarship Tournament</td>
</tr>
<tr>
<td></td>
<td>Columbia Country Club</td>
</tr>
<tr>
<td></td>
<td>2210 Country Club Dr.</td>
</tr>
<tr>
<td></td>
<td>Columbia, MO 65201</td>
</tr>
</tbody>
</table>
Billbug Control on Zoysiagrass: Updates and Control Options

Michael Patterson, Dr. Bruce Barrett, and Dr. Xi Xiong

Introduction

In recent years, billbug (Sphenophorus spp.) damage on zoysiagrass (Zoysia japonica Steud.) turf have become an emerging problem in the transition zone that, left untreated, can destroy large areas of zoysiagrass turf. Billbugs are weevils; adults measure 0.3 inches long or less with long snouts, and their larvae are legless (Fig 1). Billbugs have a complete life cycle; both larvae and adults feed on stems, crowns, or roots and stolons of susceptible grass species, depending upon the developmental stages. The adult females lay eggs in the grass stems or on the surface of leaf sheaths. The eggs hatch within 3-10 days after being laid and then begin feeding on the roots and crowns of the plants in their vicinity, feeding as deep as 5 – 7.5 cm deep in the soil. As the emerged larvae chew into the tillers, it disrupts the plants ability to translocate water and nutrients. Damage symptoms often resemble drought, nutrient deficiency, disease, other insect problems such as white grubs, or sometimes winter injury (Fig 1).

Fig 1. Left pane, two billbug adults (bluegrass billbug, left; and hunting billbug, right); center panel, a billbug larva; and right panel, damage on ‘Meyer’ zoysiagrass fairway photographed in July, 2014. All insect specimens and the damaged fairway were taken from a local golf course in Columbia, MO.

There are at least nine species of billbugs that attack turfgrass plants in the United States. Among them, bluegrass billbug (S. parvulus Gyllenhal) is considered the most widely distributed species and has received the most attentions from turfgrass researchers. As the name indicates, the primary host plant for bluegrass billbugs is believed to be Kentucky bluegrass (Poa pratensis L.), although other turfgrass and nonturf species can be attacked as well. Hunting billbugs (S. venatus vestitus Chitten-den), which apparently have spread into the northern states in the recent years, has been recognized as the species that damages the warm-season grasses, including zoysiagrasses. Accurate identifying billbug to species is almost impossible at the larva stage. However, at the adult stage, billbugs can be differentiated to species primarily based on the markings on the pronotum and elytra (Fig 1).

Bluegrass billbug, the most studied species, is generally believed to be one generation per year. The individuals overwinter as young adults and emerge in spring. The females may lay eggs over a 2 months period under favorable environmental conditions, individuals might overwinter as large larvæ, which results in a partial second generation. It is reported that all developmental stages, includ-
Billbug Control on Zoysiagrass: Updates and Control Options

In addition to larvae, pupa, and adult, can be found simultaneously during most of the year. Hunting billbug is believed to share a similar life cycle with bluegrass billbug, however, our understanding is limited in biology and ecology of this species, due to insufficient numbers and/or scope of researches.

Current Findings

At the University of Missouri, we have been conducting a series of experiments that aim to understand the billbug population composition in transition zone and their life cycles, in order to develop management strategies that provide effective control.

Unlike previous beliefs, both bluegrass and hunting billbugs feed on zoysiagrass and, in most cases, co-exist on zoysiagrass turf. A research conducted at Kansas State University found that bluegrass billbugs can cause up to 38% damage to zoysiagrass turf. At the University of Missouri, one experiment found a mixed population in a zoysiagrass fairway in a local golf course monitored. A close monitor at weekly basis revealed a mixed population of both bluegrass and hunting billbugs. The population shifts along with the season changes, with the percentage of hunting billbugs varied from 50 to 100% of the population from April to the beginning of July, 2015 (Fig 2).

![Fig 2. Billbug population composition collected from pitfall traps located at a fairway of local golf course in Columbia, MO from April to July 2015.](image)

A separate study conducted at the University of Missouri also found that there were two peak adult billbug activities per growing season, indicating a possibility of 1.5 or 2 generation per year (Fig 3). This results agree with findings from Florida or North Carolina where multiple overlapping generations of billbugs have been identified. Identifying the peak adult activity is essential, as most effective insecticide controls were found to be applied at the adult stage, but not at the larvae stages. Our data indicates that likely two insecticides applications might be necessary with one in spring and another in fall in order to effectively control the adult billbugs.
Currently, we are conducting a field-based study at A.L. Gustin Golf Course to test the efficiency and residual effects of various insecticides for billbug control. This experiment is established on ‘Meyer’ zoysiagrass (Z. japonica) fairway. Treatments were arranged in a split block and replicated in four blocks. Pitfall traps were built and installed below the mowing line year-round to monitor the activity of adult billbugs. Treatments described in table 1 were applied using a CO₂ pressurized back pack sprayer calibrated to deliver 44 gal/ac using TeeJet XR 8004 flat fan nozzle tips. Results from this experiment will be discussed in the Field Day presentation.

Table 1. Treatment rates and schedule applied at the A.L. Gustin Golf Course. Treatments were applied either as single application on May 21, 2015, or as sequential application on May 21 and June 19, 2015.
Dealing with Problem Patches on Warm & Cool Season Grasses

Dr. Lee Miller and Daniel Earlywine

Introduction

Large patch and brown patch are two diseases caused by *Rhizoctonia solani*. While similar morphologically and sharing the same name, the pathogens belong to different anastomosis groups (meaning their hyphae don’t fuse), and therefore are two completely different beasts. The differences show in their choice of hosts. Large patch (caused by AG 2-2 LP) prefers to dine on bermudagrass and more importantly zoysiagrass, whereas brown patch (caused by AG 2-2 IIIB) prefers cool-season species such as tall fescue and creeping bentgrass. The spring and summer of 2015 have been particularly conducive for both of these diseases. High humidity and frequent rainfall events have created more than enough leaf wetness and saturated soil conditions to spur on both diseases. Temperatures have also remained just mild enough to keep zoysia from growing at its optimum, and yet warm enough to spur brown patch outbreaks.

Brown Patch on Tall Fescue

Cultural Practices

Previous research regarding the impact of nitrogen fertilization on brown patch of tall fescue (Burpee, 1995; Vincelli et al., 1997; Watkins et al., 2001) and perennial ryegrass (Fidanza and Dernoeden, 1996) indicate excessive application during the summer infection period results in increased brown patch severity. A common lawn care practice is to apply nitrogen fertilizer every 4-6 weeks throughout the season to enhance the color and vigor of tall fescue. While not detrimental in the spring, summer applications can result in undesirable increases in brown patch severity. Other recommended cultural practices for brown patch control include the use of resistant cultivars, appropriate mowing heights (3-4”), and various practices that reduce the period of leaf wetness (i.e. irrigation in the morning, shade reduction, etc.).

Spring Fertilization Trial

A field experiment was initiated in 2014 on full sun ‘RTF’ tall fescue to evaluate the impact of spring fertilization with various nitrogen sources, including urea (0.8 lb N/1000 ft²), Scotts Turf Builder® (0.8 lb N/1000 ft²), and Duration® 80 day (1.93 lb N/1000 ft²) and 120 day (3.5 lb N/1000 ft²) slow release fertilizers. In 2015, the experiment was expanded to replicate the trial on a shaded ’Rembrandt’ tall fescue block. Urea and Scotts Turf Builder® were applied either once in mid-April or mid-May, or twice in mid-April and mid-May. Duration fertilizers were applied once in either mid April or mid May. On 5/30/14 and 6/5/15, 30 cc of rye grain infested with *Rhizoctonia solani* was broadcast across each plot. In the center of each plot, a clear plastic cup was placed over an additional 10 cc of rye
grain inoculum, and left for 3 d to encourage infection. Disease severity was assessed every 14 days by visual estimation of percent brown patch disease per plot. Data was subjected to analysis of variance, and means were separated with Fisher’s LSD (P = 0.05).

**Current Findings**

The experiment was only conducted in a full sun environment in 2014. Because of this and mild summer temperatures, disease development was poor in 2014, with the most disease being observed in mid and late August (Figure 1). Mild temperatures have also been the norm for early summer 2015, but frequent rainfall, high humidity, and sporadic heat events have spurred considerably more brown patch pressure. In the full sun ‘RTF’ plot, Duration® 120 day applied in mid May resulted in less brown patch severity than any urea treatment on July 9th. In the shaded ‘Rembrandt’ plot, Duration® 80 day applied in mid May than urea applied in April on June 23 (Figure 2). Disease severity dropped off significantly on July 9th due to cool nighttime temperatures which were exacerbated by the shady conditions. In both plots in 2015, plots not fertilized in the spring had numerically the highest level of brown patch infection. May-June 2015 ranked as the 5th wettest on record in Missouri, with 5.63” falling in Columbia in May and 6.24” falling in June. Non-fertilized plots (previously fertilized in fall 2014 with 2 lb N/1000 ft²) may have been predisposed to infection due to a lack of nutrition caused by nitrogen loss.

![Figure 1: Effect of Spring Fertilizer Applications on Brown Patch Severity](image-url)

*Columns with the same letter do not significantly differ (P=0.05, Fisher's Protected LSD).*
Fungicides

Previous research demonstrated fungicides available to homeowners in major retail outlets provided inferior brown patch control compared to those used by commercial pest applicators (Smith and Walker, 2013). Older chemistries such as myclobutanil, propiconazole, and thiophanate-methyl are common active ingredients in homeowner grade products, whereas azoxystrobin and newer chemistries are readily available to lawn care operations. Because of this research, our current suggestion for homeowners dealing with brown patch damage on tall fescue is to utilize a lawn care operator to apply the more expensive, but effective compounds properly, or to save their funds and plan to reseed or overseed with more resistant tall fescue varieties the subsequent fall.

Curative Fungicide Trial

A substantial brown patch outbreak occurred on a partially shaded ‘Rembrandt’ tall fescue block in late June 2015. On June 30, five granular fungicides, including two consumer fungicides (Bayer Advanced® and Scotts Lawn Fungus Control®) and three professional grade fungicides (Heritage G®, Headway G®, and Pillar G®) were applied at curative label rates to assess disease recovery. Applications were timed so brown patch severity could be observed at field day at 21 days post application.
Current Findings

Brown patch severity decreased in early July due to a sharp decrease in daily high and low temperatures (lows in lower 60s to high 50s F). Plots treated with Heritage G had significantly lower brown patch severity than the untreated control and both consumer grade products on July 9 (Figure 3). Plots treated with the two consumer grade products were not significantly different from the untreated control plots on July 9.

Large Patch on Zoysiagrass

Large patch is the most important disease limiting zoysiagrass use for lawns and golf course fairways in Missouri. Commonly utilized cultural management practices (increasing drainage, limiting excessive leaf wetness periods) are often not sufficient to limit disease occurrence. Fungicide applications are normally scheduled once or twice during the fall and once again in the spring during high infection periods. The MU turfgrass pathology program is currently focusing on the impact of nitrogen source and application timing on the large patch epidemic, and application strategies to maximize fungicide efficacy to perhaps reduce the overall number of applications necessary per annum.
Cultural Practices
Large patch is favored by wet, or oversaturated soil conditions, (a common occurrence in spring 2015) so increasing drainage in perennially affected areas should reduce disease severity. Current recommendations also advise avoidance of fertilizer applications during periods of large patch infection, either fall or spring. Very little research evidence exists to support this recommendation, which may stem from an unsubstantiated link between the brown patch and large patch epidemics. Current research indicates no increase or actually a slight decrease in large patch severity with spring nitrogen applications. For more information, see the report “Impact of nitrogen source and application timing on incidence of large patch on zoysia” on page 56.

Fungicides
Two or even three fungicide applications are often used for large patch control in Missouri. Along with selection of the most effective fungicide chemistry, reduction of the frequency of these applications may be possible by improving application strategy. The following summaries describe research investigating the impacts of application timing and post-application irrigation on large patch control.

Application Timing
Field trials were conducted at the MU Turfgrass Research Farm on ‘Meyer’ zoysiagrass in 2013 and 2014 to evaluate the effect of fall vs. spring timing of a single preventive fungicide application for large patch control. Fungicide treatments included Heritage WG (0.2 oz/1000 ft²) or Torque (0.6 fl oz/1000 ft²) applied either in early fall, late fall, early spring or late spring. Zoysiagrass was still dormant in early spring applications, and had just slightly greened up in late spring applications. Fungicides were applied with a CO²-powered backpack sprayer with TeeJet 8008 nozzles at 40 psi in water equivalent to 2 gallons H²O/1000 ft². Large patch severity was estimated as a visual estimate of percent disease area per plot, with assessments made every two weeks during the spring season.

Current Findings
Large patch in Missouri is generally more severe and important in the spring, particularly since users expect maximal utility during the spring, summer, and early fall months. If only one fungicide application is to be used, early and late April fungicide applications provide more reliable control than early and late fall applications (Figure 4). Homeowners or turfgrass managers considering utilizing a single fungicide application for control should use less severe fall large patch outbreaks to determine the extent of the epidemic, and plan to treat in April for maximum spring disease control.
Dealing with Problem Patches on Warm & Cool Season Grasses

Post Application Irrigation
The objective of this project is to investigate the impact of different PAI amounts on the residual efficacy of a granular and liquid formulation of Heritage® applied once in the fall. Treatments were applied to ‘Meyer’ zoysiagrass at the MU Turf Research Farm (inoculated) on either Sept 20, 2013 or Sept 18, 2014. Plots were 5 × 10 ft, and arranged in a randomized complete block design with 4 replications. Fungicides were either applied in 2 gal of water carrier/1000 sq ft with 8008 nozzles (liquid), or applied by hand with a shaker bottle (granular). Treatments were unirrigated, or watered in with 0.1” (3.11 gal/plot), 0.125” (3.89 gal/plot), or 0.25” (7.78 gal/plot). Post-application irrigation was applied with a hand-held hose equipped with a flow meter in 2013, and with a PVC overhead irrigation system equipped with a flow meter in 2014. Plots were inoculated in late September of each year by placing 25 cc of rye grain infested with *Rhizoctonia solani* AG2-2 LP in the center of each plot under a metal plate. Plates were removed on mid April of each year.

Current Findings
Results of this trial are variable, and do not indicate any amount of post-application irrigation aids efficacy of a single fall fungicide application for large patch control. In 2014 and 2015, plots treated with either Heritage formulation and no post-application irrigation had lower large patch severity than the untreated control. No statistical differences were observed between the granular and liquid Heritage formulation in either year. If spraying fungicides in a 2 gallon/1000 ft² carrier volume or applying a granular formulation in the fall, it is recommended to not apply any post-application irrigation. This study is being expanded considerably in 2015 to evaluate the impact of post-application irrigation on single spring as well as fall applied preventive fungicide applications.
Dealing with Problem Patches on Warm & Cool Season Grasses

Figure 5: Impact of Post-Application Irrigation on Single Fall Fungicide Application for Large Patch Control

- **Post-Application Irrigation**
  - Untreated
  - Heritage G (4 lb/M)
  - Heritage TL (1.98 fl oz/M)

*Bars with the same letter are not statistically different according to LSD (α = 0.05)*
Daniel Earlywine and Dr. Lee Miller

Introduction

Turfgrass managers may time their first preventative fungicide application based on preplanned calendar date or use measured weather variables including soil temps or growing degree-days. In 2015, warm temperatures in early April jump-started the dollar spot epidemic at a time 2-3 weeks earlier than normal. At this time, some turf managers may have only mowed putting greens once or twice, and in some cases sprayers weren’t even calibrated for the season yet.

Many turf diseases can be found on creeping bentgrass putting greens from May- August in Missouri, including brown patch, red leaf spot, copper spot, and summer patch. Due to the large window of infection and symptom development, however, more of the budget is spent on dollar spot than any other disease.

Summary

Multiple fungicide trials were conducted to evaluate turf quality and summer disease control on a “Penncross” creeping bentgrass green. Dollar spot symptoms occurred in the trial area in early April before trials were initiated. Therefore, two curative applications of Daconil Ultrex (3.25 oz/1000 ft²) were applied to the green prior to trial initiation in May.

The green is mowed 5 times weekly and watered as needed to prevent drought stress. From May to September, a 30-0-0 liquid fertilizer (0.375 lb N/1000 ft²) + Ferromec Liquid Iron 10-2-4 + micros (1.5 fl oz/1000 ft²) are being applied every 3 weeks. Revolution (6.0 fl oz/ 1000 ft²) is being applied once a month to control localized dry spot.

Trial 1 was designed to evaluate fungicide efficacy focused on preventative dollar spot control, turf quality and safety. Multiple fungicides were applied preventatively before onset of any disease. Initial applications were made on May 12 and applied every 14 days.

Trial 2 was designed to evaluate Exteris StressGard for efficacy focused on preventative dollar spot and brown patch control, turf quality, and safety. Initial applications were made on May 19 and applied every 14 or 21 days.
**Trial 3** was designed to evaluate Exteris and Signature StressGard used within two season long fungicide programs on a golf green. Treatments (listed in the table below) are applied on a 14-day interval from May 19 – Sept 8.

**Trial 4** was designed to evaluate multiple fungicides for preventative dollar spot and brown patch control on creeping bentgrass greens. Initial applications were made on May 21, when <4 dollar spot infection centers/plot were observed within the trial area.

Pathogen inoculation was conducted on all trials. On May 22, Trial 1 and 4 were inoculated with rye grain infested with three isolates of *Sclerotinia homoeocarpa*, the causal pathogen of dollar spot. Inoculum was uniformly applied at 25 cc per plot using a small broadcast spreader, and left on the turf surface for 3 days to enable pathogen establishment. On June 5, Trials 2, 3, and 4 were inoculated with rye grain infested with four isolates of *Rhizoctonia solani* AG2-2 IIIB, the causal pathogen of brown patch. Inoculum was applied at 25 cc per plot using a small broadcast spreader. A clear 5 fl oz plastic cup was randomly placed over five to eight rye grains and left on the turf for 3 days to further encourage brown patch development.

**Current Findings**

**Trial 1:** After trial initiation, dollar spot was first observed on May 26, but no differences among treatments were noted until June 9. On June 9, all treated plots had less dollar spot infections centers than plots treated with Disarm and the untreated control. By 23 June, significantly less dollar spot was observed in all treated plots compared to the untreated control. On that same date, plots treated with Lexicon Intrinsic (0.34 and 0.47 fl oz/1000 ft$^2$), Headway, and Emerald had less dollar spot severity than plots treated with Chipco Signature, Disarm, and the untreated control. Brown patch was first noted within the trial area on the June 23 rating date, however no significant differences in brown patch control have been observed among treated and untreated plots. On June 9th and 23rd, phytotoxicity (bronzing/discoloration) was observed in plots treated with Headway (3.0 fl oz/1000 ft$^2$) every 14 days. No significant differences in turf quality were noted among treated and untreated plots until the June 23 rating date. Turf quality was below acceptable levels (<6) in Headway treated plots due to turfgrass discoloration. The trial will continue to be evaluated through July and August.

### Trial 1. Dollar spot and Brown Patch Control.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/1000 ft$^2$</th>
<th>Application Interval</th>
<th>Dollar Spot Severity (# of infection centers)$^\gamma$</th>
<th>Brown Patch Severity (%)$^z$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>9 Jun</td>
<td>23 Jun</td>
<td>23 Jun</td>
</tr>
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<td>---------</td>
<td>6.5</td>
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<td>ABCDEFG</td>
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<td>0.8</td>
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<tr>
<td></td>
<td></td>
<td>c</td>
<td>d</td>
<td>a</td>
</tr>
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<td>Chipco Signature</td>
<td>4.0 oz</td>
<td>ABCDEFG</td>
<td>3.3</td>
<td>14.5</td>
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<tr>
<td></td>
<td></td>
<td>ab</td>
<td>ab</td>
<td>a</td>
</tr>
<tr>
<td>Daconil Action</td>
<td>3.5 fl oz</td>
<td>ABCDEFG</td>
<td>0.5</td>
<td>6.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c</td>
<td>d</td>
<td>a</td>
</tr>
</tbody>
</table>

$^\gamma$ Brown Patch severity based on a scale of 0 to 100% (0= no incidence, 100= entire plot completely covered).

$^z$ Dollar spot infection centers are means of counts per plot.
New Tools for Disease Control on Golf Putting Greens

*Means (n=4) within columns followed by the same letters are not significantly different according to Fisher’s Protected LSD (P = 0.05).

*Application code indicates date of each application:  A-12 May, B-26 May, C-9 Jun, D-23 Jun, E- 7 Jul, F- 21 Jul, G- 4 Aug.

**Trial 1. Turf Quality**

<table>
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<th>Treatment</th>
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<th>23 Jun</th>
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<td>Chipco Signature</td>
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<td>a</td>
<td>7.0</td>
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</table>

*Turfgrass quality using a 1 to 9 scale (9=best, 5=acceptable) based on color, density, and uniformity.

**Trial 2: Dollar spot (<3 dollar spot infection centers per plot) was first observed within the trial area on May 19 when the first initial fungicide application was made. By June 6, the number of dollar spot infections centers were significantly less in Lexicon Intrinsic treated plots than all other treatments including the untreated control. By June 17, all treated plots had significantly less dollar spot infection centers than the untreated control. On that same date, no significant differences in dollar spot control were noted among fungicide treatments. Brown patch was first observed in the trial area on June 17. Brown patch severity was significantly lower in all treated plots than the untreated control, but no differences in brown patch control were noted among the fungicide treatments. On June 6, (due to an increase in dollar spot severity) turf quality was significantly lower in plots treated with Exteris StressGard (1.5 fl oz/1000 ft² -14 day interval) and the untreated control than plots treated with Exteris StressGard (4.0 fl oz/1000 ft² - 21d) and Lexicon Intrinsic. By June 17, turf quality was significantly higher in treated plots than the untreated control. This trial will continue to be evaluated for disease control as the summer progresses.
New Tools for Disease Control on Golf Putting Greens

**Trial 2. Dollar Spot Infection Centers/Plot**

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<th>June 17</th>
</tr>
</thead>
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<td>Untreated Control</td>
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</tr>
<tr>
<td>ExTens StressGard (1.5 fl oz/M)</td>
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<td>a</td>
</tr>
<tr>
<td>ExTens StressGard (3.0 fl oz/M)</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Interface StressGard (4.0 fl oz/M)</td>
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<td>b</td>
</tr>
<tr>
<td>26 GT XTRA (3.0 fl oz/M)</td>
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<td>b</td>
</tr>
<tr>
<td>ExTens StressGard (2.0 fl oz/M)</td>
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<td>b</td>
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<tr>
<td>ExTens StressGard (4.0 fl oz/M)</td>
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<td>b</td>
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**Trial 2. Brown Patch Severity**

<table>
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<td>Untreated Control</td>
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<tr>
<td>ExTens StressGard (3.0 fl oz/M)</td>
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<tr>
<td>Interface StressGard (4.0 fl oz/M)</td>
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</tr>
<tr>
<td>Lexicon Intrinsic (0.34 fl oz/M)</td>
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</tr>
</tbody>
</table>
Trial 3: Dollar spot was first observed in the trial area on May 19. On this date, no significant differences in dollar spot severity were noted between the two programs and the untreated control. From June 4 through June 17, both programs had significantly lower dollar spot and brown patch severity than the untreated control. Similar results were also noted for turfgrass quality. No significant differences have been observed in disease control and turfgrass quality between both program 1 and 2. This trial will continue to be rated throughout the summer.
### Treatment

<table>
<thead>
<tr>
<th>Program 1</th>
<th>Rate Per 1,000 sq ft</th>
<th>Application date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature Xtra StressGard +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daconil Ultrex</td>
<td>4.0 oz wt + 3.2 oz wt</td>
<td>May 19</td>
</tr>
<tr>
<td>Signature Xtra StressGard +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface</td>
<td>4.0 oz wt + 4.0 fl oz</td>
<td>June 2</td>
</tr>
<tr>
<td>Signature Xtra StressGard +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daconil Ultrex</td>
<td>4.0 oz wt + 3.2 oz wt</td>
<td>June 16</td>
</tr>
<tr>
<td>Signature Xtra StressGard +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insignia SC</td>
<td>4.0 oz wt + 0.7 fl oz</td>
<td>June 30</td>
</tr>
<tr>
<td>Signature Xtra StressGard +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daconil Ultrex</td>
<td>4.0 oz wt + 3.2 oz wt</td>
<td>July 14</td>
</tr>
<tr>
<td>Signature Xtra StressGard +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface StressGard</td>
<td>4.0 oz wt + 4.0 fl oz</td>
<td>July 28</td>
</tr>
<tr>
<td>Signature Xtra StressGard +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daconil Ultrex</td>
<td>4.0 oz wt + 3.2 oz wt</td>
<td>August 11</td>
</tr>
<tr>
<td>Signature Xtra StressGard +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insignia SC</td>
<td>4.0 oz wt + 0.7 fl oz</td>
<td>August 25</td>
</tr>
<tr>
<td>Interface StressGard</td>
<td>4.0 fl oz</td>
<td>September 8</td>
</tr>
</tbody>
</table>

| Program 2                          |                      |                  |
| Signature Xtra StressGard +       |                      |                  |
| Daconil Ultrex                    | 4.0 oz wt + 3.2 oz wt| May 19           |
| Signature Xtra StressGard +       |                      |                  |
| Exteris StressGard                | 4.0 oz wt + 3.2 fl oz| June 2           |
| Signature Xtra StressGard +       |                      |                  |
| Daconil Ultrex                    | 4.0 oz wt + 3.2 oz wt| June 16          |
| Signature Xtra StressGard +       |                      |                  |
| Insignia SC                       | 4.0 oz wt + 0.7 fl oz| June 30          |
| Signature Xtra StressGard +       |                      |                  |
| Daconil Ultrex                    | 4.0 oz wt + 3.2 oz wt| July 14          |
| Signature Xtra StressGard +       |                      |                  |
| Exteris StressGard                | 4.0 oz wt + 3.0 fl oz| July 28          |
| Signature Xtra StressGard +       |                      |                  |
| Daconil Ultrex                    | 4.0 oz wt + 3.2 oz wt| August 11        |
| Signature Xtra StressGard +       |                      |                  |
| Insignia SC                       | 4.0 oz wt + 0.7 fl oz| August 25        |
| Exteris StressGard                | 3.0 fl oz            | September 8      |
Trial 3 - Programs 1 and 2 Disease Control

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Application Interval</th>
<th>Dollar Spot Severity (# of infection centers)(^y)</th>
<th>Brown Patch Severity (%)(^z)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated Control</td>
<td>19 May: 1.8 (a), 4 Jun: 29.5 (a), 17 Jun: 51.5 (a), 17 Jun: 8.3 (a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program 1</td>
<td>14 day: 0.0 (a), 2.3 (b), 0.8 (b), 0.0 (b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program 2</td>
<td>14 day: 0.0 (a), 1.0 (b), 3.0 (b), 0.0 (b)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{a}\)Brown Patch severity based on a scale of 0 to 100% (0= no incidence, 100= entire plot completely covered).

\(^{y}\)Dollar spot infection centers are means of counts per plot.

\(^{z}\)Means (n=4) within columns followed by the same letters are not significantly different according to Fisher’s Protected LSD (P = 0.05).

Trial 3 - Programs 1 and 2 Turf Quality

<table>
<thead>
<tr>
<th>Turf Quality(^z)</th>
<th>19 May</th>
<th>4 Jun</th>
<th>17 Jun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated Control</td>
<td>6.6 (ax)</td>
<td>5.6 (b)</td>
<td>4.6 (b)</td>
</tr>
<tr>
<td>Program 1</td>
<td>14 day: 6.6 (a)</td>
<td>7.6 (a)</td>
<td>7.3 (a)</td>
</tr>
<tr>
<td>Program 2</td>
<td>14 day: 6.6 (a)</td>
<td>7.6 (a)</td>
<td>7.2 (a)</td>
</tr>
</tbody>
</table>

\(^{z}\)Turfgrass quality using a 1 to 9 scale (9=best, 5=acceptable) based on color, density, and uniformity.

Trial 4: Dollar spot and brown patch were first observed in the trial area on May 21 and June 18, respectively. On both the June 4 and 18 rating dates, all treated plots had significantly lower dollar spot severity than the untreated control. No significant differences in dollar spot control were noted among treated plots. Brown patch severity was significantly less in all treated plots than the untreated control. On both June rating dates, turfgrass quality was significantly higher in all treated plots than the untreated control. By June 18, turf quality was unacceptable (<6) in plots treated with Appear + Daconil Action and Appear + Secure.
New Tools for Disease Control on Golf Putting Greens

**Trial 4. Dollar Spot Infection Centers/Plot**

- Untreated Control
- Atrifin (6.0 fl oz/M) + Valenza (0.5 oz/M) 14d
- Atrifin (6.0 fl oz/M) + Valenza (0.5 oz/M) + Heritage Action (0.2 oz/M) 14d
- Atrifin (6.0 fl oz/M) + Daconil Action (2.5 fl oz/M) 14d
- Atrifin (6.0 fl oz/M) + Secure (0.3 fl oz/M) 14d

**Trial 4. Brown Patch % Severity**

- Untreated Control
- Atrifin (6.0 fl oz/M) + Valenza (0.5 oz/M) 14d
- Atrifin (6.0 fl oz/M) + Valenza (0.5 oz/M) + Heritage Action (0.2 oz/M) 14d
- Atrifin (6.0 fl oz/M) + Daconil Action (2.5 fl oz/M) 14d
- Atrifin (6.0 fl oz/M) + Secure (0.3 fl oz/M) 14d
New Tools for Disease Control on Golf Putting Greens

Trial 4. Turf Quality

<table>
<thead>
<tr>
<th>Turf Quality</th>
<th>May 21</th>
<th>June 4</th>
<th>June 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated Control</td>
<td>a, a, a, a</td>
<td>a, a, a, a</td>
<td>a, a, a, a</td>
</tr>
<tr>
<td>Appear (6.0 fl oz/M) + Versa (0.5 oz/M) 14d</td>
<td>a, a</td>
<td>a, a</td>
<td>a</td>
</tr>
<tr>
<td>Appear (6.0 fl oz/M) + Versa (0.3 oz/M) + Heritage Action (0.2 oz/M) 14d</td>
<td>b</td>
<td>c</td>
<td>b</td>
</tr>
<tr>
<td>Appear (6.0 fl oz/M) + Defenil Action (3.5 fl oz/M) 14d</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appear (6.0 fl oz/M) + Secure (0.5 fl oz/M) 14d</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Ornamental Diseases: Sample types, diagnoses and common pathogens**

*Patricia Hosack, M.S. - MU Plant Diagnostic Clinic Director*

**Introduction**

The University of Missouri Plant Diagnostic Clinic (PDC) has been serving Missouri since 1965. The PDC was founded by Dr. Einar W. Palm who was the first state extension plant pathology specialist. The PDC was closed in 2011, due to personnel and funding issues, and reopened April 2014. The role of the PDC is to assist county Extension Specialists, commercial businesses and private citizens with their pest problems. The PDC is capable of plant disease diagnosis, identification of unknown plants and insects (including arachnids). Besides clinic staff, a diverse group of Plant Sciences faculty specializing in agronomy, entomology, horticulture, or plant pathology assist with identification as needed. The clinic is open year round to receive samples. In-state diagnostic fees are $15 for homeowners and non-commercial entities, $25 for professional lawncare, sports turf, and sod farms, and $50 for golf course turfgrass. General diagnostic techniques include a thorough microscopic investigation before and after overnight incubation in a moist chamber. Along with diagnostics, management recommendations are included. Additional diagnostic testing is also available including serological assays and multi-culture scans, additional fees apply.

**Sample Submission Guidelines**

Samples can be submitted via drop off at the clinic or shipping services. A sample representing the observed symptoms is recommended. This would include healthy and symptomatic tissues. Depending on size, it is useful to send the entire plant that includes roots and aerial plant parts. However, if samples are large representative leaves, branches or root pieces are adequate for diagnostics. It is also useful to send digital pictures of the affected plants. Pictures should include an overview of the affected plants and close ups of the symptoms, these can be sent to the PDC via email. Please call for more information or visit the webpage for complete details on sample submission.

**2015 Sample Submissions**

This year, as of July 1st, we have had 174 submitted samples. Most of these has been for disease diagnosis (Chart 1). This year the number of ornamental samples has been numerous (Chart 2). Many diseases and pests of evergreen ornamentals has been diagnosed. It seems that last year’s cool summer and wet fall set up the perfect conditions for these types of diseases. Needle blights, tip dieback and canker causing diseases are common diagnoses. Samples of deciduous trees are being submitted for leaf curl issues, insect galls, leaf spots, oak wilt and/or bacterial leaf scorch testing. Also ornamentals are being submitted with abiotic issues such winter injury (weeping cherry trees), hail damage, drowned roots / water wilt, etc. The presentation will go over what has been diagnosed, common diseases seen this year, diseases to be on the lookout for and how to submit a great sample for disease identification.

University of Missouri—Plant Diagnostic Clinic
28 Mumford Hall
Columbia, MO 65211
Phone: (573) 882-3019
Email: plantclinic@missouri.edu
Web: plantclinic.missouri.edu
Ornamental Diseases: Sample types, diagnoses and common pathogens

Chart 1

Types of Samples 2015

- Disease ID
- Insect ID
- Plant ID
- Mushroom ID

Chart 2

Disease Diagnosis 2015: Sample Category

- Agronomic: 35%
- Ornamentals: 27%
- Vegetables: 17%
- Fruit: 12%
- Turf: 9%
Soil, Plant, and Nematology Diagnostic Services Available at the University of Missouri for the Turfgrass, Lawn Care, and Landscape Industries

Dr. Manjula Nathan – Associate Professor: Nutrient Management & Amanda Howland, M.S. – Coordinator of MU Extension Nematology Lab

MU Soil and Plant Testing Lab: Provides analysis of soil, plant, water, manure, compost, greenhouse media, and environmental analysis using state of the art technology. Services are available to farmers, homeowners, horticulturists, golf course managers, landscape managers, consultants, researchers and government agencies. The lab provides quality testing and unbiased, research based recommendations to clients for economically viable and environmentally safe nutrient management practices with a rapid turnaround time.

The lab analyzes about 25,000 - 30,000 field crop (farm), 5,000 - 7,000 horticultural crop (lawn, vegetable and flower gardens, landscape), and 1,000 commercial fruits, vegetables and turf soil samples each year. Soil test reports for samples processed through the lab are sent by US mail, email, or can be also accessed online with a password. The regional agronomy/horticulture specialists review reports and make additional comments if needed and mail to the clients. The lab also analyzes about 3,600 plant samples each year to diagnose nutrient related problems and monitor the nutritional status of the plants for managing fertilizer applications. The turnaround time for a soil sample is 1 to 2 working days and for a plant sample is about 3 to 5 working days. Please see our website (listed below) for a complete list of services and fees.

MU Extension Plant Nematology Lab: This lab tests soil and plant samples for the presence of plant-parasitic nematodes. The lab provides accurate and unbiased results on all samples received. Recommendations are provided for management strategies to reduce the effect of nematodes on plant growth and yield. Services the lab provides are soybean cyst nematode egg counts; HG Type “race” tests; plant-parasitic nematode identification and enumeration counts for corn, soybeans, ornamentals, turf and vegetable crops; and quarantine tests. The turnaround time for a sample is 1 to 3 days.

For both labs, it is important to adopt good sampling techniques and submit a representative sample for proper diagnostics. Samples submitted should be accompanied by the sample information forms. Information on submitting samples to the soil and plant testing and nematology labs can be obtained by visiting http://soilplantlab.missouri.edu and http://soilplantlab.missouri.edu/nematode/.

Samples can be submitted directly to the lab or through the University Extension Centers. Mail samples to:

Soil Testing and Plant Diagnostic Services
23 Mumford Hall
University of Missouri
Columbia, MO 65211
Tel: 573-882-3250
Fax: 573-884-4288
Email: SoilTestingServices@missouri.edu

Plant Nematology Lab
23 Mumford Hall
University of Missouri
Columbia, MO 65211
Tel: 573-884-9118
Fax: 573-884-4288
Email: nematodelab@missouri.edu
Turfgrass managers may begin thinking about those first sprayer applications when snow still remains on the ground in early spring and calibration of those sprayers is a necessary first step to be completed. Throughout the month of January, if you participated in the Commercial Pesticide Applicator Training for category 3 (Ornamental & Turf) over the past several years; you were introduced to a simple calibration method. This method is called the “128th Calibration Method” or the “Ounces to Gallons Method” and requires very few steps and no mathematical equations as with standard sprayer calibration. This article will outline this method and provide turfgrass managers a tool for simple calibration for the beginning of every season as well as a simple means to spot check throughout the season. The concept of the 128th method is based on the time it takes to spray 128th of an acre with a single nozzle. That time requirement is then used to collect fluid ounces from that single nozzle. Since we all know that there are 128 fluid ounces in a gallon; the simple conversion or result is in gallons per acre (GPA). Let’s begin.

**STEP 1:**
The first step requires a tape measure to measure the distance between nozzles on your spray boom. Most sprayers are setup at 20 inches, although you may find a range from 10 to 30 inches depending on your spray tip selection.

**STEP 2:**
Use the following table to determine the distance you need to travel with your sprayer to cover 128th of an acre with a single nozzle spacing. If for some reason you do not have this table or miss placed it, the calculation can be performed for whatever nozzle spacing you have (See textbox below). You can also find this table online.

<table>
<thead>
<tr>
<th>Nozzle Spacing (inches)</th>
<th>Nozzle Spacing (feet)</th>
<th>Distance to Travel (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>3.34</td>
<td>102</td>
</tr>
<tr>
<td>38</td>
<td>3.17</td>
<td>107</td>
</tr>
<tr>
<td>36</td>
<td>3.00</td>
<td>113</td>
</tr>
<tr>
<td>34</td>
<td>2.83</td>
<td>120</td>
</tr>
<tr>
<td>32</td>
<td>2.67</td>
<td>127</td>
</tr>
<tr>
<td>30</td>
<td>2.50</td>
<td>136</td>
</tr>
<tr>
<td>28</td>
<td>2.34</td>
<td>146</td>
</tr>
<tr>
<td>26</td>
<td>2.17</td>
<td>157</td>
</tr>
<tr>
<td>24</td>
<td>2.00</td>
<td>170</td>
</tr>
<tr>
<td>22</td>
<td>1.83</td>
<td>185</td>
</tr>
<tr>
<td>20</td>
<td>1.67</td>
<td>204</td>
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<td>1.34</td>
<td>255</td>
</tr>
<tr>
<td>14</td>
<td>1.17</td>
<td>291</td>
</tr>
<tr>
<td>12</td>
<td>1.00</td>
<td>340</td>
</tr>
<tr>
<td>10</td>
<td>0.83</td>
<td>408</td>
</tr>
</tbody>
</table>

To calculate the distance needed to travel for any nozzle spacing, you will note that there are 304.31 square feet in 128th of an acre. Dividing the distance (in inches) between nozzles by 12 will convert that spacing to feet. Taking a square measure and dividing by a linear measure will equal a linear measure. Therefore, if we divide 340.31 square feet (128th of an acre) by 1.67 feet (20 inch nozzle spacing), we will see the distance required to travel is 203.78 feet or 204 feet if we round up.
STEP 3:
The distance required to travel should be flagged out on ground similar to that you plan to spray. If your nozzle spacing is 20 inches, then flag out a distance of 204 feet. Fill your sprayer half full with water and time yourself in seconds, the time it takes to travel that distance at your desired spraying speed. You can make several runs and then take an average, but be sure to take this measurement in seconds.

STEP 4:
For this step you need to have your sprayer operating with water in the tank, desired pressure and a good flow running through your spray tips. To complete this calibration method, you will need a collection cup and stop watch (most cell phones now have stop watches built in). Simply collect fluid from a single nozzle for the time (in seconds) it took for you to travel the distance determined in Table 1. The collection cup should be marked in fluid ounces. After collecting the fluids for the determined time, the fluid ounces collected simply equals Gallons Per Acre (GPA). It’s that simple.

The additional benefit of this method is the ease to spot check your output during the spraying season. If the operating speed of your sprayer remains the same, then measure the output of your nozzles with the collection cup and stop watch. For example, if you were collecting 40 fluid ounces in the determined time and you are still collecting 40 fluid ounces in that time; then you are still putting out 40 GPA. Also keep in mind if you wish to have an output different from what you collect, then simply adjust pressure up or down depending on what direction you wish the output to be. For example, if you are collecting 37 fluid ounces (37 GPA) and wish to be at 40 GPA; adjust the pressure upward until you collect 40 fluid ounces (equal to 40 GPA) in the determined time.

From time to time, it is always recommended to test all spray tips for consistency across the entire boom. If any spray tip is off by 10%, simple replace it. Several inconsistencies across the spray boom may warrant the changing of all spray tips.

This simple calibration method should make spraying preparations easier this spring and help maintain consistent sprayer outputs throughout the season. Several on-line sources discuss and present this method of calibration so the instructions are only a smart phone away – search for “128th calibration method”.

Tip Selection:
Tip selection should be based on the type of product you wish to apply and the gallons per acre required for that product (check product label). Optimum coverage of an herbicide, fungicide or insecticide is determined by the type of spray tip (flat fan, extended range flat fan, cone, flood, air-induction, etc.) selected. Most spray tips these days are color coded by size and still identified by the degree of angle and gallons per minute (GPM) at 40 psi (i.e. – an 8004 is an 80 degree angled tip that delivers 0.4 GPM @ 40 psi). So, make sure you select a tip that is best for your product, applied at the recommended spray volume according to the label, and that you can operate within the desired pressure for that spray tip. Make sure all spray tips are the same, not damaged, and operate properly. For questions please contact: Brad S. Fresenburg, Ph.D. Assistant Extension Professor fresenburghb@missouri.edu
Collin Wamsley - State Entomologist: Missouri Department of Agriculture

We’ve been hearing about emerald ash borer since 2002 when it was first discovered in North America in southeast Michigan. It was first discovered in Missouri in 2008 in southeast Missouri. It is now present in our two major metropolitan areas of Kansas City and St. Louis and many other parts of the state. Missouri Department of Agriculture State Entomologist, Collin Wamsley, will present the latest news on emerald ash borer and what you can do to prepare for it. For more information about exotic forest pests that threaten Missouri, visit treepests.missouri.edu.
When you’re up to your neck in alligators, it’s hard to think about draining the swamp.” So goes the wording of an old saying aimed at reminding people that certain dilemmas in life could have been prevented, had we thought about their cause earlier. It bodes well for those of us having plants that are suffering from the very wet spring we have experienced this year.

The first question to address is, “How does too much rainfall damage plants?” The answers lies in the fact that the cells of plants (including their roots) respire just as do the cells of animals. Since oxygen is needed for respiration, plant cells die without adequate oxygen. The oxygen content of the atmosphere is about 21 percent. The oxygen concentration in the soil atmosphere is significantly lower. Should it drop to less than 10 to 12 percent, plant roots suffocate and die.

When excessive rainfall occurs, soil pores that had been filled with air suddenly become filled with water. The latter forces oxygen-laden air from the soil fairly rapidly. The result is a sub-oxidized, or oxygen-deficient, soil atmosphere.

Plants in standing water or sub-oxidized soil first lose their lower roots where the oxygen concentration initially is lower. If the water persists in the soil for long periods, the roots will gradually die upward until only surface roots remain. The greater the number of roots that die, the less likely the plant will survive after the soil finally dries. Fortunately, not many gardens experience standing water for extended periods of time.

When the soil warms during the early spring, woody ornamentals begin to develop new roots. When the soil is saturated, these roots become oxygen-starved and die nearly as quickly as they are formed. These “feeder roots” are very important for the well-being of the plant. Thus, trying to establish new trees and shrubs in the landscape when the soil continually is wet becomes a challenge.

Additionally, plants that have lost roots during an extended wet period are ill-prepared to handle the rigors of a typical Missouri summer. If the summer remains cool and moist, few root-related problems would be expected. However, if the weather transitions from cool and wet to hot and dry, the reduced root area cannot keep up with the loss of water via transpiration. Leaf scorch, twig dieback, wilting or even death of the plant may result.

Another problem that tends to develop in wet soils is compaction. Driving equipment on or, to a lesser extent, walking on wet, saturated soil tends to reduce larger inter-particle pore spaces into smaller ones, resulting in soil compaction. The problem is more severe in clay soils than in sandy soils. Compaction not only reduces the amount of air in the soil while it is wet, it will continue (to a lesser extent) the problem after the soil dries.

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Because of heavy spring rains this year, garden plants should be monitored carefully during the next months. Water them regularly if we should experience dry periods. As a rule, most garden plants require about an inch of water per week during the summer. If this is not received as rainfall, supplemental irrigation should be practiced. When doing the latter, water well but avoid frequent, light watering. The latter tends to discourage plants from developing a deep, penetrating root system.

What about “draining the swamp?”

Other than not locating a garden in a flood plain, little can be done to prevent damage to plants growing in standing water. However, there are things that can be done to minimize the damage to garden plants during extended wet periods of weather. All involve working with the soil.

Plants growing in permeable, well-drained soil are less subject to wet-weather damage than those growing in “tight” soils. Permeable soils retain less of the rainfall they receive because of their large inter-particle pores. Thus, the pore spaces that held air before a rain event soon re-establish their air content, thanks largely to gravity.

Permeability is a function of soil structure. The latter describes the arrangement of soil particles (solids) and the pore spaces between them. When soil particles aggregate, they form “clumps” and have larger pores form between the solids. This promotes rapid infiltration of water and good drainage. Conversely, when soil particles are dispersed, pores become small and are more likely to retain water rather than air. Dispersed soils are notorious for being poorly drained.

Few things are better at building good soil structure than organic matter. As organic matter is broken down by soil microbes, the mineral components of soil (sand, silt and clay) tend to become coated. The latter facilitates the aforementioned aggregation, which provide large pores and that allow rainfall to pass through the soil.

Soil organic matter is liable, meaning it is constantly undergoing chemical, physical and biological change. For this reason the incorporation of about four inches of well-decomposed organic matter on an annual basis is considered to be a “best management practice” for garden soils.

Gypsum (calcium sulfate) is a naturally-occurring substance that has been used for centuries to improve soil. Gypsum causes soil structure to be more sponge-like, causing water to infiltrate faster through the soil rather than “pond” or run-off. The end result is an increase in the amount of oxygen available to plants roots.

Another technique to cope with wet weather or poorly-drained soils is to plant on berms. A berm simply is a mound of soil with sloping sides. Since berms are sloped, rain is more likely to run off than to be absorbed by the soil. Properly designed, berms also tend to control erosion in gardens that are not level.

In closing, Charles Dudley Warner is credited with the saying, “Everybody talks about the weather, but no one does anything about it.” Evidently, Mr. Warner was not a gardener.
Most people who are active in caring for their lawns and landscaped plants are aware of (and concerned about) the decline of insect pollinators, such as certain types of bees and butterflies, that has occurred over the past couple of decades. Regarding the economic importance of pollinators, a recent government report stated that “honey bees enable the production of at least 90 commercially grown crops in North America . . . [and that] native wild pollinators, such as bumble bees and alfalfa leafcutter bees, also contribute substantially to the domestic economy.”

Reasons for the diminishing numbers of honey bees include combinations of habitat loss, parasites (such as mites), diseases (including bacteria and viruses), and pesticide exposure. Even sublethal exposures to pesticides can negatively impact insect pollinators in many ways, such as negatively affecting their orientation and feeding behaviors, ability to reproduce, and increase their susceptibility to diseases.

For pollinator conservation, the most important thing a homeowner can do is to not apply pesticides to plants with open flowers. Additionally, to encourage pollinator presence a homeowner should plant a variety of plants with different bloom colors and shapes that flower at different times throughout the growing season. This will provide continuous food (nectar and pollen) sources and nesting habitats for many types of insect pollinators.

When utilizing turfgrass insecticides, several practical measures for protecting pollinators and other beneficial insects should be implemented. For example:

- Mow all areas before applying insecticides. This will remove most of the weed flowers, and it will reduce bee foraging in insecticide treated areas.
- Apply insecticides in the early morning or late evening when bees are less likely to be actively foraging (or when the air temperature is below 55°F).
- Use buffer strips between treated turf areas and landscape beds.
- Consider using spot treatments rather than broadcast applications.
- Whenever possible, use insecticides that are less toxic to bees.

It should be remembered that insecticide use should be the last resort in managing insect pests. We all want to maintain the visual appeal of our yards and landscapes, but most insect species found feeding on our flowers, ornamentals and turf are not harmful to the plant, and their presence in low densities should be tolerated. Both homeowner and commercial use of insecticides should involve careful, responsible, and prudent applications of compounds that are toxic to beneficial insects. Beginning in 2014, some pesticide labels started to feature a “pollinator protection box” (or bee icon) that will alert applicators about specific use restrictions found in the directions that apply to the product's use in order to protect bees and other insect pollinators.
Dr. Xi Xiong and Enzhan Song

Introduction

Pylex® (a.i. topramezone) is an HPPD inhibitor that was introduced to the turf market recently. It is labeled for golf courses, athletic fields, sod farms and residential areas (spot treatment only) where tolerant turf species, mainly cool-season turfgrasses except bentgrass, grow. Warm-season species, including zoysiagrass (*Zoysia* spp.), are susceptible to Pylex®. This trial conducted at the University of Missouri was to evaluate the effectiveness of Pylex® for control of zoysiagrass (*Zoysia japonica*) on tall fescue (*Festuca arundinacea*) turf with or without Turflon® (a.i. triclopyr).

Materials & Methods

Field plots were established at the University of Missouri Turfgrass Research Facility in Columbia, Missouri. Plots were established on ‘Winning Colors’ tall fescue maintained at 3 inches mowing height with adequate moisture and fertility. Total five treatments (Table 1) were arranged in a randomized complete block design with 4 replications, with individual plot measured 5ft by 5ft. On June 20th, 2014, a strip of sod, measured 20 in by 5ft, were removed from the center of each plot by a sod cutter and replaced by a piece of ‘Meyer’ zoysiagrass sod. After zoysiagrass sod established, the initial treatment were applied on September 5th, 2014, with sequential applications made 3 weeks apart at September 26th and again October 18th, 2014. Applications were made using a CO2-pressurized backpack boom sprayer equipped with TeeJet XR8004 flat fan nozzles calibrated to deliver 44 gallons/acre.

<table>
<thead>
<tr>
<th>PRODUCT*</th>
<th>RATE</th>
<th>INTERVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Untreated</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>2. Pylex</td>
<td>1.5, 1.5, 1 oz</td>
<td>3 apps. - 3 weeks apart</td>
</tr>
<tr>
<td>3. Pylex</td>
<td>1 + 1 + 1</td>
<td>3 apps. – 3 weeks apart</td>
</tr>
<tr>
<td>4. Pylex+Triclopyr ester</td>
<td>1.5+32, 1.5+32, 1+32 oz</td>
<td>3 apps. – 3 weeks apart</td>
</tr>
<tr>
<td>5. Pylex+Triclopyr ester</td>
<td>1+32, 1+32, 1+32 oz</td>
<td>3 apps. – 3 weeks apart</td>
</tr>
</tbody>
</table>

*All rates are in ounces per acre; all Pylex®-containing treatments were sprayed with MSO at .5% (v/v).

Data collected included turf quality (1-9) and potential phytotoxicity (1-9) at weekly basis prior to treatment application till November, 2014, and resumed in spring 2015 from May to mid-June after zoysiagrass resumed full growth from dormancy. Treatment effect, such as discoloration on zoysiagrass, were also recorded as percent injury (%) in fall 2014. In spring 2015, zoysiagrass greenup was monitored from April till May as percent zoysiagrass greenup (%) in the sodded area. In spring 2015, tall fescue started to grow into the sodded area, which was recorded as percent tall fescue regrowth. Once zoysiagrass resumed full growth in late-May, zoysiagrass cover in the sodded area were monitored and percent zoysiagrass control were calculated relative to the initial zoysiagrass cover in 2014 after sodding. All data collected were subjected to statistical analysis using SAS (9.3) Proc Glm procedure, and significant means were separated using Fisher’s Protected LSD at 0.05 probability level. The data/graphs presented in this report only contain partial data from selected evaluation dates for simplicity.
Results & Discussion

1. Phytotoxicity: Throughout this experiment, none of the treatments applied resulted in any visible phytotoxicity to tall fescue plants, regardless of treatment rates and/or addition of Turflon.

2. Treatments effects on zoysiagrass: In fall, 2014, treatment applied caused visual injury to zoysiagrass plants.

![Zoysiagrass Injury% in Fall, 2014](image)

**Fig 1. Zoysiagrass percent injury (%) affected by treatments applied in fall, 2014.** Bars at each week after initial treatment (WAIT) labeled with the same letters were not significantly different at 0.05 probability level.

Injury symptoms included discoloration (bleached color for treatments containing Pylex only, or brown color for treatments containing Pylex and Turflon), and thinning of the zoysiagrass stand towards later part of the season. At 4 weeks after initial treatment (WAIT, Oct 6, 2014), all treatments showed 10% or more injury to zoysiagrass, compared to control plots where no injury were found (Fig 1). At 8 WAIT, all treatments showed 40% or more injury to the zoysiagrass plants, and treatments containing Pylex at a higher rate (1.5 oz/a) and/or tank-mixing with Turflon showed up to 15% more injury compared to Pylex at a lower rate (1 oz/a) alone.

In spring, 2015, zoysiagrass greenup in the treated plots delayed significantly compared to untreated plots (Fig 2). By May 22nd, 2015 (37 WAIT), zoysiagrass in untreated plots reached 80%+ greenness, relative to the sodded area. In comparison, treated plots, regardless of Pylex rates and/or addition of Turflon, only showed 10% or less greenness.
Fig 2. Zoysiagrass spring greenup (%) affected by treatments applied in fall, 2014. Bars at each evaluation timing labeled with the same letters were not significantly different at 0.05 probability level.

Percent zoysiagrass cover (%) relative to each plot area (5 ft by 5 ft) were evaluated from the end of May to mid-June, 2015. Data showed that treated plots had 5.5% or less plot areas that were covered by zoysiagrass by June 15th, 2015 (Fig 3). In comparison, the untreated control plots showed approximately 15% of zoysiagrass cover by mid-June, 2015. Pylex rate and/or addition of Turflon did not show statistical difference in zoysiagrass cover by mid-June.

Fig 3. Percent zoysiagrass cover (%) in late spring, 2015 affected by treatments applied in fall, 2014. Bars at each evaluation timing labeled with the same letters were not significantly different at 0.05 probability level.
When zoysiagrass plants were still in dormancy, tall fescue plants started to encroach into the sodded area in spring 2015. Although tall fescue plants re-established into the sodded area of the untreated plots as well, treated plots appeared to show higher percent of tall fescue plants (Fig 4). By Mid-June, 2015, treatment with Pylex at 1.5+1.5+1 oz/a rate without Turflon yielded the highest re-establishment of tall fescue in the sodded area, which accounts for 1.7 times more coverage than the untreated control.

Subsequently, treated plots showed significantly zoysiagrass control compared to control plots. By mid-June, all treatments reached 80% or above zoysiagrass control (Fig 5), compared to the initial zoysiagrass cover after sodding (33% of a plot). In the control plots, tall fescue encroachment into the sodded areas as well, which reduced zoysiagrass cover from 33% initially to approximately 15% by mid-June. This explains the zoysiagrass control in control plots (~55%) in Fig 5 below.

Fig 4. Treatment effects on percent tall fescue (%) encroached into the sodded area in spring, 2015. Significant differences were only found for data collected on June 15th, 2015, and hence mean separation was only performed for data collected at this timing. Bars labeled with the same letters were not significantly different at 0.05 probability level.

Subsequently, treated plots showed significantly zoysiagrass control compared to control plots. By mid-June, all treatments reached 80% or above zoysiagrass control (Fig 5), compared to the initial zoysiagrass cover after sodding (33% of a plot). In the control plots, tall fescue encroachment into the sodded areas as well, which reduced zoysiagrass cover from 33% initially to approximately 15% by mid-June. This explains the zoysiagrass control in control plots (~55%) in Fig 5 below.

Fig 5. Treatment effects on percent (%) zoysiagrass control evaluated on June 15, 2015. Bars labeled with the same letters were not significantly different at 0.05 probability level.
Treatments effects on turf quality: In fall 2014, treatment applied did not influence the turf quality due to the sod replaced in each plot. In spring 2015, however, treatment applied affected the zoysiagrass regrowth and tall fescue re-establishment in the sodded area, and consequently affected the turf quality evaluated from the end of May to mid-June, 2015.

Figure 6. Treatment effect on turf quality (1-9) evaluated in spring, 2015. There were significant treatment by evaluation timing interaction; hence multi-comparison were performed. Treatments at the same evaluation timing labeled with the same letters were not significantly different at 0.05 probability level; the same treatment at different evaluation timings labeled with the same numbers were not significantly different at 0.05 probability level.

Turf quality in control plots and treated plots all increased from May to June, 2015 (Fig 6), primarily due to the regrowth of zoysiagrass and establishment of tall fescue into the sodded area. By Mid-June, 2015, although all plots showed acceptable turf quality (6 or above), plots treated with Pylex at 1.5 oz/a rate alone showed the best turf quality at 7, which was mainly contributed by the tall fescue re-establishment showed in Fig 4 above.

Conclusion

- Pylex® appears to be safe on tall fescue turf, regardless of application rate (1 or 1.5 oz/a) or w/o Turflon;
- Sequential Pylex application starting in fall appears effective (>80% control) for suppress zoysiagrass on tall fescue turf;
- Tank-mixing with Turflon reduces the bleaching color initially compared to Pylex alone, but does not show a significant additive effect on zoysiagrass control;
- Although sequential application of Pylex alone at 1.5 oz/a is as effective as 1.0 oz/a rate for control of zoysiagrass, our data suggest that the higher rate of Pylex results in a higher percentage of tall fescue re-establishment the next season, and ultimately a higher turf quality.
- This is an ongoing experiment with applications in fall, 2015 to be scheduled, in order to assess Pylex® for eradicating of zoysiagrass on tall fescue turf.
Summary

The objective of this study is to evaluate the safety and performance of SMS soil surfactants at various application rates and timings. Experimental plots (5ft x 5ft) were established on two locations, one on creeping bentgrass (Agrostis stolonifera L.) USG green and the second on creeping bentgrass growing on native soil maintained at a typical fairway mowing height (0.75 inches). Treatments were arranged in a randomized complete block design with four replications. A detailed list of treatments can be found in table 1 below. Treatments were applied using a CO$_2$ pressurized backpack sprayer calibrated to deliver 60 gal/ac using TeeJet XR 8006 flat fan nozzle tips. Following applications, all treatments were watered in with a minimum of 0.2 inch of irrigation. Maintenance irrigation is applied at a rate no more than 75% evapotranspiration (ET) replacement.

Measurements include weekly ratings of turf quality, normalized difference vegetative index (NDVI), volumetric water content (VWC), phytotoxicity of treatment, and percentage of localized dry spot. Turf quality were measured on a scale of 1-9 (1= poor turf quality, 6= minimally accepted quality, and 9= best turf quality), NDVI measurements were collected using a Green Seeker® handheld sensor and range from 0.0-1.0, VWC measurements were taken using a soil moisture sensor with 4.0 inches probes, and phytotoxicity of treatment were measured on a scale of 1-9 (9= no toxicity and 1= completely kill).

Table 1. Description of the treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Product</th>
<th>Rate</th>
<th>Re- application Interval (days)</th>
<th>Total Number of Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Untreated</td>
<td>---</td>
<td>------</td>
<td>____</td>
</tr>
<tr>
<td>2</td>
<td>SMS-0714</td>
<td>7.0 fl oz./1000 ft$^2$</td>
<td>7</td>
<td>(2+1)*</td>
</tr>
<tr>
<td>3</td>
<td>SMS-0714</td>
<td>3.5 fl oz./1000 ft$^2$</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>SMS-0714</td>
<td>7.0 fl oz./1000 ft$^2$</td>
<td>28</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>SMS-0714</td>
<td>7.0 fl oz./1000 ft$^2$</td>
<td>7</td>
<td>(2+1)*</td>
</tr>
<tr>
<td>6</td>
<td>SMS-0214</td>
<td>24 fl oz./A</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>SMA-0214</td>
<td>24 fl oz./A</td>
<td>28</td>
<td>4</td>
</tr>
</tbody>
</table>

*First two applications are applied on 7 days interval and third application is applied on the third week of August.
**The first treatment was applied on June 9th.
Trial Map

Plot size: 5ft x 5ft
Number inside cell represents treatment #

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Current findings

At 3 weeks after the initial treatment, we observed improved turf quality from most of the treatment, compared to control (Fig 1). This is an ongoing experiment and results will be collected continuing to October, 2015.

Fig 1. Treatment effect on turf quality (1-9) at 3 weeks after the initial treatment application (June 30, 2015). Data were collected from the creeping bentgrass turf maintained at 0.75 inches mowing height.
Zoysiagrass has relatively few disease problems in comparison with cool-season turfgrass species. However, large patch, caused by the fungal pathogen *Rhizoctonia solani* AG-2-2 LP, can be a serious problem. The objective of this study was to evaluate the effects of soil amendments on large patch disease development and soil physical and chemical properties.

Field plots were established on the 9th hole fairway at the Columbia Country Club in Columbia, Missouri. Treatments were arranged in a split-plot design with application method as the whole plot variable and organic amendment as the subplot variable with four replications. Each sub-plot (5 ft × 8 ft) was inoculated with *R. solani* in the fall of 2012. Application methods included topdressing only, or topdressing following core aerification. Organic amendments included mustard seed meal (MSM), Back to Nature® chicken manure, and Milorganite® fertilizer, in addition to UMAXX® (urea-based fertilizer), Heritage® fungicide, and an untreated control (Table 1). The rates of organic amendments were determined based on the nitrogen content compared to MSM. All organic amendments and synthetic fertilizer provide 1.5 lb N/1,000 ft² per application. The rate of Heritage® was 0.4 oz/1000 sq ft, and it was applied by a CO₂ pressurized backpack sprayer calibrated to deliver 60 gallon per acre using Tee Jet XR8006 flat fan tips.

Evaluations included biweekly assessments of turfgrass quality (1-9), phytotoxicity (1-9), percent large patch cover, volumetric soil water content, normalized difference vegetation index (NDVI) by GreenSeeker® handheld sensor, and digital image analysis for percent of green cover. Soil physical properties included thatch layer depth and bulk density using a bulk density sampler. Soil chemical properties were monitored by measuring organic matter content, pH, concentrations of P, K, Fe, Ca, Mn, and NH₄-N and NO₃-N. All soil characteristics were analyzed before initial treatment application, and one and two years after the initial treatment application. Prior to the initial treatment application in June 2013, more than 90% of plots inoculated with *R. solani* the previous fall had developed large patch disease symptoms (Fig 1). Sequential applications were made once in fall (in late September) 2013, and again in June and September, 2014.

**Current findings**

Thatch layer depth and bulk density were reduced at two years after initial treatment application compared to one year after initial treatment application. Topdressing following aerification method significantly reduced thatch layer depth and bulk density at 23% and 9%, respectively, compared to topdressing method over the 2-year period (Table 2). Large patch percent coverage over the two growing seasons was calculated and expressed as the area under disease progress curve (AUDPC). Compared to the untreated control, plots that received organic amendments showed a trend of reduced AUDPC. Plots that received chicken manure and fungicide Heritage® showed significant reduction of AUDPC over the two growing seasons (Fig 2).
**Table 1. Description of products, application rates, and application delivery methods.**

<table>
<thead>
<tr>
<th>Trt #</th>
<th>Application method</th>
<th>Product</th>
<th>Application rate</th>
<th>Delivery amount (USGA sand plus product)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>topdressing</td>
<td>Back to Nature® chicken manure</td>
<td>1338 lb/A</td>
<td>0.25 inch</td>
</tr>
<tr>
<td>2</td>
<td>topdressing</td>
<td>Heritage®</td>
<td>0.4 oz/1000 sq ft</td>
<td>0.25 inch</td>
</tr>
<tr>
<td>3</td>
<td>topdressing</td>
<td>Milorganite® fertilizer</td>
<td>1338 lb/A</td>
<td>0.25 inch</td>
</tr>
<tr>
<td>4</td>
<td>topdressing</td>
<td>Mustard seed meal</td>
<td>1338 lb/A</td>
<td>0.25 inch</td>
</tr>
<tr>
<td>5</td>
<td>topdressing</td>
<td>UMAXX®</td>
<td>143 lb/A</td>
<td>0.25 inch</td>
</tr>
<tr>
<td>6</td>
<td>topdressing</td>
<td>Untreated control</td>
<td>--</td>
<td>0.25 inch</td>
</tr>
<tr>
<td>7</td>
<td>Topdressing + aeration</td>
<td>Back to Nature® chicken manure</td>
<td>1338 lb/A</td>
<td>Adequate to fill the aeration holes</td>
</tr>
<tr>
<td>8</td>
<td>Topdressing + aeration</td>
<td>Heritage®</td>
<td>0.4 oz/1000 sq ft</td>
<td>Adequate to fill the aeration holes</td>
</tr>
<tr>
<td>9</td>
<td>Topdressing + aeration</td>
<td>Milorganite® fertilizer</td>
<td>1338 lb/A</td>
<td>Adequate to fill the aeration holes</td>
</tr>
<tr>
<td>10</td>
<td>Topdressing + aeration</td>
<td>Mustard seed meal</td>
<td>1338 lb/A</td>
<td>Adequate to fill the aeration holes</td>
</tr>
<tr>
<td>11</td>
<td>Topdressing + aeration</td>
<td>UMAXX®</td>
<td>143 lb/A</td>
<td>Adequate to fill the aeration holes</td>
</tr>
<tr>
<td>12</td>
<td>Topdressing + aeration</td>
<td>Untreated control</td>
<td>--</td>
<td>Adequate to fill the aeration holes</td>
</tr>
</tbody>
</table>

**Table 2. Thatch layer depth and bulk density for two delivery methods or at one and two years after initial application.**

<table>
<thead>
<tr>
<th>Method</th>
<th>Thatch layer (mm)</th>
<th>Bulk density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topdressing</td>
<td>9.6a†</td>
<td>1.2a</td>
</tr>
<tr>
<td>Topdressing + Aeration</td>
<td>7.8b</td>
<td>1.1b</td>
</tr>
<tr>
<td>Year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>9.4a</td>
<td>1.3a</td>
</tr>
<tr>
<td>2</td>
<td>7.9b</td>
<td>1.0b</td>
</tr>
</tbody>
</table>

†Means followed by the same letter within the same column indicated no significant differences (P=0.05) between two delivery methods or between two years.
Figure 1. Large patch development on zoysiagrass (Z. japonica) fairway at Columbia Country Club in Columbia, Missouri, after inoculation with R. solani the previous fall. Photo was taken on June 11, 2013.

Figure 2. Treatment effect on area under disease progress curve (AUDPC) over 2 years after initial treatment application. Bars labeled with the same letter are not significant different ($P=0.05$).
Dollar spot, caused by the fungus Sclerotinia homoeocarpa F. T. Bennett, is a widely distributed disease affecting most turfgrass species in North America. Peak development of dollar spot on cool season turfgrasses occurs during late spring to early summer, and again in late summer to early fall. Disease symptoms include bleached leaf blades with the edge of lesions outlined in red/brown coloration and straw-colored turf patches as the size of a silver dollar coin. Progression of this disease leads to coalescing of the infected patches, which subsequently results in larger irregular patches. On a golf course putting green, patchy, sunken areas of dead turf reduce the aesthetic value, affect ball roll, and negatively impact playability.

The objective of this experiment was to evaluate organic amendments and fertilizers for safety and efficacy in control of dollar spot on creeping bentgrass (Agrostis stolonifera) green. Treatments were arranged in a completely randomized block design with four replications. The products included organic amendments of mustard seed meal (MSM), Back to nature® chicken manure, and Milorganite®, and fertilizers of UMAXX® and MicroPel®, in addition to 26 GT® fungicide (a.i. iprodione) and an untreated control. The field plots (each 3ft × 3ft) were inoculated with Sclerotinia homoeocarpa on May 13, 2015. The first treatment application was applied after all plots developed dollar spot and 70% or more infection centers reached 1/3 of a dollar coin. This study is an ongoing project and will be carried out for two years. Sequential applications included MSM at 749 lb/A, MicroPel® at 435 lb/A, and other organic amendments and fertilizers which provide the same about of N to treatment contained in MSM (Table 1). The 26 GT® fungicide was applied at the label rate of 4 fl oz/1000 sq ft. Measurements, including phytotoxicity (1-9), turf color (1-9), turf quality (1-9), normalized difference vegetation index (NDVI) and numbers of dollar spot infection centers, were evaluated weekly, in addition to digital image analysis for percent of green cover.

Current findings

The first application was applied on the chipping green at Columbia Country Club in Columbia, Missouri, on May 21, 2015. At 6 weeks after the initial treatment application, some of the treatment significantly reduced dollar spot counts, and subsequently improved turf quality compare to untreated controls. This experiment is still ongoing. The results will be discussed next year.
Table 1. Description of products, application rates and application schedule.

<table>
<thead>
<tr>
<th>Trt#</th>
<th>Material</th>
<th>Application rate</th>
<th>Initial application</th>
<th>Second application</th>
<th>Third application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Back to Nature® chicken manure</td>
<td>999 lb/A</td>
<td>21-May-15</td>
<td>05-June-15</td>
<td>19-June-15</td>
</tr>
<tr>
<td>2</td>
<td>26 GT® fungicide</td>
<td>4 fl oz/1000 sq ft</td>
<td>21-May-15</td>
<td>05-June-15</td>
<td>19-June-15</td>
</tr>
<tr>
<td>3</td>
<td>Micropel® fertilizer</td>
<td>435 lb/A</td>
<td>21-May-15</td>
<td>05-June-15</td>
<td>19-June-15</td>
</tr>
<tr>
<td>4</td>
<td>Micropel®+UMAXX®</td>
<td>435lb/A+106lb/A</td>
<td>21-May-15</td>
<td>05-June-15</td>
<td>19-June-15</td>
</tr>
<tr>
<td>5</td>
<td>Milorganite® fertilizer</td>
<td>999 lb/A</td>
<td>21-May-15</td>
<td>05-June-15</td>
<td>19-June-15</td>
</tr>
<tr>
<td>6</td>
<td>Mustard seed meal</td>
<td>749 lb/A</td>
<td>21-May-15</td>
<td>05-June-15</td>
<td>19-June-15</td>
</tr>
<tr>
<td>7</td>
<td>Mustard seed meal</td>
<td>999 lb/A</td>
<td>21-May-15</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>8</td>
<td>Mustard seed meal</td>
<td>1499 lb/A</td>
<td>21-May-15</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>9</td>
<td>UMAXX®</td>
<td>106 lb/A</td>
<td>21-May-15</td>
<td>05-June-15</td>
<td>19-June-15</td>
</tr>
<tr>
<td>10</td>
<td>Untreated control</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Figure 1. Representative picture for dollar spot development on creeping bentgrass (Agrostis stolonifera L.) green at Columbia Country Club in Columbia, Missouri, after inoculation with Sclerotinia homoeocarpa on May 13, 2015. Photo was taken on May 21, 2015.
Enzhan Song and Dr. Xi Xiong

Objective

The objective of this study is to:
1. investigate the effect of selected wetting agents on plant available water under reduced irrigation; and
2. determine the potential effect of wetting agent on improving nitrogen use efficiency.

Materials and Methods

Water repellent sand was collected from a USGA green at the Turfgrass Research Center of the University of Missouri, Columbia. Water droplet penetration tests (WDPT) on the sand collected showed a strong hydrophobicity (>120 seconds). Creeping bentgrass plugs at one inch diameter were pulled from the same green, and propagated with the collected hydrophobic sand in containers (1.5 inches diameter and 8.25 inches depth). Plants were grown in the growth chamber with adequate water for 4 days, and allowed to dry down for 3 days. All plants were then fertilized with UFLEX at 1 lb/A of nitrogen immediately before wetting agent applications. Selected wetting agents (Table 1) were applied and watered in with 0.25 inches of irrigation.

The treated plants were subjected to varied irrigation at 75, 100, or 125% of evapotranspiration (ET) rate every 24 hours. ET replacement was carried out by weighing each container after irrigation and again 24 h after in order to calculate ET loss during the 24-h period. Factorial treatments combinations (4×3) were arranged in a complete randomized design with four replications.

Measurements included turf quality and leave relative water content (RWC) at weekly basis. By the end of 21 days after treatment (DAT), the shoot and root tissues were separated for biomass measurements. The dried leaf tissue were then analyzed for the percent nitrogen content. The experimental design was a complete randomized design with four replications.

Current Finding

By the end of 21 DAT, results showed a significantly greater turf quality (Table 2) and RWC by Cascade Plus (Figure 1), under reduced irrigation maintenance (75% ET compensation). Analysis of tissue nitrogen content is still ongoing and this is study is going to be repeated one more time for conclusive results. More data will be updated in publications.
Table 1. Wetting agents list and application rates.

<table>
<thead>
<tr>
<th>Wetting agent</th>
<th>Rate (fl oz/1000 ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascade Plus</td>
<td>8</td>
</tr>
<tr>
<td>Hydro-Wet</td>
<td>8</td>
</tr>
<tr>
<td>Tournament-Ready</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 2. Turf quality of plants treated with different wetting agents under varied irrigation regime. Means followed by the same letter in each column are not significant different (P=0.05).

<table>
<thead>
<tr>
<th>Wetting agents</th>
<th>% ET compensation</th>
<th>0 DAT</th>
<th>7 DAT</th>
<th>14 DAT</th>
<th>21 DAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascade Plus 75</td>
<td>8</td>
<td>5.7de</td>
<td>5.3bc</td>
<td>5.3c</td>
<td></td>
</tr>
<tr>
<td>Cascade Plus 100</td>
<td>8</td>
<td>5.3e</td>
<td>5.7b</td>
<td>5.7c</td>
<td></td>
</tr>
<tr>
<td>Cascade Plus 125</td>
<td>8</td>
<td>5.7de</td>
<td>5.7b</td>
<td>6bc</td>
<td></td>
</tr>
<tr>
<td>Control 75</td>
<td>8</td>
<td>6.7bc</td>
<td>5.0bc</td>
<td>3.0d</td>
<td></td>
</tr>
<tr>
<td>Control 100</td>
<td>8</td>
<td>7.7a</td>
<td>7.0a</td>
<td>7.0a</td>
<td></td>
</tr>
<tr>
<td>Control 125</td>
<td>8</td>
<td>7.7a</td>
<td>7.3a</td>
<td>6.7ab</td>
<td></td>
</tr>
<tr>
<td>Hydro-Wet 75</td>
<td>8</td>
<td>6.7bc</td>
<td>4.7c</td>
<td>2.0e</td>
<td></td>
</tr>
<tr>
<td>Hydro-Wet 100</td>
<td>8</td>
<td>7.0ab</td>
<td>6.7a</td>
<td>6.7ab</td>
<td></td>
</tr>
<tr>
<td>Hydro-Wet 125</td>
<td>8</td>
<td>6.7bc</td>
<td>7.0a</td>
<td>6.7ab</td>
<td></td>
</tr>
<tr>
<td>Tournament-ready 75</td>
<td>8</td>
<td>6.0cde</td>
<td>5.3bc</td>
<td>3.3d</td>
<td></td>
</tr>
<tr>
<td>Tournament-ready 100</td>
<td>8</td>
<td>6.3bcd</td>
<td>6.7a</td>
<td>6.7ab</td>
<td></td>
</tr>
<tr>
<td>Tournament-ready 125</td>
<td>8</td>
<td>7.0ab</td>
<td>6.7a</td>
<td>6.7ab</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Relative water content (%) of treated plants at 21 day after treatment influenced by wetting agents and irrigation regimes. Bars labeled with the same letter are not significant different (P=0.05).
Summary

This growth chamber study was to quantitatively determine if application of MicroPel® enhances the root/shoot growth of Creeping Bentgrass (Agrostis stolonifera L.) under reduced irrigation. Creeping bentgrass core samples (0.75 inch diameter) were pulled from a USGA green, and transplanted into cone-tainers (1.5 inches diameter and 14 inches depth) with USGA-spec sand. Plants were acclimated in the growth chamber for 4 days before subjected to treatments of MicroPel® at 5.0 lbs/1000 ft$^2$ followed by daily water compensation of 100% or 50% evapotranspiration (ET) loss. Evaluations include turf quality and color (1-9 scale, where 9 is the best and 6 is acceptable) at weekly basis, and shoot and root biomass determined at 3 weeks after initial treatment (WAIT). This experiment was a factorial treatment combination, and arranged in a randomized complete block design with four replications. The factorial treatment combinations were with/without MicroPel® and irrigation at 100% or 50% ET replacement, i.e. 2×2=4 total treatments.

Current Finding

At 2 and 3 WAIT, application of MicroPel® significantly improved turf color of plants maintained under 50% ET compensation, compared to untreated control (Figure 1). At 3 WAIT, MicroPel® treated plants under reduced irrigation regime showed 29% and 39% increase for above-ground shoot biomass and root biomass, respectively, compared to controls (Figure 2). The results indicated an overall improved creeping bentgrass performance under reduce irrigation, when MicroPel® was applied.

Figure 1. Turf Color from 0 to 3 WAIT. Bars labeled with the same letter are not significantly different (P=0.05).
Effect of Micronutrient Fertilizer MicroPel® on Improving Creeping Bentgrass (Agrostis stolonifera L.) Shoot and Root Growth under Reduced Irrigation

Figure 2. Creeping bentgrass shoot biomass (gram) influenced by different treatments at 3 weeks after treatment application. Bars labeled with the same letter are not significant different (P=0.05).

Figure 3. Creeping bentgrass root biomass (gram) influenced by different treatments at 3 weeks after treatment application. Bars labeled with the same letter are not significant different (P=0.05).
Introduction

Windmill grass (Chloris truncate) is a perennial, warm-season grass that is native or has been introduced to nearly every region of the United States. The shape of the seed head is where the name ‘Windmill’ comes from, with several horizontal spikelet grow out from the stem to form a circular pattern that resembles the sails of a windmill. Windmill grass has the ability to survive and even thrive in poor soil conditions such as sand and clay base soils where desired turfgrass may become thinned out under competitive stress conditions. Recently, it has been observed that windmill grass started to encroach into various turf area in Missouri and surrounding states. The objective of this experiment was to determine the efficacy of selected post-emergence herbicides for control of windmill grass.

Summary

This study was conducted in greenhouse at the University of Missouri in Columbia, Missouri. Windmill grass was propagated with seeds collected from local lawns and public turf area. Once reached 3 tiller stage, individual plants were transplanted into 6 inch diameter pots with ProMix as growing medium. Eight treatments (Table 1) were arranged in a randomized complete block design with 4 replications. Treatments were applied at 44 gallons/acre using a CO2-pressurized backpack boom sprayer with TeeJet XR8004 flat fan nozzles.

Visual assessments of percent shoot injury were taken weekly for 4 weeks, along with photos at each rating date. Total above ground tissues were harvested at 4 weeks after treatment (WAT) and dried for a biomass determination. Shoot regrowth condition was also monitored after removing the above-ground shoots. Current results showed an excellent control from Acclaim alone and Pylex tank-mixing with Turflon, with >65% and >40% shoot injury at 1 WAT, respectively, and 100% shoot death at 4 WAT for both treatments (Figure 1). No shoot regrowth was observed for these two treatments at 2 weeks after shoot removal (Figure 2), indicating total kill of the underground tissues. Tenacity alone exhibited certain level of suppression with maximum 50% shoot injury at 3 WAT, but the plants started to recover at 4 WAT. It is to be noted, however, Tenacity tank-mixing with Turflon was not included in this run of experiment. Other treatments showed limited effect on windmill grass control. However, regrowth was suppressed for all treated plants, indicating impact to the crown and/or roots system. As Tenacity and Pylex have the same mode of action (HPPD herbicides), further research will be conducted to investigate the potential enhanced effect of Tenacity tank-mixing with Turflon, in comparison to Pylex plus Turflon, or Turflon alone.

Table 1. Treatment list.

<table>
<thead>
<tr>
<th>Trt #</th>
<th>Product</th>
<th>Product Rate (fl oz/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control Untreated</td>
<td>---</td>
</tr>
<tr>
<td>2</td>
<td>Revolver</td>
<td>35.2</td>
</tr>
<tr>
<td>3</td>
<td>Tribute Total</td>
<td>3.2</td>
</tr>
<tr>
<td>4</td>
<td>Dismiss</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Acclaim</td>
<td>39</td>
</tr>
<tr>
<td>6</td>
<td>Tenacity</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Drive</td>
<td>64</td>
</tr>
<tr>
<td>8</td>
<td>Pylex + Turflon</td>
<td>2 + 32</td>
</tr>
</tbody>
</table>
Effect of Post Emergent Herbicides on Windmill Grass (Chloris truncate) Control

Figure 1. Photos taken 4 weeks after treatments.

Figure 2. Photos taken 2 weeks after aboveground tissue was harvested.
Summary

The objective of this experiment was to evaluate selected pre-emergence herbicides for control of crabgrass (Digitaria spp.) and broadleaf weeds applied at different timings. Treatments included a Specticle Flo (a.i. indaziflam), as well as two pre-emergence herbicides Dimension (a.i. dithiopyr) and Barricade (a.i. prodiamine). In addition, Specticle Flo was evaluated at full (9 fl oz/A) and half (4.5 fl oz/A) rates (Table 1). Application timing was also considered as a factor where treatments were applied at three stages: pre-, early post-, and post-emergence. Representative local weeds, smooth crabgrass (Digitaria ischaemum) and common lespedezas (Lespedeza striata (Thunb.) Schind), were seeded on April 14th, 2015 to create significant weed pressure. Treatments were applied using a CO2-pressurized backpack sprayer equipped with XR 8004 flat fan spray tips and calibrated to deliver 44 gal/A.

Current Findings

This study is still ongoing and results were updated to the date when this report was composed (10 week after initial treatment; W AIT). When applied as pre-emergence treatments, Specticle at both rates and Dimension achieved statistically same levels of control, which were the lowest crabgrass germination/establishment (<20%) at 10 W AIT (Figure 1). Barricade pre-emergence treatment showed a similar level of crabgrass control at 3 W AIT. However, the residue effect did not last as long as the other pre-emergence treatments (Figure 1).

Control of lespedezas showed a similar trend, where all pre-emergence treatments resulted in excellent control at 3 W AIT (<2%). At 6 W AIT, none of the treatments applied at early post or post timing influenced lespedeza establishment, compared to controls (Figure 2). It is also important to note that, the spring of 2015 accompanied with a historically high amount of precipitation, which makes a very atypical year for evaluating any pre-emergence herbicide activities.

Table 1. Treatments list with application timing and rates.

<table>
<thead>
<tr>
<th>#</th>
<th>Treatments</th>
<th>Rates</th>
<th>Application timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Untreated Check</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>2</td>
<td>Specticle FLO</td>
<td>4.5 oz/A</td>
<td>pre-emergence</td>
</tr>
<tr>
<td>3</td>
<td>Specticle FLO</td>
<td>9 oz/A</td>
<td>pre-emergence</td>
</tr>
<tr>
<td>4</td>
<td>Specticle FLO</td>
<td>4.5 oz/A</td>
<td>early post-emergence</td>
</tr>
<tr>
<td>5</td>
<td>Specticle FLO</td>
<td>9 oz/A</td>
<td>early post-emergence</td>
</tr>
<tr>
<td>6</td>
<td>Specticle FLO</td>
<td>4.5 oz/A</td>
<td>post-emergent</td>
</tr>
<tr>
<td>7</td>
<td>Specticle FLO</td>
<td>9 oz/A</td>
<td>post-emergent</td>
</tr>
<tr>
<td>8</td>
<td>Dimension</td>
<td>2 qt/A</td>
<td>pre-emergent</td>
</tr>
<tr>
<td>9</td>
<td>Dimension</td>
<td>2 qt/A</td>
<td>early post-emergent</td>
</tr>
<tr>
<td>10</td>
<td>Dimension</td>
<td>2 qt/A</td>
<td>post-emergent</td>
</tr>
<tr>
<td>11</td>
<td>Barricade 4 FL</td>
<td>48 qt/A</td>
<td>pre-emergent</td>
</tr>
<tr>
<td>12</td>
<td>Barricade 4 FL</td>
<td>48 qt/A</td>
<td>early post-emergent</td>
</tr>
<tr>
<td>13</td>
<td>Barricade 4 FL</td>
<td>48 qt/A</td>
<td>post-emergent</td>
</tr>
</tbody>
</table>
Effect of Specticle and other pre-emergence herbicides for pre, early post and post control of Crabgrass (Digitaria spp.) and broadleaf weeds

Figure 1. Percent crabgrass coverage (%) at 10 weeks after initial treatments (WAIT), which was 2 weeks after early post-emergence application. Bars at each evaluation timing labeled with the same letters were not significantly different at 0.05 probability level.

Figure 2. Percent lespedezas coverage (%) at 2 weeks after early post-emergence application, which is 10 weeks after initial treatments (WAIT). Bars at each evaluation timing labeled with the same letters were not significantly different at 0.05 probability level.
Summary

This trial evaluated the herbicide ‘Specticle Flo’ (a.i. indaziflam), for pre-emergence control of crabgrass in zoysiagrass turf. Treatments are Specticle Flo at high (9 fl oz/A) and low (4.5 fl oz/A) rates, in addition to Barricade (a.i. prodiamine) and an untreated control (Table 1). All treatments were applied using a CO₂ pressurized backpack boom sprayer equipped with TeeJet XR8004 flat fan spray tips calibrated to deliver 44 gal/acre. Treatments were immediately watered in with approximately 0.15 inch of irrigation.

Current Findings

This trial was placed on ‘Mayer’ zoysiagrass (Zoysia japonica) maintained as home lawn with significant crabgrass (Digitaria spp.) weed pressure, where untreated areas became heavily infested with crabgrass (~30%) in late May. One application of all treatments was applied prior to crabgrass germination on April 14th, 2015. Crabgrass was first observed germinating in untreated areas at 4 weeks after treatments (WAT) in early May. By 10 WAT (June 20th), both Specticle Flo rates showed a significant control of crabgrass (~0% germination), which were equivalent to the effect of Barricade (Figure 1). No phytotoxicity was observed on desired zoysiagrass turf. This trial is ongoing and the further residue effect will be evaluated throughout the summer months.

Table 1. Treatments list.

<table>
<thead>
<tr>
<th>#</th>
<th>Treatments</th>
<th>Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Untreated Check</td>
<td>---</td>
</tr>
<tr>
<td>2</td>
<td>Specticle Flo</td>
<td>9 fl oz/A</td>
</tr>
<tr>
<td>3</td>
<td>Specticle Flo</td>
<td>4.5 fl oz/A</td>
</tr>
<tr>
<td>4</td>
<td>Barricade 65WG</td>
<td>1 lb/A</td>
</tr>
</tbody>
</table>

Figure 1. Treatment effect at various weeks after treatments (WAT). Bars at each evaluation timing labeled with the same letters were not significantly different at 0.05 probability level.
Daniel Earlywine and Lee Miller

Summary

Large patch is the most serious disease of zoysiagrass on golf fairways and home lawns. Three trials were set up on ‘Meyer’ zoysiagrass at the MU Turf Research Farm in the fall of 2014. Mowing was performed twice weekly at 0.75 inches. Plots were inoculated for all three trials on Sept 30 by placing 25 cc of rye grain (*Secale cereale* L.) infested with *Rhizoctonia solani* AG2-2 LP in the center of each plot under a metal plate. Plates were removed on April 14 2015 and mycelial growth was noted within the turf canopy.

**Trial I and II** were initiated in the fall of 2014 to evaluate fall fungicide applications on residual large patch control (with and without irrigation following application). Trial III was designed to evaluate the impact of fall vs. spring application timings on the efficacy of multiple preventive fungicide applications for large patch control. All three trials were evaluated in the spring, as zoysiagrass came out of dormancy and large patch activity increased.

**Trial I.** Treatments consisted on Lexicon Intrinsic (0.47 fl oz/1000 ft²), Xzemplar (0.26 fl oz/1000 ft²), Torque (0.6 fl oz/1000 ft²), and Heritage WDG (0.4 oz/1000 ft²) applied on A-Sept 18 and B-Oct 16. All treatments were allowed to dry on the turf canopy following application and were not watered in with any irrigation.

**Trial II.** Treatments consisted of single or multiple applications of Headway (1.5 and 3.0 fl oz/1000 ft²) (A) and Velista (0.5 fl oz/1000 ft²) (A) and Velista (0.5 fl oz/1000 ft²) (AB). Initial applications were made on A- Sept 22 and B- 20 Oct and immediately watered in with 0.2” of overhead irrigation.

**Trial III.** Multiple fungicide applications were made either twice in the fall (AB), twice in the fall followed by once in the spring (ABC) at (50% greenup) or just two applications in the spring alone (CD). Treatments consisted of ProStar (2.2 oz/1000 ft²) (CD), Mirage (1.0 fl oz/1000 ft²) (AB), Mirage (1.0 fl oz/1000 ft²) (ABC), ProStar (2.2 oz/1000 ft²) (A) followed by Mirage (1.0 fl oz/1000 ft²) (B), ProStar (2.2 oz/1000 ft²) (A) followed by Mirage (1.0 fl oz/1000 ft²) (BC), and Heritage WDG (0.4 oz/1000 ft²) (AB). Application timings were made on A- Sept 19, 2014, B- Oct 17, 2014, C-Apr 14, 2015, and D- May 12, 2015. Following each application timing, all treated plots were allowed to dry for 1 hour and then 0.2” of overhead irrigation was applied.
Current Findings

**Trial I.** Large patch was first observed on Apr 28, 2015. By 12 May, plots treated with Lexicon Intrinsic, Torque, and Heritage had significantly less large patch severity than plots treated with Xzemplar. By 9 June, no significant differences in large patch control were noted among treated and untreated plots. At that time, however, plots treated with Lexicon Intrinsic, Torque, and Heritage were numerically lower and still exhibited acceptable large patch control (≤5%) than plots treated with Xzemplar or the untreated control. Turf quality remained the highest in plots treated with Lexicon Intrinsic and Heritage on both rating dates. By Jun 9, no statistical differences were observed in turf quality within treated and untreated plots. Plots treated with Xzemplar and the untreated control had unacceptable turf quality (<6) due to large patch damage.

**Trial II.** The first observation of large patch in the trial area was on May 12. From May 26 – June 23, plots receiving single fall applications of Headway (both rates) had significantly less large patch severity than plots receiving a single fall application of Velista. By June 23, plots that received single fall applications of Headway (both rates) were still significantly lower in large patch severity than plots treated with a single fall application of Velista. On that same rating date, no differences in large patch control were observed among plots treated with Velista and the untreated control. Although no significant differences in turf quality among treated and untreated plots were observed on both the May 26 and June 23 rating dates, plots treated with Velista tended to be unacceptable (<6) due to large patch damage.

**Trial III.** Large patch was first observed on April 28 within the trial area. On May 26, all treated plots regardless of application timing had significantly less large patch severity than the untreated control. On this date, no differences in large patch control were noted among fungicide treatments. Although large patch severity slightly increased in plots treated with ProStar (A) followed by Mirage (B) (2.8% severity) on June 23, no significant differences were noted among the treatments. Similar results were also noted in turf quality. Turf quality in treated plots remained at acceptable levels (>6) throughout the trial period. On June 23, turf quality in plots treated with ProStar (A) followed by Mirage (B) was significantly lower than other treatments.
### Table 1. Turf Quality and Large Patch Severity (%) for Trial I.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/1000 ft&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Application Interval</th>
<th>Turf Quality&lt;sup&gt;y&lt;/sup&gt;</th>
<th>Large Patch Severity (%)&lt;sup&gt;z&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>12 May</td>
<td>9 June</td>
<td>12 May</td>
</tr>
<tr>
<td>Untreated Control</td>
<td></td>
<td>5.7</td>
<td>c&lt;sup&gt;x&lt;/sup&gt;</td>
<td>5.3</td>
</tr>
<tr>
<td>Lexicon Intrinsic</td>
<td>0.47 fl oz</td>
<td>AB&lt;sup&gt;w&lt;/sup&gt;</td>
<td>7.2</td>
<td>a</td>
</tr>
<tr>
<td>Xzemplar</td>
<td>0.26 fl oz</td>
<td>AB</td>
<td>6.0</td>
<td>bc</td>
</tr>
<tr>
<td>Torque</td>
<td>0.6 fl oz</td>
<td>AB</td>
<td>7.0</td>
<td>ab</td>
</tr>
<tr>
<td>Heritage WDG</td>
<td>0.4 oz</td>
<td>AB</td>
<td>7.1</td>
<td>a</td>
</tr>
</tbody>
</table>

<sup>x</sup>Large Patch severity based on a scale of 0 to 100% (0= no incidence, 100= entire plot completely covered).  
<sup>y</sup>Turfgrass quality based on a scale of 1 to 9, where 9= highest quality, 5= acceptable based on color, density, and uniformity.  
<sup>z</sup>Values are means of four replications. Means (n=4) within columns followed by the same letter are not significantly different according to Fisher’s Protected LSD (P = 0.05).  

### Table 2. Turf Quality and Large Patch Severity (%) for Trial II.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/1000 sq ft</th>
<th>Application Interval</th>
<th>Turf Quality&lt;sup&gt;y&lt;/sup&gt;</th>
<th>Large Patch Severity (%)&lt;sup&gt;z&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>26 May</td>
<td>23 June</td>
<td>26 May</td>
</tr>
<tr>
<td>Untreated Control</td>
<td></td>
<td>6.1</td>
<td>a&lt;sup&gt;x&lt;/sup&gt;</td>
<td>6.1</td>
</tr>
<tr>
<td>Headway</td>
<td>1.5 fl oz</td>
<td>A&lt;sup&gt;w&lt;/sup&gt;</td>
<td>6.8</td>
<td>a</td>
</tr>
<tr>
<td>Headway</td>
<td>3.0 fl oz</td>
<td>A</td>
<td>7.0</td>
<td>a</td>
</tr>
<tr>
<td>Velista</td>
<td>0.5 oz</td>
<td>A</td>
<td>5.5</td>
<td>a</td>
</tr>
<tr>
<td>Velista</td>
<td>0.5 oz</td>
<td>AB</td>
<td>6.1</td>
<td>a</td>
</tr>
</tbody>
</table>

<sup>x</sup>Large Patch severity based on a scale of 0 to 100% (0= no incidence, 100= entire plot completely covered).  
<sup>y</sup>Turfgrass quality based on a scale of 1 to 9, where 9= highest quality, 5= acceptable based on color, density, and uniformity.  
<sup>z</sup>Values are means of four replications. Means (n=4) within columns followed by the same letter are not significantly different according to Fisher’s Protected LSD (P = 0.05).  

### Table 3. Turf Quality and Large Patch Severity (%) for Trial III.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/1000 sq ft</th>
<th>Application Interval</th>
<th>Turf Quality&lt;sup&gt;y&lt;/sup&gt;</th>
<th>Large Patch Severity (%)&lt;sup&gt;z&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>26 May</td>
<td>23 June</td>
<td>26 May</td>
</tr>
<tr>
<td>Untreated Control</td>
<td></td>
<td>5.5</td>
<td>bx</td>
<td>4.7</td>
</tr>
<tr>
<td>ProStar</td>
<td>2.2 oz</td>
<td>CDw</td>
<td>6.7</td>
<td>a</td>
</tr>
<tr>
<td>Mirage</td>
<td>1.0 fl oz</td>
<td>AB</td>
<td>6.6</td>
<td>a</td>
</tr>
<tr>
<td>Mirage</td>
<td>1.0 fl oz</td>
<td>ABC</td>
<td>6.8</td>
<td>a</td>
</tr>
<tr>
<td>ProStar</td>
<td>2.2 oz</td>
<td>A</td>
<td>7.1</td>
<td>a</td>
</tr>
<tr>
<td>followed by Mirage</td>
<td>1.5 fl oz</td>
<td>BC</td>
<td>7.1</td>
<td>a</td>
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<sup>x</sup>Large Patch severity based on a scale of 0 to 100% (0= no incidence, 100= entire plot completely covered).  
<sup>y</sup>Turfgrass quality based on a scale of 1 to 9, where 9= highest quality, 5= acceptable based on color, density, and uniformity.  
<sup>z</sup>Values are means of four replications. Means (n=4) within columns followed by the same letter are not significantly different according to Fisher’s Protected LSD (P = 0.05).  
Max Gilley, Lee Miller

Summary

*Pythium* spp. have the ability to cause extensive damage to creeping bentgrass (CB) root systems. When this damage is coupled with physiological stress accrued from managing putting greens in the transition zone during summer months, turfgrass stands often experience foliar symptoms and decline.

Four distinct diseases of CB can be caused *Pythium* spp.: *Pythium* blight, *Pythium* damping off, *Pythium* root rot, and *Pythium* root dysfunction. This study focuses specifically on *Pythium* incited root diseases. *Pythium* root rot (PRR) favors over-saturated conditions or areas with poor drainage. Disease outbreaks can occur following excessive rainfall accompanied by high temperature stress. Turfgrass symptoms initially look wilted, and then progress into chlorotic or necrotic areas occurring in irregular, mosaic-like patterns (Fig. 1). Individual plants infected with PRR may have rotted crowns and roots. Several *Pythium* spp. have been associated with PRR throughout the country. *Pythium* root dysfunction (PRD) has been described in Nebraska, Maryland and North Carolina on young (<5-7 years) sand-based bentgrass putting greens. Symptoms of PRD include plants that are initially wilted and chlorotic then develop a yellow-to-orange foliar decline. Infected roots will simply be tan or buff and lack root hairs, one of the distinguishing characters between PRD and PRR. Unlike PRR, symptoms of PRD are most severe during periods of hot and/or dry weather and develop on exposed, dry areas as opposed to low-lying saturated areas most commonly associated with PRR.

![Fig. 1) Chlorotic and necrotic symptoms associated with PRR.](image)

In 2011, a considerable outbreak of *Pythium* root rot (PRR) prompted a multi-season survey to determine which *Pythium* spp. were most prevalent in the Midwest region. Proper identification of *Pythium* spp. involved in these diseases is imperative as management recommendations and fungicide efficacy differ between PRR and PRD. The objective of this research is to isolate and identify *Pythium* spp. in samples symptomatic of *Pythium* incited root diseases.
Methods

Cup-cutter sized samples were collected from CB putting greens in Arkansas, Illinois, Kansas, Missouri, and Oklahoma. A local course with newly constructed and methyl bromide renovated greens in 2013 is also being routinely monitored for potential PRD development. Symptomatic and asymptomatic roots are washed under tap water for 6-10 h to remove debris and non-target organisms. Roots are sectioned into 5 mm segments, and then 30 segments are placed on three different types of culture media, (1 selective and 2 nonselective). Hyphae emerging after 12h, 24h, and each subsequent 24h period up to 120 hours were collected and subcultured onto fresh media.Isolates are identified to species through morphological classification, and confirmed with molecular sequencing.

Current Findings

Samples collected in 2012 and 2013 yielded 18 Pythium isolates. In 2014, occurrence and severity of Pythium root diseases was low in the region, and only 15 samples were processed yielding only four Pythium spp. Frequent rainfall events in 2015 season have been conducive to Pythium disease development, and 13 samples have already been processed. These 13 samples have yielded 16 isolates tenatively identified as Pythium spp. No Pythium isolates have been recovered from samples collected from the newly constructed greens to date. The 38 collected isolates represent eight Pythium spp. including P. aphanidermatum, P. arrhenomanes, P. graminicola, P. rostratum, P. torulosum, P. ultimum, P. vanterpooli, and P. vexans. All species collected are known pathogens of creeping bentgrass except P. rostratum, P. torulosum, and P. vexans. Both pathogenic and non-pathogenic Pythium spp. have been isolated from the same sample. The virulence of collected isolates on CB will be determined with future field and greenhouse experiments.
Impact of nitrogen source and application timing on incidence of large patch on zoysia

John Koehler and Lee Miller

Introduction

Large patch is caused by the fungal pathogen *Rhizoctonia solani* AG2-2 LP, and is the most limiting disease on zoysiagrass in the transition zone. Large patch occurs in early fall and spring when zoysiagrass is either going into or coming out of cold temperature dormancy, with optimal infection temperatures between 68-77°F. Patch symptoms appear as circular matted areas of brown necrotic turf, with active outbreaks firing a bright orange color along patch margins. Fungicides for large patch control are applied once or twice in the fall and once again in the spring. Little research has been done on the effects of cultural practices, particularly nitrogen application timing and source, on large patch incidence. Nitrogen applications during fall and spring are commonly avoided due to concern of increasing large patch severity. However, no definitive correlation between nitrogen applications and increased large patch severity has been found.

Summary

The goal of this project is to determine if applying nitrogen during the spring and fall infection periods will increase large patch severity, or decrease it and promote disease recovery. Along with application timing, we will also investigate the impact of different nitrogen sources and a single spring fungicide application on disease severity. The overall goal of this project is to integrate a nitrogen application strategy into the large patch management scheme. Plots in this field trial are 5 × 10 ft and arranged in a randomized complete block design. All plots received 0.75 lbs N/1000 sq ft of UMaxxTM in June and July of 2014, and the same rate of urea in August 2014 before the project was initiated. Fall and spring fertility was applied when 2” soil temperatures reached 65°F on 9/16/14 and 5/6/15, respectively. Fertility treatments were granular and applied with shaker bottles. On 5/6/15, tebuconazole was applied at 0.6 fl oz/1000 sq ft in 1.0 gal water carrier as an additional treatment factor. One plot per block was left untreated and unfertilized. Each plot was inoculated at two evenly-spaced points with 25 cc rye grain infested with *R. solani* AG 2-2 LP on 9/23/14, and each point was covered with a metal plate until spring green-up. Pictures and ratings were taken every 7-10 days until winter dormancy, beginning again when symptoms became noticeable in spring. Pictures were digitally analyzed for disease and percent non-green turf using SigmaScan, and LSMeans were subjected to analysis of variance using PROC GLIMMIX (SAS 9.3) and were separated with pairwise comparison using the lsmeans command (α=0.05).
Impact of nitrogen source and application timing on incidence of large patch on zoysia

Table 1: Treatment description

Ammonium sulfate, calcium nitrate, and urea fertility treatments will be 2lbs N/1000ft² per annum.
Fall 65°F @ 1/2 lb N/1000ft² + 1/2 lb N/1000ft² in June, July, and August.
Spring 65°F @ 1/2 lb N/1000ft² + 1/2 lb N/1000ft² in June, July, and August.
Fall + Spring 65°F @ 1/2 lb N/1000ft² each (1lb N/1000ft² Total) + 1/3 lb N/1000ft² in June, July, and August.

Duration™ 120-day controlled-release fertilizer: One spring 65°F application @ 3.0lbs N/1000ft²

Plot Map

<table>
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<tr>
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<th>Fall + Fung</th>
<th>Fall + Fung</th>
<th>Sum + Fung</th>
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<th>Fa+Sp + Fung</th>
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Urea Calcium Nitrate Ammonium Sulfate Duration™ 120-Day
Current Findings

Fertilizer timing had a significant effect (p<0.05) on lowering large patch severity. Plots fertilized in the spring and fall+spring had significantly less non-green turf than plots where only UMaxx™ and urea were applied in the summer of 2014 and those fertilized only in fall 2014. This is contrary to current practices of avoiding spring nitrogen applications on zoysia to prevent large patch infection. Plots treated with a single spring application of tebuconazole also had more green turfgrass area than non-fungicide treated plots. No statistical differences were observed between nitrogen sources. The study will continue to further investigate the impact of timing and nitrogen source on large patch severity.

*Columns with the same letters are not significantly different from each other according to lsmeans pairwise comparison (α=0.05) within their respective dates.*
Summary

Spring dead spot caused by *Ophiosphaerella* spp. is the most severe pest problem affecting bermudagrass sports fields in Missouri. The soilborne pathogen infects roots, rhizomes and stolons as the plant goes into dormancy in the fall. During the greenup period the following spring, infected patches up to 3” in diameter remain dormant and eventually die. Recovery of patches occurs from regrowth of rhizomes and stolons of uninfected, perimeter plants, and oftentimes weed emerge in spring dead spot affected areas first. Since the pathogen is soilborne, control is difficult, particularly in a curative situation. Current control recommendations rely almost exclusively on fungicide use, but even with fall applications recovery from an existing epidemic may be a multi-year process.

Several research trials have indicated hollow-tine aerification or other cultivation methods may reduce spring dead spot severity and increase fungicide efficacy. Recently, an intense surface cultivation method termed “fraze mowing” has gained popularity as a method of thatch reduction and playing surface adjustment in sports fields. The objective of this research is to determine the impact of fraze mowing on spring dead spot severity, and determine how this practice can be implemented in an integrated pest management plan for the disease.

The trial was initiated on July 22, 2014 at the MU Turfgrass Research Farm on a 'Riviera' bermudagrass plot severely infested with spring dead spot caused by *O. herpotricha*. Plots were 5 ft x 10 ft and arranged in a randomized complete block design with four replications. Treatments were arranged in a split plot design with fraze mowing as the main plot and nitrogen source as the subplot. Before treatments were applied, an initial disease rating was conducted on 24 June 2014 to assess treatment effects. Fraze mowing was conducted on 22 July 2014 at 4 and 8 mm with a Koro Field Topmaker® or not cultivated. To encourage bermudagrass regrowth, ammonium sulfate or urea was applied weekly at 0.5 lb N/1000 ft² for six weeks after fraze mowing. Spring dead spot severity and green cover were evaluated every 14 d by visual estimation of percent disease area and digital image analysis, respectively. Area under the disease progress curve (AUDPC) was calculated with the trapezoidal rule. All data were subjected to analysis of variance, and where applicable means were separated with Fisher's Protected LSD.
Current Findings

Fraze mowing at either 4 or 8 mm did not statistically increase or decrease spring dead spot severity in spring 2015 compared to the initial rating date. Numerically, however, all fraze mowed plots fertilized with urea had less spring dead spot severity than non-fraze mowed plots. Plots treated with ammonium sulfate had lower spring dead spot severity than urea on two of the four rating dates, reducing disease by 12-22% from the initial 2014 rating. Over a single season of study, fraze mowing alone did not increase or reduce an established spring dead spot epidemic. The plot area was fraze mowed again on June 30, 2015 and will be evaluated for another season.

Current and Future Research

Although our results from the first year of study were not statistically significant, no increase in spring dead spot severity is also noteworthy. The slight reductions are promising, and fraze mowing could be a piece of an overall IPM strategy for spring dead spot control. On June 30 2015, we expanded our fraze mowing research to a ‘Patriot’ bermudagrass block that was inoculated with O. herpotricha in 2013. Spring dead spot was consistently present in each plot of this research block, providing a steady disease pressure background for analysis. This split block experimental design integrates several control methods, including fraze mowing as the main plot, with nitrogen source, manganese, and fungicide application as subplot factors. As before, fraze mowing was either at 4 or 8 mm with Koro Field Topmaker® or not cultivated. Ammonium sulfate or calcium nitrate was used for plot regrowth, at 0.5 lb N/1000 ft² per week for 6 weeks. Manganese sulfate will be applied three times at 2 lb/A, for a total of 6 lb/A over the 6 week period. Velista fungicide (0.7 oz/1000 ft²) was applied immediately after fraze mowing, and will be applied again in late September.

Zoysiagrass

A small trial is also being conducted on ‘Meyer’ zoysiagrass to investigate the practice for utility on golf fairways. Fraze mowing was conducted on June 30, 2015 again either at 4 or 8 mm with Koro Field Topmaker® or not cultivated. Urea, calcium nitrate, or ammonium sulfate was used at 0.5 lb N/1000 ft² once every six weeks for recovery.
Kyle Robertson

Summary

Dollar spot is the most economically important disease in the turf industry, affecting the aesthetics, playability and uniformity of turfgrass used on golf courses, sports turf, and residential lawns. Dollar spot is caused by the pathogen *Sclerotinia homoeocarpa* F.T. Bennett and has a wide variety of turfgrass host species. Due to intensive fungicide use to control this disease, selection for resistant pathogen strains and a decrease in fungicide efficacy have been tested and observed (Miller et al., 2002). Continuous use of fungicides for dollar spot control could lead to the exposure of sub-inhibitory doses of fungicide to resistant strains of the pathogen. A low-dose exposure could actually stimulate the pathogen instead of inhibiting it, leading to a dose response defined as hormesis. Ultimately, this may result in increased pathogenicity of *Sclerotinia homoeocarpa*, increased dollar spot severity, and decreased plant productivity. Our goal is to define these increases in pathogenicity and disease severity by exposing strains of the dollar spot pathogen to sub-inhibitory doses of fungicides and provoking a potential hormetic response.

Methods

In the lab, plates of potato dextrose agar are being amended with multiple concentrations of fungicides ranging from 0.0002 ppm to 20 ppm. Radial growth of each plate is measured to compare to the control to find relative growth values (Figure A). Our focus lies with demethylation-inhibiting (DMI) fungicides, since decreased efficacy and apparent quantitative resistance to these fungicides have been observed previously in *Sclerotinia homoeocarpa*. At the molecular level, oxalic acid, a secondary metabolite of various plant pathogens, is being evaluated because of its role in disease development. (Cessna, et al., 2000). Oxalic acid production is being detected with high performance liquid chromatography (HPLC). A defined oxalic acid peak (Figure B) was obtained by running synthetic oxalic acid concentrations through HPLC. The definition of this peak will allow for the conformation of oxalic acid production. The next step is to detect and quantify the oxalic acid production from different dollar spot isolates within different concentrations of fungicides by using a standard curve created by HPLC. This will help to determine if there is a correlation between increased pathogenicity due to sub-inhibitory doses of fungicide and the amount of oxalic acid produced by the pathogen.

Literature Cited


(A) Example of increased relative growth on potato dextrose agar plates amended with sub-lethal doses of the fungicide Propiconazole. Two reps of an isolate (PHPG4) with fungicide concentrations ranging from a 0 ppm control (left) to 0.002 ppm (right).

(B) A chromatogram produced by HPLC depicting oxalic acid peaks (circled) for various solutions and concentrations.
The National Turfgrass Evaluation Program (NTEP)* has been and still is one of the most widely known sources for information on turfgrass species, cultivar selections and evaluations. NTEP is designed to develop and coordinate uniform evaluation trials and now covers 17 species in their program within 40 U.S. states and six provinces of Canada.

Results can be used to determine if a cultivar is well adapted to a local area or level of turf maintenance. Each trial is designed to have a specific maintenance program followed during the life of the trial at a particular location. That information can be found on their website.

Information such as turfgrass quality, color, density, resistance to diseases and insects, tolerance to heat, cold, drought and traffic is collected and summarized by NTEP annually. NTEP information is used by individuals and companies in thirty countries. Plant breeders, turfgrass researchers and extension personnel use NTEP data to identify improved environmentally-sound turfgrasses. Local and state government entities, such as parks and highway departments, use NTEP for locating resource-efficient varieties. Most important, growers and consumers use NTEP extensively to purchase drought tolerant, pest resistant, attractive and durable seed or sod. It is the acceptance by the end-user that has made NTEP the standard for turfgrass evaluation in the U.S. and many other countries worldwide. *Information from NTEP website.

Four cool-season NTEP trials are being conducted at the University of Missouri Turfgrass Research Facility. They are the 2012 Tall Fescue trial, 2014 Creeping Bentgrass – Fairway trial, 2014 Creeping Bentgrass Putting Green trial, and the 2014 Fine Fescue trial. The following is the main maintenance guidelines set forth by NTEP for these trials. This is the third season for the tall fescue trial and the first seasons for all others.

**Maintenance guidelines:**

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<thead>
<tr>
<th>2012 Tall Fescue Trial</th>
<th>2014 Fine Fescue Trial</th>
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<tr>
<td>Mowing height:</td>
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<td>Nitrogen rate:</td>
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<td>Irrigation:</td>
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<td>Herbicides:</td>
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<td>Fungicides:</td>
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<td>Insecticides:</td>
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**Per growing month, however not monthly applications, 2-4 applications annually.**

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<th>2014 Creeping Bentgrass Fairway</th>
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<td>Mowing height:</td>
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<tr>
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<td>Topdressing:</td>
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<td>Grooming:</td>
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**Per growing month, however not monthly applications, 3-6 applications annually.**

Attached are plot plans of these four trials. Feel free to look through the numerous cultivars on-site and try to pick your favorites.
## 2012 Tall Fescue NTEP Trial

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5 X 5 plots, RCBD, 3 replications, 116 cultivars (55’ X 160’)

Planted: October 2, 2012
## 2012 NATIONAL TALL FESCUE TEST

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* Commercially Available 2014
### 2014 Creeping Bentgrass NTEP Fairway Trial

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Planted **9/9/2014**
### 2014 NTEP National Bentgrass (Fairway/Tee) Test Entries and Sponsors

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*Commercially Available 2014
# 2014 Creeping Bentgrass NTEP Putting Green Trial

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Planted **9/12/2014**
### 2014 NTEP National Bentgrass (Putting Green) Test

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