Wisconsin Turfgrass Field Day

July 28, 2015

O.J. Noer Turfgrass Research & Education Facility
2502 Hwy M, Verona, WI 53593

2015 Wisconsin Turfgrass Field Day

Morning Tour: General Turf Management (see map on last two pages for locations of talks)

No.	Time	Topic	Speaker	Pg
1	9^{30}-11	Tree trunk injection technology	Andrews	3
2	9^{30}-11	Turfgrass species identification	Koch	4
3	9^{30}-11	Backpack sprayer calibration	Schweiger	6
4	9^{30}-11	Soil drenching injection techniques	Liesch	7
5	9^{30}-11	Pollinators and insecticides	Williamson	9
6	9^{30}-11	Improving lawns with compost	Soldat	10

11:00-1:30pm- Lunch, Trade Show and Networking

Afternoon Tour: Golf Turf Research

No.	Time	Topic	Speaker	Pg
7	1^{30}-1^{45}	Ant control on putting greens	Williamson	13
8	1^{45}-2^{00}	Reduced risk disease management, dollar spot prediction model	Koch	14
9	2^{00}-2^{15}	Nitrogen impact on dollar spot and update from the CDGA	Townsend/Koch/ Nangle	25
10	2^{15}-2^{30}	Potassium soil test requirements	Soldat	30
11	2^{30}-2^{45}	Carbon and nitrogen in turfgrass soils	Ruis	33
12	2^{45}-3^{00}	Fine fescue fairway drought tolerance	Reiter	36
13	3^{00}-3^{15}	Weed control in unmowed areas	Soldat	39
14	3^{15}-3^{30}	Use of drones for turf management	Kreuser	41

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Editor's Note

We are grateful for and humbled by the tremendous industry support for the UW Turfgrass Program provided by the above sponsors. Without your help, our turfgrass research and educational program would be unable to function at our current and targeted level. While we strive for perfection and attempt to list all our supporters, if we accidentally missed you then you have our sincere apology; please let us know so we may correct the situation in the future. If you have any comment or suggestions for next year's program, please contact me at 608-263-3631 or djsoldat@wisc.edu. References to products in this booklet are intended to convey objective, unbiased information and do not imply an endorsement.

On behalf of the entire UW-Madison Turf Team, thanks again for your support, and we look forward to continuing to provide the industry with research and outreach programs that improve your turf, your bottom line, and the environment.

Sincerely,

Doug Soldat
Associate Professor and Extension Specialist

Tree Trunk Injection Application Technology

Curt Andrews
John Deere Landscapes
I.S.A. Certified Arborist #MW-0433

Trunk injections have been utilized by arborists for decades in management programs addressing problems such as Dutch elm disease and micronutrient deficiencies. Since the discovery of emerald ash borer in the U.S., the number of municipalities, golf courses, lawn care operators, and landscape maintenance contractors developing injection treatment programs or offering injection services has increased.

Trunk injections have been in the arborist toolbox for many years and often utilized in environmentally sensitive areas such as trees overhanging lakes or rivers. In some instances, the only effective application method of a product is through trunk injection (e.g. oak wilt). Injecting a product into the vascular system of a tree is an invasive procedure which causes injury to the tree. As with pruning, if performed properly, the extent of the damage can be minimized to a point which makes the benefit of the application outweigh the injury from the treatment itself. If performed incorrectly, the treatment may be ineffective, cause decline of the tree, or possibly transmit disease which can lead to death.

There are numerous injection systems and products available to help plant health care professionals protect trees against diseases, insects, and nutrient deficiencies (e.g. Acecaps, Arborjet, Arborsystems, Mauget, Medicaps, Rainbow, TreeTech, etc). Each injection tool is designed to deliver product to the outer growth rings in the sapwood, which are responsible for moving water up the trunk to the crown of the tree.

The basic method of administering a trunk application through the majority of these devices is similar. Understanding how a tree moves the product and responds to the injection wound will help applicators make effective treatments for long term health of the tree and minimize the extent of the injury from the procedure.

Grass Species Identification and Management

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INTRODUCTION

Being able to accurately identify the different types of common grass species found in Wisconsin lawns is a key factor in managing those lawns. Different grass species have different strengths and weaknesses and require different management regimes for optimal health. One management regime DOES NOT fit all sites or grass species.

COMMON WISCONSIN GRASS SPECIES

Kentucky bluegrass - This is the most popular turf of all cool-season grasses in the upper Midwest region. Its attributes are a medium leaf texture, dark green color, aggressive spreading growth habit, and good tolerance to most environmental conditions except shade. There are hundreds of different cultivars of Kentucky bluegrass to choose from, some being selected for more shade tolerance, ability to withstand lower mowing height, more disease or drought tolerance, and preferred texture or color of the leaf. It is common to blend three or four different Kentucky bluegrass cultivars together to maximize the desirable traits of each and to mask any undesirable traits.

> ID keys: Boat-shaped tip, folded vernation, strong midvein, rhizomes, very small to nearly absent ligule
>
> Strengths: Appearance, texture, traffic tolerance
> Weaknesses: Poor shade tolerance, requires irrigation and fertilizer to succeed

Perennial ryegrass - This turf is a bunch-type grass that does not spread like Kentucky bluegrass. It is also a shorter-lived perennial in our climate, thus it should be overseeded every few years if planted in a monostand. Its attributes are a very rapid establishment rate, nice medium leaf texture, good color, and decent wear resistance. Perennial ryegrass is useful in mixtures with Kentucky bluegrass to control erosion until the Kentucky bluegrass can get established.

> ID keys: Glossy blade underside, parallel veins on blade surface, folded vernation, small ligule, bunch-type growth
>
> Strengths: Fast establishment, appearance (most cultivars), resiliency
> Weaknesses: Susceptibility to ice damage, susceptible to rust and other diseases, bunch type growth

Fine fescues - This is the most shade tolerant of the cool-season turfgrasses. Consequently, fine fescues are popular in shade seed mixtures with other turfgrass species. Fine fescues also require less fertilizer and irrigation than most other cool-season turfs. However, they are less wear tolerant than most other cool-season turfs and are intolerant of heavy, wet soils.

ID Keys: Very thin leaf blade, folded vernation, very small ligule, bunch type growth (except for creeping red fescue which has rhizomes)

Strengths: Shade tolerance, drought tolerance, less intensive management
Weaknesses: Thin leaf blade, very slow growing, needs adequate drainage, susceptible to red thread

Tall fescue – Traditionally considered more of a utility grass due to its wide leaf blade, newer types of 'turf-type' tall fescue have a finer leaf blade and are more desirable in home lawns and athletic fields. It's another non-spreading bunch-type grass that may need overseeding to keep a dense appearance over a prolonged period of time. The attributes of tall fescue are its good drought, wear and salt tolerance. It also has good heat and shade tolerance.

ID Keys: Coarse leaf blade, rolled vernation, bunch-type growth, veins on upper surface

Strengths: Drought tolerance, shade tolerance, traffic tolerance
Weaknesses: Thick leaf blade, susceptibility to brown patch

Rough bluegrass – This is usually considered a WEED in home lawn situations. This grass grows rapidly along the surface of the soil in spring through stolons, often growing out radially into a large circular patch. However, it produces very shallow roots, so that in the heat and drought of summer it often turns brown in appearance. Because it will commonly turn brown in a large circular patch during the summer it can be confused with a disease. Rough bluegrass grows well in shaded, moist sites and often establishes there first. It is even included in some lower quality shade-seed mixtures due to its tolerance to shade. It should be removed from the lawn at the earliest possible date because of its ability to rapidly spread.

ID Keys: Folded vernation, strong central vein, stoloniferous growth, ligule often present

Strengths: Shade tolerance, rapid spring growth
Weaknesses: Poor root structure, turns off color in summer, easily 'lifts' off the surface

Bentgrass - This is also a WEED in a home lawn situation. It is not compatible with maintenance needs or texture with other cool-season turfs. Its prostrate growth habit and tolerance of extremely low mowing heights make it ideal for certain recreational uses such as golf course turfs, but it becomes puffy and easily scalped at lawn height. Bentgrass has poor shade tolerance, disrupts the appearance of the lawn, and is more susceptible to diseases. It should be removed from the lawn at the earliest possible date because of its ability to rapidly spread.

ID Keys: Coarse leaf blade, "puffy" growth habit, rolled vernation, veins on upper surface, moderate ligule, presence of stolons

Strengths: Tolerance to extremely low mowing heights
Weaknesses: Lime-green color, Drought tolerance, puffy appearance, susceptible to many diseases

Backpack and Hand Can Sprayer Calibration

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Turf managers often use backpack sprayers for applying various pesticides. The key to applying pesticides correctly starts with the calibration of the sprayer. We will use a 2 gallon sprayer with a spray dye to show different rates and application possibilities. For proper calibration we will discuss the methods recommended for calibrating any hand type sprayer to ensure the any pesticide that is applied is done so at the right rate, lowest cost and best chance for success. The two methods include 1) the percentage basis approach and 2) the area basis approach.

The percentage basis is useful for spot treating areas. Pesticide calculations are done using a percentage dilution (e.g. 2% solution of Roundup). To mix a 2% solution, multiply 0.02 x 128 (ounces per gallon) to get 2.6 ounces per gallon. So for a five gallon sprayer you'd want to mix 13 ounces of product. The table below shows the amount of pesticide to add based on dilution and sprayer size.

Table 1. Amount of product per volume for various pesticide recommendations.

Pesticide	Ounces of product to add to:			
recommendation	1 gallon	2 gallons	3 gallons	5 gallons
1%	1.3	2.6	4	6
2%	2.6	5.2	8	13
3%	3.8	7.6	11	19
4%	5.1	10.2	15	26
5%	6.4	12.8	19	32

The area basis approach is useful for uniformly treating small areas. First, you must determine the sprayer output by measuring how much liquid the sprayer sprays over a known area. For this method it is important to know and maintain a constant sprayer pressure and use a constant walking speed. After the sprayer output is known, you can read the label to determine how much pesticide to add. The table below shows amounts of product to add based on sprayer output and target pesticide application rate.

Table 1. Ounces of product per gallon required based on sprayer coverage and target product application rate.

Sprayer Output	Target product application per acre:			
(Gallons/Acre)	1 pint	1 quart	1.5 quarts	2 quarts
	oz/gallon			
10	1.6	3.2	4.8	6.4
15	1.1	2.1	3.2	4.3
17	0.9	1.9	2.8	3.8
20	0.8	1.6	2.4	3.2
25	0.6	1.3	1.9	2.6

Pesticide Application Techniques: Soil Drenches and Soil Injections

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While the putting green may be the ultimate focus of a golfer's attention, trees on golf courses can do a lot to affect the overall ambiance of a course. Likewise, trees in other turfgrass settings (residential yards, parks, cemeteries, properties of businesses, etc.) can also have a dramatic impact on the look and feel of the landscape. While each tree species faces different diseases and insect pests, there are many cases where systemic pesticides may be a management consideration. When it comes to applying these products, many different methods and types of application equipment are available, each with its own strengths and weaknesses. Common methods used to apply systemic products include: **soil drenches**, **soil injections**, **basal bark sprays**, **trunk implants**, and **trunk injections**. For an in depth discussion of all the various application techniques just mentioned, see the Utah State University factsheet "Getting Chemicals into Trees without Spraying" available online: http://extension.usu.edu/files/publications/publication/NR_FF_020pr.pdf.

Soil drenches and **soil injections** are two of the most commonly used methods for applying systemic pesticides and these techniques have certain advantages over the other techniques. Because these techniques apply a pesticide as a liquid directly to the soil, spray drift (which could occur with a basal bark spray) isn't an issue. In addition, these techniques are non-invasive, so wounds aren't created in trees by drilling or coring, which occurs with trunk injections and implants. However, soil drenches and soil injections are not appropriate in all situations, such as when heavier clay-based soils are present. In those situations, the pesticides can bind to the fine soil particles, reducing efficacy. Furthermore, soil drenches and soil injections do differ from each other, as summarized below in **Table 1**.

Table 1. Pros and Cons of Soil Drench vs. Soil Injection Applications

Soil Drench	
Pros	-**Simplicity** (No specialized equipment needed; *just a bucket*) -**Speed** (Trees can be treated rapidly by pouring) -**No drift** (Drift and off-target movement unlikely)
Cons	-**Soil moisture requirements** (Soil must be moist for best results) -**Mulch removal** (Must remove mulch before treating) -**H_2O requirements** (May need to haul large amounts of water with you) -**Slopes** (Delayed absorption on slopes can lead to uneven protection)
Soil Injection	
Pros	-**Mulch removal may not be required** -**Slopes not much of an issue** -**No drift** (drift and off-target movement unlikely)
Cons	-**Soil moisture requirements** (soil must be moist for best results) -**Equipment** (may need to purchase additional equipment; can be bulky) -**Speed** (slower) -**H_2O requirements** (may need to haul large amounts of water with you)

Soil drench and **soil injection** applications are simple as they require little to no calibration. In both cases, the size of the tree will need to be determined by measuring the tree at breast height. Most products base the amount of pesticide on the diameter at breast height (DBH), but some products base the dosage on circumference, so make sure to consult the label. The general procedures for making **soil drench** and **soil injections** are summarized in Table 2.

Table 2. General Application Notes for Soil Drenches and Soil Injections

Soil Drench
- Always consult the label and follow all directions; wear appropriate PPE 1) Measure the size of the tree at Breast Height; *check label for diameter vs. circumference* 2) Measure appropriate amount of pesticide and mix with water in bucket 3) Pull back bark mulch from base of trunk 4) Gently pour solution around base of trunk; replace any bark mulch after product has soaked in
Soil Injection
- Always consult the label and follow all directions; wear appropriate PPE 1) Calibrate soil injection equipment *Some injectors deliver a determined volume in a set amount of time; other injectors use a pump mechanism to deliver a set dosage per pump* 2) Measure the size of the tree at Breast Height; *check label for diameter vs. circumference* 3) Consult label for pattern (grid, ring, etc.) and depth of soil injections (usually 2-“6”) 4) Apply solution to soil using injection probe

Pollinator Protection:

Pollinators such as bees play an important role in the environment. Unfortunately, bees have been declining for a number of reasons such as diseases, parasites, and interactions with pesticides. In particular, a specific class of insecticides (neonicotinoids) is being looked at for their potential interactions with pollinators. Many of these same insecticides are important pest management tools for difficult to control pests, such as the Emerald Ash Borer, Bronze Birch Borer, and others. It is critical that pesticide applicators act responsibly to minimize the risks to bees. Several steps can be taken to help protect bees:

1) Use pesticides only if needed
2) Thoroughly read the label and follow all directions
3) Choose products that are less toxic to bees
4) For spray applications, apply insecticides early in the morning or later in the evening when bees are less active
5) Take steps to eliminate drift and off-site movement of pesticides
6) Avoid applying pesticides to flowering plants, or apply after bloom has occurred
7) Be aware of your surroundings; even though your target plant might not be flowering, nearby flowering weeds could be attractive to bees and could pose a risk if drift occurs

Insecticides and Pollinators: What's All the Buzz?

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The amount of "buzz" over the past few year has continued to intensify regarding the perceived association of insecticides, especially neonicotinoids (a.k.a. neonics) and the uncertain and often highly debated decline of pollinating insects. To exacerbate and muddle this important issue, there are several vastly differing theories that exist. Unfortunately, the theory that most mainstream media and popular press covers or emphasizes is the one that pesticides (i.e., neonicotinoids) are primarily responsible or have a detrimental or negative effect on bee feeding, learning and memory. To this end, public perception tends to ascribe to this narrative. Numerous research studies that the news media frequently likes to make reference-to or cite are laboratory studies that simply don't represent field realistic (i.e., real-world) insecticide rates (amounts) that insect pollinators would likely experience or encounter in field setting (habitat). Conversely, published field-based research studies show little effect of neonics on pollinators. As a result, uncertainty and intense debate surrounds this important issue. The Green Industry must make a concerted effort to address this issue "head-on' by continuing to educate the public about insecticides and pollinators as well as continuing to practice good product (pesticide) stewardship practices to minimize potential risks to pollinators.

First and foremost, an insecticide is a substance designed to kill an insect, and since honey bees and wild bees are insects; it is no surprise or mystery that insecticides can be detrimental to pollinating insects if they are not used appropriately and according to the pesticide label. As applicators of pesticides, we MUST be diligent in exercising good stewardship of the products (pesticides) that we use! Make certain to read and appropriately follow the label, after all it is the law.

The bottom line is that bee decline is as a complex and complicated issue whereby many combined factors or causes can be implicated, merely one cause cannot be singled-out or blamed. Honeybees and wild bees are affected by habitat loss, and the can face nutritional deficiencies especially when areas of highly diverse flower plants such as prairies are replaced by large cropping systems (monocultures) where only one plant blooms at a time. In addition, social bees (e.g., honeybees) are affected by numerous colony pests and pathogens that compromise their immune system, factors such as diseases, parasites, pesticides (including fungicides, herbicides and insecticides), habitat loss and poor nutrition can all contribute to pollinator decline. We must make a concerted effort to protect and promote pollinator's, they are vital to the ecosystem.

Improving Lawns with Compost

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OBJECTIVE

Professional and consumer interest in organic turfgrass management is growing rapidly. There are many different organic products on the market but very little data with which to compare products. This trial is an attempt to gather data on the efficacy of a range of organic fertilizers and compost treatments. This information will be useful to turfgrass professionals, consumers, and organic fertilizer companies for promoting their products.

MATERIALS AND METHODS

This research was conducted at the O.J. Noer Turfgrass Research and Education Center in Madison, WI on a Batavia silt loam. The experiment was conducted on a mixture of perennial ryegrass and Kentucky bluegrass mowed weekly or more frequently as needed at a cutting height of 2.5 inches. The plots were irrigated weekly to replace 80% of the evapotranspiration estimated by an on-site weather station. A randomized complete block design with four replications of each treatment was used. The individual plots measured four feet by six feet. The treatments (fertilizers and compost) are listed below and classified into three groups to aid in interpretation of results. A detailed analysis of the forms of nitrogen can be found in Table 1. Fertilizers were applied using hand shakers three times during the growing season (June 14, July 6th, and Sept 17th, 2012) to give a total of 3 lbs N/1000 ft^2. The Scotts product was applied at the labeled rate of 0.8 lbs N/M for a total of 2.4 lbs N/M.

The Kompost Kids and Madison Municipal composts were applied to a 0.25 inch depth on June 14th and Sept 17th, for a total of 0.50 inches for the season. The Purple Cow compost treatment was applied on June 18th and Sept 17th to a depth of 0.125 inches, for an annual total of 0.25 inches. The Purple Cow compost + tea treatment received compost on June 18th at the rate of 2 cu. ft. per 1,000 sq. ft. plus a solution of compost tea prepared by Purple Cow applied using a garden watering can. This treatment was repeated on July 13th, August 27th, and Sept. 25th, for a total of 8 cu. ft. per 1,000 sq. ft, or approximately 0.06 inches of compost for the year.

During the growing season, several turfgrass and soil parameters were evaluated at various collection intervals. Turfgrass color was evaluated approximately every other week using a reflectance meter (CM-1000, Spectrum Technologies) which measures the amount of green light reflected from the turf. Visual turfgrass quality ratings were also taken on a biweekly basis using a 1 – 9 scale where a rating of 9 indicates highest possible turf quality and 6 represents the minimally acceptable turf quality to a (in this case) discerning homeowner. Clippings were collected on August 24th and September 14th, dried at 60°C for at least 24 hours, and weighed to determine dry matter production.

Table 1. Detailed breakdown on the forms of nitrogen in each of the product.

Fertilizer	Total N	WIN	Ammoniacal + WSN	% Quick Release N
	-------------------------------------	%	-------------------------------------	
Chick Magic	5	> 4	< 1	< 20
Kompost Kids	0.5	0.5	0.0	0.0
Madison Municipal Compost	0.7	0.7	0.0	0.0
Milorganite	5	4.25	0.25	5.0
Purple Cow Compost	0.8	0.8	0.0	0.0
Purple Cow Compost + Tea	0.8	0.8	0.0	0.0
Scotts Turf Builder (29-0-4)	29	0.8 + 6.8[1]	21.4	73.8

[1] indicates from methylene urea, technically classified as "other WSN" but behaves more like slow release nitrogen.

RESULTS

Averaged over the three years of the trial, all compost or fertilized treatments had significantly greater visual turfgrass quality than the non-treated control (Table 2). Chick Magic fertilizer resulted in significantly greater visual turfgrass quality than all other treatments. Scotts Turf Builder stood alone in second place, even though this treatment received 20% less nitrogen than all other fertilizer treatments (including Chick Magic). The Kompost Kids and Madison Municipal compost treatments resulted in statistically similar visual quality as the Milorganite treatment. The two Purple Cow treatments grouped together with average turfgrass quality around 5.5; significantly greater than the control, but statistically lower than all others. This is likely because the Purple Cow compost treatment received half the compost rate as the Kompost Kids and Madison Municipal treatments. The Purple Cow compost tea treatment received a tiny annual amount of compost (0.06 inches), so the tea solution did seem to provide a quantifiable benefit for visual quality over the three year period.

The turfgrass color and NDVI results followed similar patterns to visual quality, with minor differences (Table 3). Averaged over the three year study period, all fertilizer or compost treatments had greater turfgrass clipping yield than the non-treated control (Table 4). Chick Magic, Milorganite, and Scotts Turf Builder grouped together as having the greatest clipping production. The compost treatments also grouped mostly together and had intermediate clipping yield, with the Purple Cow compost tea producing the fewest clippings and the Kompost Kids treatment producing the most of all compost treatments.

CONCLUSIONS

Compost treatments are effective for maintaining acceptable turfgrass quality, although traditional and organic fertilizers applied at label directions can produce superior quality at lower rates and less labor. It appears that 1/2 inch of compost per year is an appropriate application rate, as the ¼ inch per year rate resulted in slightly lower than acceptable quality over the three year period. However, nitrogen content of composts can vary significantly and less compost will be required when the material has a higher nitrogen content. Future reports will focus on soil physical and chemical changes associated with these fertilizer and compost treatments.

Table 2. Turfgrass visual quality as affected by fertilizer or compost treatment. Turfgrass quality is measured on a scale of 1 to 9 where 9 represents the highest possible quality.

Fertilizer	2012	2013	2014	Three yr. avg.
Chick Magic	6.46 A	7.23 A	6.77 A	6.87 A
Kompost Kids	5.71 D	6.73 C	6.15 B	6.26 C
Madison Municipal Compost	6.21 ABC	6.39 D	6.10 B	6.23 C
Milorganite	5.93 BCD	6.73 C	6.19 B	6.33 C
Purple Cow Compost	5.82 CD	5.91 E	5.29 C	5.64 D
Purple Cow Compost + Tea	5.89 BCD	5.86 E	4.98 D	5.52 D
Scotts Turf Builder (29-0-4)	6.32 AB	6.98 B	6.67 A	6.70 B
Non-Fertilized Control	5.54 D	5.27 F	4.60 E	5.07 E

Table 3. Turfgrass color index and NDVI (2014). Both measurements rely on reflectance of light but use different wavelenghts. Color index was measured with a CM-1000 (scale 0-1000, 1000 = greenest). NDVI was measured using a Trimble GreenSeeker (scale 0-1, 1=greenest).

Fertilizer	2012	2013	2014
Chick Magic	330 A	470 A	0.75 A
Kompost Kids	296 CD	400 C	0.75 AB
Madison Municipal Compost	275 E	369 D	0.72 C
Milorganite	304 BC	451 B	0.74 B
Purple Cow Compost	280 DE	349 E	0.70 D
Purple Cow Compost + Tea	270 E	343 E	0.68 E
Scotts Turf Builder (29-0-4)	318 AB	469 A	0.74 AB
Non-Fertilized Control	263 E	317 F	0.66 F

Table 4. Turfgrass clipping yield

Fertilizer	8/21/12	7/17/12	8/8/13	9/10/13	10/8/13	10/23/13
Chick Magic	15.9 A	18.3 A	9.1 A	19.3 A	16.5 A	9.3 A
Kompost Kids	7.2 BC	6.4 C	0.4 B	7.5 B	9.4 B	4.0 B
Madison Municipal Compost	5.7 BC	5.3 C	0.7 B	6.2 B	8.3 BC	1.3 C
Milorganite	8.5 B	17.3 A	7.6 A	18.4 A	16.0 A	8.4 A
Purple Cow Compost	3.8 C	8.7 BC	1.4 B	8.0 B	10.6 B	5.5 B
Purple Cow Compost + Tea	3.6 C	10.7 ABC	1.2 B	10.4 B	6.8 BC	3.1 BC
Scotts Turf Builder	14.8 A	15.9 AB	7.4 A	17.9 A	16.3 A	8.5 A
Non-Fertilized Control	3.3 C	4.3 C	0.8 B	6.3 B	4.1 C	0.9 C

Table 4. Turfgrass clipping yield (cont.)

Fertilizer	6/6/14	7/8/14	8/8/14	9/8/14	9/26/14	All Dates
Chick Magic	43.5 A	34.5 A	17.3 A	56.9 A	56.9 A	27.0 A
Kompost Kids	20.6 B	19.1 BC	11.4 BC	49.5 AB	49.5 AB	16.8 B
Madison Municipal Compost	23.8 B	15.9 CD	9.5 CD	37.8 BC	37.8 BC	13.8 CD
Milorganite	46.7 A	24.4 B	13.8 AB	59.7 A	59.7 A	25.1 A
Purple Cow Compost	26.6 B	14.8 CD	5.4 E	38.7 BC	38.7 BC	14.7 BC
Purple Cow Compost + Tea	20.7 B	13.5 CD	5.8 DE	28.6 CD	28.6 CD	12.1 D
Scotts Turf Builder	42.1 A	30.6 A	13.3 ABC	52.4 AB	52.4 AB	24.7 A
Non-Fertilized Control	21.1 B	11.2 D	4.0 E	19.5 D	19.5 D	8.6 E

Evaluation of Abamectin for Control of Mound Building Ants in Turf

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OBJECTIVE

To determine the performance of two rates of abamectin for control of mound building ants (*Lasius neoniger* L.) in turf.

MATERIALS AND METHODS

A research study site was selected at the O.J. Noer Turfgrass Research and Education Facility (Verona, WI) based on a history of ant and ant mound activity. The study site was comprised of creeping bentgrass maintained at putting green height. Plots were arranged in a completely randomized design with four replications, plots were 3 feet x 5 feet (15 ft^2). A total of three treatments were included in the research trial: 1) untreated (control); 2) abamectin, High rate(0.262 fl oz/M) and 3: Low rate (0.131 fl oz/M). Insecticide treatments were applied with a CO_2 backpack sprayer equipped with TeeJet flat fan spray nozzles calibrated to deliver 2.0 gallons spray volume/1000 ft^2. The low application rate was re-applied every 14 days and the high application rate was applied every 28 days after initial application timing. Immediately following treatment application, plots were watered with about 0.10 inches of water. The number of ant mounds within each plot were counted every 14 days after treatment application.

Smith-Kerns Dollar Spot Probability Model

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OBJECTIVE

To determine the accuracy of the Smith-Kerns dollar spot prediction model for use in controlling dollar spot caused by the fungus *Sclerotinia homoeocarpa*.

MATERIALS AND METHODS

The study was conducted at the O. J. Noer Turfgrass Research and Education Facility on a stand of creeping bentgrass (*Agrostis stolonifera* 'Penncross') maintained at 0.125 inches. Individual plots measured 3 feet by 10 feet and were arranged in a randomized complete block design with four replications. Treatments were applied at a nozzle pressure of 40 p.s.i. using a CO_2 pressurized boom sprayer equipped with two XR Teejet AI8004 VS nozzles. The only fungicide used was Banner MAXX II, which was agitated by hand and applied in the equivalent of 1.5 gallons of water per 1000 ft^2. Treatment 2 was applied on a 21-day interval initiated on May 22nd, while the remaining treatments were applied based on various probabilities produced by the Smith-Kerns dollar spot model. Number of dollar spot foci and turfgrass quality (1-9, 9 being excellent, 6 acceptable, and 1 bare soil) were visually assessed every 2 weeks. Turf quality and disease severity were subjected to an analysis of variance and means separated using the Waller-Duncan test ($P = 0.05$). Results of disease severity and turfgrass quality ratings can be found in table 1 and 2, respectively.

RESULTS AND DISCUSSION

Dollar spot pressure has been high throughout the summer to date, and likely was high enough to break through the 21-day application interval of Banner MAXX II no matter what probability was used. Treatments 2 (calendar-based method), 3 (10% probability), and 4 (15% probability) have been applied 3 times to date. Treatments 5 (20%) and 6 (25%) have been applied twice, while treatment 7 (30%) has only been applied once.

Table 1. Mean number of dollar spots per treatment at the OJ Noer Turfgrass Research Facility in Madison, WI in 2015.

	Treatment	Rate	Application Interval/Model Prob.	Dollar Spot Severity[a]		
				Jun 4	Jun 17	Jul 15
1	Non-treated control			258.3ab	400.8ab	261.5abc
2	Banner MAXX II	2.0 FL OZ/1000 FT2	21 Day	86.5ab	152.5b	105.5bc
3	Banner MAXX II	2.0 FL OZ/1000 FT2	10%	20.3b	104.3b	75.8c
4	Banner MAXX II	2.0 FL OZ/1000 FT2	15%	51.5ab	77.5b	50.0c
5	Banner MAXX II	2.0 FL OZ/1000 FT2	20%	117.3ab	284.0ab	122.3bc
6	Banner MAXX II	2.0 FL OZ/1000 FT2	25%	257.8ab	389.3ab	331.3ab
7	Banner MAXX II	2.0 FL OZ/1000 FT2	30%	311.0a	511.0a	400.0a

[a]Dollar spot severity assessed as number of dollar spot infection centers per plot. Means followed by the same letter do not significantly differ (P=.05, Waller Duncan).

Table 2. Turfgrass quality at the OJ Noer Turfgrass Research Facility in Madison, WI in 2015.

	Treatment	Rate	Application Interval/Model Prob.	Turfgrass Quality[a]		
				Jun 4	Jun 17	Jul 15
1	Non-treated control			4.0bc	4.3ab	4.0b
2	Banner MAXX II	2.0 FL OZ/1000 FT2	21 Day	5.0abc	4.8ab	5.0a
3	Banner MAXX II	2.0 FL OZ/1000 FT2	10%	5.8a	5.0a	4.8a
4	Banner MAXX II	2.0 FL OZ/1000 FT2	15%	5.3ab	5.0a	5.0a
5	Banner MAXX II	2.0 FL OZ/1000 FT2	20%	4.8abc	4.3ab	5.0a
6	Banner MAXX II	2.0 FL OZ/1000 FT2	25%	3.8c	4.0ab	4.0b
7	Banner MAXX II	2.0 FL OZ/1000 FT2	30%	3.8c	3.8b	3.8b

[a]Turfgrass quality was rated visually on a 1 – 9 scale with 6 being acceptable. Means followed by the same letter do not significantly differ (P=.05, Waller Duncan).

Dollar Spot Suppression Using Strobilurin Fungicides

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OBJECTIVE

To determine the efficacy of various strobilurin fungicides in suppressing dollar spot caused by the fungus *Sclerotinia homoeocarpa* on creeping bentgrass.

MATERIALS AND METHODS

The study was conducted at the O. J. Noer Turfgrass Research and Education Facility on a stand of creeping bentgrass (*Agrostis stolonifera* 'Penncross') maintained at 0.125 inches. Individual plots measured 3 feet by 5 feet and were arranged in a randomized complete block design with four replications. Treatments were applied at a nozzle pressure of 40 p.s.i. using a CO_2 pressurized boom sprayer equipped with two XR Teejet AI8004 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 1.5 gallons of water per 1000 ft^2. All treatments were initiated on June 3rd and subsequent applications were made at 21-day intervals. Number of dollar spot foci per plot, turfgrass quality (1-9, 9 being excellent, 6 acceptable, and 1 bare soil), and normalized difference vegetation index (NDVI) were assessed every 2 weeks. Turf quality and disease severity were subjected to an analysis of variance and means were separated using the Waller-Duncan test ($P = 0.05$). Results of the disease intensity and turfgrass quality ratings can be found in table 1 and 2, respectively.

RESULTS AND DISCUSSION

Dollar spot pressure has been high throughout summer 2015 as non-treated controls averaged 245 foci per plot on the June 29th rating date. Three of the treatments reduced dollar spot relative to the non-treated control on the Jun 29th and July 15th rating dates. Turfgrass quality mirrored disease severity, and only treatment 7 provided acceptable turf quality on the July 15th rating date. Phytotoxicity was not observed with any treatment.

Table 1. Mean number of dollar spot foci per treatment at the OJ Noer Turfgrass Research and Education Facility in Madison, WI during 2015.

	Treatment	Rate	Application Interval	Dollar Spot Severity[a]		
				Jun 4	Jun 29	Jul 15
1	Non-treated control			133.0a	245.0a	207.0a
2	Heritage TL	2.0 FL OZ/1000 FT2	21 Day	132.5a	242.8a	259.8a
3	Compass 50 WDG	0.25 OZ/1000 FT2	21 Day	136.0a	222.0a	239.5a
4	Disarm 480 SC	0.36 FL OZ/1000 FT2	21 Day	128.8a	206.3ab	279.0a
5	Insignia	0.7 FL OZ/1000 FT2	21 Day	346.8a	173.3ab	91.3b
6	Lexicon	0.47 FL OZ/1000 FT2	21 Day	163.5a	98.5b	22.3b
7	Xzemplar	0.26 FL OZ/1000 FT2	21 Day	121.5a	105.8b	13.3b

[a]Dollar spot severity assessed as number of dollar spot infection centers per plot. Means followed by the same letter do not significantly differ (P=.05, Waller Duncan).

Table 2. Mean turfgrass quality at the OJ Noer Turfgrass Research and Education Facility in Madison, WI during 2015.

	Treatment	Rate	Application Interval	Turfgrass Quality[a]		
				Jun 4	Jun 29	Jul 15
1	Non-treated control			4.0a	3.0b	3.3c
2	Heritage TL	2.0 FL OZ/1000 FT2	21 Day	4.0a	3.3ab	3.0c
3	Compass 50 WDG	0.25 OZ/1000 FT2	21 Day	4.0a	3.5ab	3.0c
4	Disarm 480 SC	0.36 FL OZ/1000 FT2	21 Day	4.0a	3.8ab	3.0c
5	Insignia	0.7 FL OZ/1000 FT2	21 Day	4.0a	4.0ab	4.5bc
6	Lexicon	0.47 FL OZ/1000 FT2	21 Day	4.0a	4.5a	5.3ab
7	Xzemplar	0.26 FL OZ/1000 FT2	21 Day	4.0a	4.3ab	6.3a

[a]Turfgrass quality was rated visually on a 1 – 9 scale with 6 being acceptable. Means followed by the same letter do not significantly differ (P=.05, Waller Duncan).

Reduced-Risk Dollar Spot Management

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OBJECTIVE

To determine the efficacy of various reduced-risk programs primarily for the control of dollar spot on creeping bentgrass maintained as a golf course fairway.

MATERIALS AND METHODS

The study was replicated at 3 locations: the O.J. Noer Turfgrass Research and Education Facility in Madison, WI and the 14th and 18th holes at University Ridge Golf Course in Madison, WI. At the O.J. Noer site the study was conducted on creeping bentgrass (*Agrostis stolonifera* 'Pencross') maintained at a 0.125 inch cutting height. At the University Ridge sites the study was conducted on creeping bentgrass (*Agrostis stolonifera* 'Penncross') maintained at a 0.5 inch cutting height. The individual plots measured 6 ft X 10 ft and were arranged in a randomized complete block design with four replications. Individual treatments were applied at a nozzle pressure of 40 p.s.i using a CO_2 pressurized boom sprayer equipped with XR Teejet AI8004 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 1.5 gallons of water per 1000 ft^2. Three fungicide programs were tested in addition to the non-treated control. One was a conventional fungicide program based off the program of a local golf course, the second based the application timing on the Smith-Kerns dollar spot prediction model using conventional fungicides, and the third based application timing on the Smith-Kerns dollar spot model but used exclusively fungicides labeled as reduced risk by the Environmental Protection Agency. Number of dollar spot infection centers per plot, turfgrass quality (1-9, 9 being excellent, 6 acceptable, and 1 bare soil), and normalized difference vegetation index (NDVI) were assessed every two weeks. Results were subjected to an analysis of variance and means were separated using the Waller-Duncan test ($P = 0.05$). Disease severity and turfgrass quality from each location can be found in the following tables.

RESULTS AND DISCUSSION

Dollar spot pressure has been high throughout summer 2015, with non-treated controls averaging 1013, 408, and 977 dollar spot foci per plot at the OJ Noer, 14th, and 18th hole locations, respectively. All three programs significantly reduced dollar spot compared to the non-treated control at each location. Differences in dollar spot severity were observed between the 3 fungicide programs at the University Ridge sites, with treatments 2 and 4 providing acceptable dollar spot control on the July 15th rating date. Treatments 2 and 3 have been applied 3 times, and treatment 4 has been applied twice.

Table 2. Mean number of dollar spot infection centers per treatment at the O. J. Noer Turfgrass Research and Education Facility in Madison, WI in 2015.

		Treatment	Rate	Application Date/Interval	Dollar spot severity[a]		
					Jun 4	Jul 2	Jul 15
1		Non-treated control			975.5a	1116.3a	947.5a
2	Conventional Program	Emerald (A)	0.18 OZ/1000 FT2	May 20	339.5b	455.3c	100.0b
		Torque (B)	0.6 FL OZ/1000 FT2	June 17			
		Daconil WStik (C)	3.2 FL OZ/1000 FT2	July 8			
		Banner MAXX II (C)	1.0 FL OZ/1000 FT2	July 8			
		Subdue MAXX (C)	1.0 FL OZ/1000 FT2	July 8			
		Chipco 26GT (D)	3.0 FL OZ/1000 FT2	July 21			
		Subdue MAXX (D)	1.0 FL OZ/1000 FT2	July 21			
		Daconil WStik (E)	3.2 FL OZ/1000 FT2	August 4			
		Torque (F)	0.6 FL OZ/1000 FT2	August 4			
		Curalan (G)	1.0 OZ/1000 FT2	September 1			
		Chipco 26GT (H)	3.0 FL OZ/1000 FT2	September 22			
3	Smith-Kerns model: Conventional	Emerald (A)	0.18 OZ/1000 FT2	28 Days	857.8a	656.3bc	136.8b
		Banner MAXX II (B)	1.0 FL OZ/1000 FT2	14 Days			
		Daconil WStik (B)	3.2 FL OZ/1000 FT2	14 Days			
		Chipco 26GT (C)	2.0 FL OZ/1000 FT2	14 Days			
		Daconil WStik (C)	3.2 FL OZ/1000 FT2	14 Days			
		Banner MAXX II (D)	1.0 FL OZ/1000 FT2	14 Days			
		Daconil WStik (D)	3.2 FL OZ/1000 FT2	14 Days			
		Emerald (E)	0.18 OZ/1000 FT2	28 Days			
		Banner MAXX II (F)	2.0 FL OZ/1000 FT2	21 Days			
4	Smith-Kerns model: Reduced Risk	Emerald (A)	0.18 OZ/1000 FT2	28 Days	767.5a	797.5b	89.5b
		Velista (B)	0.5 OZ/1000 FT2	21 Days			
		Secure (B)	0.5 FL OZ/1000 FT2	21 Days			
		Emerald (C)	0.18 OZ/1000 FT2	28 Days			
		Heritage TL (C)	2.0 FL OZ/1000 FT2	28 Days			
		Compass (D)	0.25 OZ/1000 FT2	21 Days			
		Velista (D)	0.5 OZ/1000 FT2	21 Days			
		Secure (D)	0.5 FL OZ/1000 FT2	21 Days			
		Emerald (E)	0.18 OZ/1000 FT2	28 Days			
		Velista (F)	0.5 OZ/1000 FT2	21 Days			
		Secure (F)	0.5 FL OZ/1000 FT2	21 Days			

[a]Dollar spot was visually assessed as number of dollar spot infection centers per plot. Means followed by the same letter do not significantly differ (P=.05, Waller-Duncan).

Table 3. Mean turf quality ratings per treatment at the O. J. Noer Turfgrass Research and Education Facility in Madison, WI in 2015.

		Treatment	Rate	Application Date/Interval	Turfgrass Quality[a]		
					Jun 4	Jul 2	Jul 15
1		Non-treated control			3.0b	2.8a	3.0a
2	Conventional Program	Emerald (A)[b]	0.18 OZ/1000 FT2	May 20	4.0a	3.8a	5.0b
		Torque (B)	0.6 FL OZ/1000 FT2	June 17			
		Daconil WStik (C)	3.2 FL OZ/1000 FT2	July 8			
		Banner MAXX II (C)	1.0 FL OZ/1000 FT2	July 8			
		Subdue MAXX (C)	1.0 FL OZ/1000 FT2	July 8			
		Chipco 26GT (D)	3.0 FL OZ/1000 FT2	July 21			
		Subdue MAXX (D)	1.0 FL OZ/1000 FT2	July 21			
		Daconil WStik (E)	3.2 FL OZ/1000 FT2	August 4			
		Torque (F)	0.6 FL OZ/1000 FT2	August 4			
		Curalan (G)	1.0 OZ/1000 FT2	September 1			
		Chipco 26GT (H)	3.0 FL OZ/1000 FT2	September 22			
3	Smith-Kerns model - Conventional	Emerald (A)	0.18 OZ/1000 FT2	28 Days	3.0b	3.0a	5.0b
		Banner MAXX II (B)	1.0 FL OZ/1000 FT2	14 Days			
		Daconil Wstik (B)	3.2 FL OZ/1000 FT2	14 Days			
		Chipco 26GT (C)	2.0 FL OZ/1000 FT2	14 Days			
		Daconil Wstik (C)	3.2 FL OZ/1000 FT2	14 Days			
		Banner MAXX II (D)	1.0 FL OZ/1000 FT2	14 Days			
		Daconil WStik (D)	3.2 FL OZ/1000 FT2	14 Days			
		Emerald (E)	0.18 OZ/1000 FT2	28 Days			
		Banner MAXX II (F)	2.0 FL OZ/1000 FT2	21 Days			
4	Smith-Kerns model – Reduced Risk	Emerald (A)	0.18 OZ/1000 FT2	28 Days	3.3b	3.0a	5.0b
		Velista (B)	0.5 OZ/1000 FT2	21 Days			
		Secure (B)	0.5 FL OZ/1000 FT2	21 Days			
		Emerald (C)	0.18 OZ/1000 FT2	28 Days			
		Heritage TL (C)	2.0 FL OZ/1000 FT2	28 Days			
		Compass (D)	0.25 OZ/1000 FT2	21 Days			
		Velista (D)	0.5 OZ/1000 FT2	21 Days			
		Secure (D)	0.5 FL OZ/1000 FT2	21 Days			
		Emerald (E)	0.18 OZ/1000 FT2	28 Days			
		Velista (F)	0.5 OZ/1000 FT2	21 Days			
		Secure (F)	0.5 FL OZ/1000 FT2	21 Days			

[a]Turfgrass quality was visually assessed on 1-9 scale, with 9 being excellent, 6 being acceptable, and 1 bare dirt. Means followed by the same letter do not significantly differ (P=.05, Waller-Duncan).

Table 4. Mean number of dollar spot infection centers per treatment on the 14th fairway at University Ridge GC in Madison, WI during 2015.

		Treatment	Rate	Application Date/Interval	Dollar spot severity[a]		
					Jun 3	Jun 29	Jul 15
1		Non-treated control			51.3a	330.5a	843.3a
2	Conventional Program	Emerald (A)[b]	0.18 OZ/1000 FT2	May 20	2.3a	25.0a	12.5b
		Torque (B)	0.6 FL OZ/1000 FT2	June 17			
		Daconil WStik (C)	3.2 FL OZ/1000 FT2	July 8			
		Banner MAXX II (C)	1.0 FL OZ/1000 FT2	July 8			
		Subdue MAXX (C)	1.0 FL OZ/1000 FT2	July 8			
		Chipco 26GT (D)	3.0 FL OZ/1000 FT2	July 21			
		Subdue MAXX (D)	1.0 FL OZ/1000 FT2	July 21			
		Daconil WStik (E)	3.2 FL OZ/1000 FT2	August 4			
		Torque (F)	0.6 FL OZ/1000 FT2	August 4			
		Curalan (G)	1.0 OZ/1000 FT2	September 1			
		Chipco 26GT (H)	3.0 FL OZ/1000 FT2	September 22			
3	Smith-Kerns model: Conventional	Emerald (A)	0.18 OZ/1000 FT2	28 Days	2.3a	129.5a	137.0b
		Banner MAXX II (B)	1.0 FL OZ/1000 FT2	14 Days			
		Daconil Wstik (B)	3.2 FL OZ/1000 FT2	14 Days			
		Chipco 26GT (C)	2.0 FL OZ/1000 FT2	14 Days			
		Daconil Wstik (C)	3.2 FL OZ/1000 FT2	14 Days			
		Banner MAXX II (D)	1.0 FL OZ/1000 FT2	14 Days			
		Daconil WStik (D)	3.2 FL OZ/1000 FT2	14 Days			
		Emerald (E)	0.18 OZ/1000 FT2	28 Days			
		Banner MAXX II (F)	2.0 FL OZ/1000 FT2	21 Days			
4	Smith-Kerns model: Reduced Risk	Emerald (A)	0.18 OZ/1000 FT2	28 Days	6.0a	337.5a	0.8b
		Velista (B)	0.5 OZ/1000 FT2	21 Days			
		Secure (B)	0.5 FL OZ/1000 FT2	21 Days			
		Emerald (C)	0.18 OZ/1000 FT2	28 Days			
		Heritage TL (C)	2.0 FL OZ/1000 FT2	28 Days			
		Compass (D)	0.25 OZ/1000 FT2	21 Days			
		Velista (D)	0.5 OZ/1000 FT2	21 Days			
		Secure (D)	0.5 FL OZ/1000 FT2	21 Days			
		Emerald (E)	0.18 OZ/1000 FT2	28 Days			
		Velista (F)	0.5 OZ/1000 FT2	21 Days			
		Secure (F)	0.5 FL OZ/1000 FT2	21 Days			

[a]Dollar spot was visually assessed as number of dollar spot infection centers per plot. Means followed by the same letter do not significantly differ (P=.05, Waller-Duncan).

Table 5. Mean turf quality ratings per treatment on the 14th fairway at University Ridge GC in Madison, WI during 2015.

		Treatment	Rate	Application Date/Interval	Turfgrass Quality[a]		
					Jun 3	Jun 29	Jul 15
1		Non-treated control			6.0a	3.8a	3.5c
2	Conventional Program	Emerald (A)[b] Torque (B) Daconil WStik (C) Banner MAXX II (C) Subdue MAXX (C) Chipco 26GT (D) Subdue MAXX (D) Daconil WStik (E) Torque (F) Curalan (G) Chipco 26GT (H)	0.18 OZ/1000 FT2 0.6 FL OZ/1000 FT2 3.2 FL OZ/1000 FT2 1.0 FL OZ/1000 FT2 1.0 FL OZ/1000 FT2 3.0 FL OZ/1000 FT2 1.0 FL OZ/1000 FT2 3.2 FL OZ/1000 FT2 0.6 FL OZ/1000 FT2 1.0 OZ/1000 FT2 3.0 FL OZ/1000 FT2	May 20 June 17 July 8 July 8 July 8 July 21 July 21 August 4 August 4 September 1 September 22	7.0a	5.3a	6.8a
3	Smith-Kerns model - Conventional	Emerald (A) Banner MAXX II (B) Daconil Wstik (B) Chipco 26GT (C) Daconil Wstik (C) Banner MAXX II (D) Daconil WStik (D) Emerald (E) Banner MAXX II (F)	0.18 OZ/1000 FT2 1.0 FL OZ/1000 FT2 3.2 FL OZ/1000 FT2 2.0 FL OZ/1000 FT2 3.2 FL OZ/1000 FT2 1.0 FL OZ/1000 FT2 3.2 FL OZ/1000 FT2 0.18 OZ/1000 FT2 2.0 FL OZ/1000 FT2	28 Days 14 Days 14 Days 14 Days 14 Days 14 Days 14 Days 28 Days 21 Days	7.0a	4.5a	5.0b
4	Smith-Kerns model – Reduced Risk	Emerald (A) Velista (B) Secure (B) Emerald (C) Heritage TL (C) Compass (D) Velista (D) Secure (D) Emerald (E) Velista (F) Secure (F)	0.18 OZ/1000 FT2 0.5 OZ/1000 FT2 0.5 FL OZ/1000 FT2 0.18 OZ/1000 FT2 2.0 FL OZ/1000 FT2 0.25 OZ/1000 FT2 0.5 OZ/1000 FT2 0.5 FL OZ/1000 FT2 0.18 OZ/1000 FT2 0.5 OZ/1000 FT2 0.5 FL OZ/1000 FT2	28 Days 21 Days 21 Days 28 Days 28 Days 21 Days 21 Days 21 Days 28 Days 21 Days 21 Days	6.8a	4.5a	7.0a

[a]Turfgrass quality was visually assessed on 1-9 scale, with 9 being excellent, 6 being acceptable, and 1 bare dirt. Means followed by the same letter do not significantly differ (P=.05, Waller-Duncan).

Table 6. Mean number of dollar spot infection centers per treatment on the 18th fairway at University Ridge GC in Madison, WI during 2015.

		Treatment	Rate	Application Date/Interval	Dollar spot severity[a]		
					Jun 3	Jun 29	Jul 15
1		Non-treated control			114.5a	765.0a	2052.8a
2	Conventional Program	Emerald (A)[b]	0.18 OZ/1000 FT2	May 20	3.3b	110.8a	0.0c
		Torque (B)	0.6 FL OZ/1000 FT2	June 17			
		Daconil WStik (C)	3.2 FL OZ/1000 FT2	July 8			
		Banner MAXX II (C)	1.0 FL OZ/1000 FT2	July 8			
		Subdue MAXX (C)	1.0 FL OZ/1000 FT2	July 8			
		Chipco 26GT (D)	3.0 FL OZ/1000 FT2	July 21			
		Subdue MAXX (D)	1.0 FL OZ/1000 FT2	July 21			
		Daconil WStik (E)	3.2 FL OZ/1000 FT2	August 4			
		Torque (F)	0.6 FL OZ/1000 FT2	August 4			
		Curalan (G)	1.0 OZ/1000 FT2	September 1			
		Chipco 26GT (H)	3.0 FL OZ/1000 FT2	September 22			
3	Smith-Kerns model: Conventional	Emerald (A)	0.18 OZ/1000 FT2	28 Days	65.0ab	422.5a	188.8b
		Banner MAXX II (B)	1.0 FL OZ/1000 FT2	14 Days			
		Daconil Wstik (B)	3.2 FL OZ/1000 FT2	14 Days			
		Chipco 26GT (C)	2.0 FL OZ/1000 FT2	14 Days			
		Daconil Wstik (C)	3.2 FL OZ/1000 FT2	14 Days			
		Banner MAXX II (D)	1.0 FL OZ/1000 FT2	14 Days			
		Daconil WStik (D)	3.2 FL OZ/1000 FT2	14 Days			
		Emerald (E)	0.18 OZ/1000 FT2	28 Days			
		Banner MAXX II (F)	2.0 FL OZ/1000 FT2	21 Days			
4	Smith-Kerns model: Reduced Risk	Emerald (A)	0.18 OZ/1000 FT2	28 Days	36.5b	1103.8a	22.3c
		Velista (B)	0.5 OZ/1000 FT2	21 Days			
		Secure (B)	0.5 FL OZ/1000 FT2	21 Days			
		Emerald (C)	0.18 OZ/1000 FT2	28 Days			
		Heritage TL (C)	2.0 FL OZ/1000 FT2	28 Days			
		Compass (D)	0.25 OZ/1000 FT2	21 Days			
		Velista (D)	0.5 OZ/1000 FT2	21 Days			
		Secure (D)	0.5 FL OZ/1000 FT2	21 Days			
		Emerald (E)	0.18 OZ/1000 FT2	28 Days			
		Velista (F)	0.5 OZ/1000 FT2	21 Days			
		Secure (F)	0.5 FL OZ/1000 FT2	21 Days			

[a]Dollar spot was visually assessed as number of dollar spot infection centers per plot. Means followed by the same letter do not significantly differ (P=.05, Waller-Duncan).

Table 7. Mean turf quality ratings per treatment on the 18th fairway at University Ridge GC in Madison, WI during 2015.

		Treatment	Rate	Application Date/Interval	Turfgrass Quality[a]		
					Jun 3	Jun 29	Jul 15
1		Non-treated control			4.5b	3.0c	2.0c
2	Conventional Program	Emerald (A)[b]	0.18 OZ/1000 FT2	May 20	7.0a	4.5a	7.0a
		Torque (B)	0.6 FL OZ/1000 FT2	June 17			
		Daconil WStik (C)	3.2 FL OZ/1000 FT2	July 8			
		Banner MAXX II (C)	1.0 FL OZ/1000 FT2	July 8			
		Subdue MAXX (C)	1.0 FL OZ/1000 FT2	July 8			
		Chipco 26GT (D)	3.0 FL OZ/1000 FT2	July 21			
		Subdue MAXX (D)	1.0 FL OZ/1000 FT2	July 21			
		Daconil WStik (E)	3.2 FL OZ/1000 FT2	August 4			
		Torque (F)	0.6 FL OZ/1000 FT2	August 4			
		Curalan (G)	1.0 OZ/1000 FT2	September 1			
		Chipco 26GT (H)	3.0 FL OZ/1000 FT2	September 22			
3	Smith-Kerns model - Conventional	Emerald (A)	0.18 OZ/1000 FT2	28 Days	5.3ab	3.5bc	4.8b
		Banner MAXX II (B)	1.0 FL OZ/1000 FT2	14 Days			
		Daconil Wstik (B)	3.2 FL OZ/1000 FT2	14 Days			
		Chipco 26GT (C)	2.0 FL OZ/1000 FT2	14 Days			
		Daconil Wstik (C)	3.2 FL OZ/1000 FT2	14 Days			
		Banner MAXX II (D)	1.0 FL OZ/1000 FT2	14 Days			
		Daconil WStik (D)	3.2 FL OZ/1000 FT2	14 Days			
		Emerald (E)	0.18 OZ/1000 FT2	28 Days			
		Banner MAXX II (F)	2.0 FL OZ/1000 FT2	21 Days			
4	Smith-Kerns model – Reduced Risk	Emerald (A)	0.18 OZ/1000 FT2	28 Days	5.8ab	3.8b	6.3a
		Velista (B)	0.5 OZ/1000 FT2	21 Days			
		Secure (B)	0.5 FL OZ/1000 FT2	21 Days			
		Emerald (C)	0.18 OZ/1000 FT2	28 Days			
		Heritage TL (C)	2.0 FL OZ/1000 FT2	28 Days			
		Compass (D)	0.25 OZ/1000 FT2	21 Days			
		Velista (D)	0.5 OZ/1000 FT2	21 Days			
		Secure (D)	0.5 FL OZ/1000 FT2	21 Days			
		Emerald (E)	0.18 OZ/1000 FT2	28 Days			
		Velista (F)	0.5 OZ/1000 FT2	21 Days			
		Secure (F)	0.5 FL OZ/1000 FT2	21 Days			

[a]Turfgrass quality was visually assessed on 1-9 scale, with 9 being excellent, 6 being acceptable, and 1 bare dirt. Means followed by the same letter do not significantly differ (P=.05, Waller-Duncan).

Impact of Nitrogen on Dollar Spot

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OBJECTIVE

The objective of this study is to determine the effect of nitrogen has on the production of oxalic acid by *Sclerotinia homoeocarpa* by looking at the nitrogen source and rate. The long term aim is to create an optimal fertility program that alters pH in foliar tissue of turfgrass with an aim of reducing oxalic acid production.

INTRODUCTION

Dollar spot which is caused by the pathogen *Sclerotinia homoeocarpa* is one of the most common diseases found on golf courses in North America. Recent research has shown that *S. homoeocarpa* produces oxalic acid which may influence the development of dollar spot symptoms. Production of oxalic acid is inhibited when the pathogen is cultured at a lower pH.

Dollar spot has long been recognized as a low nitrogen disease but the nitrogen sources could provide further insight into controlling the disease. Applications of various nitrogen sources have shown potential control options outside of traditional fungicide programs. Analyzing foliar pH may provide more information into the control of the pathogen. By utilizing nitrogen sources which each have a different effect on pH, the foliar pH may be effected as well.

MATERIALS AND METHODS

Field trials are being conducted at O.J. Noer Turfgrass Research Facility and at North Shore Country Club in Glenview, Illinois. Currently, there are three trials being conducted at each site analyzing nitrogen rate, nitrogen source and bentgrass cultivars on green height turf. The trials at North Shore Country club are being conducted on a push up based nursery that is mowed at 0.115 inch cutting height using a Toro Greensmaster 1000. Trials taking place at the O.J Noer facility are grown on a sand based root zone maintained at a height of .125" using a Toro Greensmaster 3150. Individual plots measured 6 ft X 4 ft and were arranged in a randomized complete block design with four replications. Individual treatments were applied at a nozzle pressure of 40 p.s.i. using a CO_2 pressurized boom sprayer equipped with XR Teejet AI8004 nozzles. All fungicides were agitated by hand and applied in the equivalent of 2.0 gallons of water per 1000 ft^2. Turfgrass color and quality (1-9, 9 being excellent, 6 being acceptable, and 1 bare soil) are visually assessed every 2 weeks. The number of dollar spot foci and percent disease cover are visually assessed every 2 weeks. Clippings are collected from each plot and then analyzed each month for foliar pH and foliar nitrogen content.

RESULTS AND DISCUSSION

Nitrogen Rate

Dollar Spot Pressure has been high throughout the summer of 2015, with non-treated controls averaging 404 dollar spot foci per plot. Though treatments 4 (0.4 LB N/1000 ft^2), 5 (0.6 LB N/1000 ft^2), and 6 (dollar spot control program), significantly reduced dollar spot compared to the non-treated control, none of the treatments provided acceptable levels of suppression as of the July 15th rating date. All treatments have been applied 7 times, with the first application applied on June 4th.

Table 1. Mean number of dollar spot foci per treatment at the OJ Noer Turfgrass Research and Education Facility in Madison, WI during 2015.

	Treatment	Rate	Application Interval	Dollar Spot Severity[a]		
				Jun 4	Jun 29	Jul 15
1	Non-treated control			472.5a	508.8a	232.5a
2	Urea	0.1 LB N/1000 FT2	14 Day	433.8a	461.3a	222.5a
3	Urea	0.2 LB N/1000 FT2	14 Day	465.0a	471.3a	152.5ab
4	Urea	0.4 LB N/1000 FT2	14 Day	487.5a	520.0a	57.5b
5	Urea	0.6 LB N/1000 FT2	14 Day	433.8a	397.8a	71.8b
6	Xzemplar Banner MAXX II Secure Xzemplar Secure Iprodione Secure Banner MAXX II	0.26 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 0.26 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 3.0 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2	14 Day	428.3a	201.0b	27.0b

[a]Dollar spot severity assessed as number of dollar spot infection centers per plot. Means followed by the same letter do not significantly differ (P=.05, Waller Duncan).

Table 2. Mean percent disease per treatment at the OJ Noer Turfgrass Research and Education Facility in Madison, WI during 2015.

	Treatment	Rate	Application Interval	Dollar Spot Severity[a]		
				Jun 4	Jun 29	Jul 15
1	Non-treated control			11.10a	8.60ab	2.68a
2	Urea	0.1 LB N/1000 FT2	14 Day	10.38a	11.63a	3.10a
3	Urea	0.2 LB N/1000 FT2	14 Day	12.63a	11.83a	3.20a
4	Urea	0.4 LB N/1000 FT2	14 Day	13.48a	5.85abc	0.93a
5	Urea	0.6 LB N/1000 FT2	14 Day	9.63a	3.68bc	0.55a
6	Xzemplar Banner MAXX II Secure Xzemplar Secure Iprodione Secure Banner MAXX II	0.26 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 0.26 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 3.0 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2	14 Day	9.83a	0.45c	0.10a

[a]Dollar spot severity assessed as percent diseased area per plot. Means followed by the same letter do not significantly differ (P=.05, Waller Duncan).

Table 3. Mean turfgrass quality at the OJ Noer Turfgrass Research and Education Facility in Madison, WI during 2015.

	Treatment	Rate	Application Interval	Turfgrass Quality[a]		
				Jun 4	Jun 29	Jul 15
1	Non-treated control			3.0a	2.8b	3.8b
2	Urea	0.1 LB N/1000 FT2	14 Day	3.0a	3.0b	4.0b
3	Urea	0.2 LB N/1000 FT2	14 Day	3.0a	3.0b	4.3b
4	Urea	0.4 LB N/1000 FT2	14 Day	3.0a	3.0b	5.3a
5	Urea	0.6 LB N/1000 FT2	14 Day	3.0a	3.3b	5.8a
6	Xzemplar Banner MAXX II Secure Xzemplar Secure Iprodione Secure Banner MAXX II	0.26 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 0.26 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 3.0 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2	14 Day	3.0a	4.5a	5.8a

[a]Turfgrass quality was rated visually on a 1 – 9 scale with 6 being acceptable. Means followed by the same letter do not significantly differ (P=.05, Waller Duncan).

Nitrogen Source

Dollar Spot Pressure has been high throughout the summer of 2015, with non-treated controls averaging 440 dollar spot foci per plot. Treatments 2 (calcium nitrate), 3 (ammonium sulfate), and 4 (ammonium nitrate) slightly reduced dollar spot compared to the non-treated control on the July 15th rating date, and differences in suppression between these treatments were not statistically different. Treatment 5 (dollar spot control program) significantly reduced dollar spot compared to the non-treated control on both the June 29th and July 15th rating dates, however, none of the treatments provided acceptable levels of dollar spot suppression as of the July 15th rating date. All treatments have been applied 7 times, with the first application applied on June 4th.

Table 4. Mean number of dollar spot foci per treatment at the OJ Noer Turfgrass Research and Education Facility in Madison, WI during 2015.

	Treatment	Rate	Application Interval	Dollar Spot Severity[a]		
				Jun 4	Jun 29	Jul 15
1	Non-treated control			430.0a	478.8a	412.5a
2	Calcium Nitrate	0.2 LB N/1000 FT2	14 Day	436.3a	497.5a	245.3ab
3	Ammonium Sulfate	0.2 LB N/1000 FT2	14 Day	408.8a	494.5a	333.8a
4	Ammonium Nitrate	0.2 LB N/1000 FT2	14 Day	427.5a	477.5a	277.5ab
5	Xzemplar Banner MAXX II Secure Xzemplar Secure Iprodione Secure Banner MAXX II	0.26 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 0.26 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 3.0 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2	14 Day	407.5a	21.0b	55.8b

[a]Dollar spot severity assessed as number of dollar spot infection centers per plot. Means followed by the same letter do not significantly differ (P=.05, Waller Duncan).

Table 5. Mean percent disease per treatment at the OJ Noer Turfgrass Research and Education Facility in Madison, WI during 2015.

	Treatment	Rate	Application Interval	Dollar Spot Severity[a]		
				Jun 4	Jun 29	Jul 15
1	Non-treated control			7.15a	7.78a	3.95a
2	Calcium Nitrate	0.2 LB N/1000 FT2	14 Day	10.18a	9.55a	1.40a
3	Ammonium Sulfate	0.2 LB N/1000 FT2	14 Day	5.78a	7.78a	1.45a
4	Ammonium Nitrate	0.2 LB N/1000 FT2	14 Day	7.15a	10.00a	2.00a
5	Xzemplar Banner MAXX II Secure Xzemplar Secure Iprodione Secure Banner MAXX II	0.26 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 0.26 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 3.0 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2	14 Day	7.33a	1.55a	0.10a

[a]Dollar spot severity assessed as percent diseased area per plot. Means followed by the same letter do not significantly differ (P=.05, Waller Duncan).

Table 6. Mean turfgrass quality at the OJ Noer Turfgrass Research and Education Facility in Madison, WI during 2015.

	Treatment	Rate	Application Interval	Turfgrass Quality[a]		
				Jun 4	Jun 29	Jul 15
1	Non-treated control			3.3a	3.0b	3.3b
2	Calcium Nitrate	0.2 LB N/1000 FT2	14 Day	3.3a	2.8b	3.8b
3	Ammonium Sulfate	0.2 LB N/1000 FT2	14 Day	3.5a	3.0b	3.5b
4	Ammonium Nitrate	0.2 LB N/1000 FT2	14 Day	3.3a	3.0b	4.0b
5	Xzemplar Banner MAXX II Secure Xzemplar Secure Iprodione Secure Banner MAXX II	0.26 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 0.26 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 3.0 FL OZ/1000 FT2 0.5 FL OZ/1000 FT2 1.5 FL OZ/1000 FT2	14 Day	3.3a	5.0a	5.0a

[a]Turfgrass quality was rated visually on a 1 – 9 scale with 6 being acceptable. Means followed by the same letter do not significantly differ (P=.05, Waller Duncan).

Minimum Mehlich 3 Potassium Levels for Bentgrass on a Sand Root Zone

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OBJECTIVE

The objective of this study is to determine the lowest level of Mehlich 3 soil potassium that can sustain healthy turfgrass.

MATERIALS AND METHODS

This experiment is being conducted on an ‘A4’ creeping bentgrass putting green on a 100% sand root zone overlaying a gravel layer with embedded drain tile. The green was constructed in 2008 and has been used previously for a soil test phosphorus calibration study. Mowing is conducted five days per week at 0.125”, and the green is fertilized with 0.2 lb urea N per 1000 ft^2 every two weeks, and irrigation is applied as needed based on soil moisture.

Beginning in spring of 2011, treatments consisting of different levels of potassium were applied, including no potassium, and 0.1, 0.2, and 0.6 lbs K_2O per 1000 ft^2 every two weeks. An additional treatment of 0.2 lbs per 1000 ft^2 of calcium sulfate was also included and is intended to decrease potassium in soil and tissue even more rapidly that the non-fertilized control. The treatments are arrayed in a randomized complete block design with four replications. Liquid fertilizer treatments are sprayed every two weeks during the growing season in two gallons per 1000 ft^2. The calcium sulfate is a granular application is made using hand shakers.

Beginning in 2012, a golf cart simulator to provide traffic stress three times weekly. Fungicides were not applied between a snow mold application in fall 2011 and an application intended to control dollar spot in 2014. This gave us the opportunity to evaluate the treatments for their impact on disease development. Each month, data on turfgrass color (CM-1000, Spectrum Technologies Inc., Plainfield, IL), quality (using the NTEP scale of 1-9, with 6 being minimally acceptable and 9 representing perfect quality), clipping mass, Mehlich 3 soil potassium in the top 3 inches, and tissue potassium content are collected. Pink snow mold, dollar spot, and brown patch were all quantified when they were observed to occur.

RESULTS AND DISCUSSION

Over the four years of the study, we have yet to observe statistical differences in color, quality, or clippings with the exception of very minor differences in color in 2014 (Table 1).Potassium applications have not been observed to affect dollar spot disease (Table 3) or brown patch (Table 4) but were observed to significantly influence pink snow mold disease pressure (Table 2). Treatments receiving no potassium were essentially free of snow mold damage, and treatments receiving 0.2 - 0.6 lbs K_2O/1000 ft^2 biweekly had roughly 10 infection centers per plot, covering about 3.5% of the turf. The treatment receiving 0.1 lbs of K_2O/1000 ft^2 biweekly had statistically similar damage as the controls. As you'll notice in Table 2, as potassium in the leaf tissue increased, the calcium in the leaf tissue decreased. Magnesium was less affected by potassium than calcium was. Snow mold damage (infection centers or % damage) was positively correlated (r^2=0.95) with tissue potassium and negatively correlated with tissue calcium (r^2=0.91). We do not yet understand the mechanism, but it is possible that the effect of potassium is to lower the calcium levels to a point where the plant becomes susceptible to fungal infection.

Other researchers have observed increased snow mold with increasing potassium applications (see Soldat, 2011a for a list), so this finding is another brick in the wall of that body of work. Interestingly, researchers at Rutgers reported decreased anthracnose as potassium increased (Schmid et al., 2013). Details from that study have yet to be fully reported in the literature.

The findings of this study and others mentioned above suggest that the optimum way to manage potassium on a sand root zone is to allow the soil potassium levels to drop near the PACE Turf/Asian Turfgrass Center's MLSN level of 35 ppm, then begin spoon feeding potassium in spring through summer, and stopping in August to allow the tissue levels to decrease and calcium levels to rise (which will happen naturally). This research trial will continue at least until the point where the turf shows clear visual symptoms of potassium deficiency, providing that continued funding for the plant and soil analysis can be secured.

Table 1. Average turfgrass color, quality and daily clipping mass for the four study seasons. Color is measured using the Spectrum CM-1000 on a scale from 1-999 (greenest) and quality is rated using the NTEP scale of 1-9 (best). Results followed by different letters within each column are statistically different according to Fisher's Least Significant Difference (alpha=0.05).

Treatment	------------- 2011 -------------			------------- 2012 -------------		
	Color	Quality	Clippings	Color	Quality	Clippings
	1-999	1-9	g	1-999	1-9	g
0.2 lb Ca/M (gypsum)	219 A	6.31 A	2.5 A	239 A	6.17 A	2.9 A
Control (no application)	217 A	6.06 A	3.1 A	227 A	6.21 A	2.9 A
0.1 lb K_2O/M (K_2SO_4)	215 A	6.28 A	2.4 A	229 A	6.08 A	2.0 A
0.2 lb K_2O/M (K_2SO_4)	217 A	6.38 A	2.7 A	235 A	6.13 A	2.2 A
0.6 lb K_2O/M (K_2SO_4)	214 A	6.13 A	3.1 A	235 A	6.21 A	2.7 A

Table 1 (cont.)

Treatment	------------- 2013 -------------			------------- 2014 -------------		
	Color	Quality	Clippings	Color	Quality	Clippings
	1-999	1-9	g	1-999	1-9	g
0.2 lb Ca/M (gypsum)	238 A	6.15 A	2.3 A	209 B	4.58 A	3.1 A
Control (no application)	236 A	6.10 A	2.4 A	210 AB	4.58 A	2.7 A
0.1 lb K_2O/M (K_2SO_4)	232 A	5.80 A	2.0 A	208 B	4.71 A	2.9 A
0.2 lb K_2O/M (K_2SO_4)	231 A	5.85 A	2.2 A	216 A	4.83 A	2.9 A
0.6 lb K_2O/M (K_2SO_4)	232 A	5.90 A	2.1 A	212 AB	4.79 A	2.7 A

Table 2. Pink snow mold (PSM) disease severity was quantified by counting infection centers and visually estimating the percentage of plot area occupied by infection from 4/2/2014. Tissue and soil nutrient content data was collected on 9/28/2013, the most recent sampling date prior to winter. Results followed by different letters within each column are statistically different according to Fisher's Least Significant Difference (alpha=0.05).

Treatment	PSM Infection Centers	PSM Damage	9/28/2013 ---------Tissue Content---------			9/28/2013 ---------Mehlich 3 Soil Test---------		
	#/plot	% area	% K	% Ca	% Mg	K (ppm)	Ca (ppm)	Mg (ppm)
0.2 lb Ca/M (gypsum)	0.5 B	0.0 B	1.42 D	0.69 A	0.46 AB	21.5 C	934 A	243 A
Control (no application)	1.0 B	0.5 B	1.45 D	0.61 B	0.48 A	26.2 BC	875 A	248 A
0.1 lb K_2O/M (K_2SO_4)	6.0 AB	2.5 A	1.81 C	0.57 B	0.47 AB	33.6 B	803 A	233 A
0.2 lb K_2O/M (K_2SO_4)	9.8 A	3.3 A	2.02 B	0.51 C	0.43 BC	33.1 B	930 A	252 A
0.6 lb K_2O/M (K_2SO_4)	8.8 A	3.5 A	2.19 A	0.48 C	0.41 C	45.9 A	848 A	234 A

Table 3. Dollar spot (DS) disease severity was quantified by counting infection centers from 7/17/2014. Tissue and soil nutrient content data was collected on 6/3/2014, the most recent sampling date prior to infection analysis. Results followed by different letters within each column are statistically different according to Fisher's Least Significant Difference (alpha=0.05).

Treatment	DS Infection Centers	6/3/2014 ---------Tissue Content---------			6/3/2014 ---------Mehlich 3 Soil Test---------		
	#/plot	% K	% Ca	% Mg	K (ppm)	Ca (ppm)	Mg (ppm)
0.2 lb Ca/M (gypsum)	1066 A	0.86 C	0.65 A	0.53 A	14.4 D	657 A	165 A
Control (no application)	1215 A	0.91 C	0.63 AB	0.57 A	12.7 CD	619 A	168 A
0.1 lb K_2O/M (K_2SO_4)	957 A	1.07 B	0.59 AB	0.57 A	17.5 C	592 AB	166 A
0.2 lb K_2O/M (K_2SO_4)	1068 A	1.17 AB	0.59 AB	0.52 A	24.8 B	580 AB	178 A
0.6 lb K_2O/M (K_2SO_4)	1116 A	1.28 A	0.52 B	0.52 A	37.4 A	510 B	166 A

Table 4. Brown patch disease damage was quantified using an 81 intersection grid on 8/26/2014 at peak disease development. Tissue and soil data from August are not yet available for comparison. Results followed by different letters within each column are statistically different according to Fisher's Least Significant Difference (alpha=0.05).

Treatment	Brown Patch
	% area
0.2 lb Ca/M (gypsum)	43.5 A
Control (no application)	37.4 A
0.1 lb K_2O/M (K_2SO_4)	69.1 A
0.2 lb K_2O/M (K_2SO_4)	43.5 A
0.6 lb K_2O/M (K_2SO_4)	38.3 A

Characterization of Wisconsin Turfgrass C and N

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INTRODUCTION

Turfgrass is an expanding land cover in the United States, and currently covers an area about the size of the state of Wisconsin. Across the country, turfgrass soils accumulate C and N and can achieve quantities of C and N similar to prairies. As C and N accumulate and portions of the stored organic C and N are mineralized; some of the N may then be available for plant use. When more N is available through mineralization, N fertility could be reduced. Current UW-Extension recommendations are to reduce N-fertilizer by half once a turfgrass site reaches 10-12 yrs of age. What we don't know, is whether or not we could refine those recommendations using the level of soil organic N. The overall aim of this research is to lay the groundwork for determining what level of soil organic N might be required to reduce fertilizer inputs and also the risk for N-leaching.

The purpose of this study was to characterize C and N in turfgrass systems: both in quantity and where it was stored in the soil.

MATERIALS AND METHODS

Soil samples (8 in depth) from golf course fairway-rough pairs on forest derived soils (37 sites) were collected and analyzed soil C and soil N. The 37 sites were also divided into northern and southern regions of Wisconsin, and had a gradient in age from 9 to 119 years old. Soil was separated or fractionated using wet-sieving and syphoning into coarse sand, fine sand, silt, and clay associated organic matter. Each fraction was analyzed for soil C and N.

RESULTS

- There were no differences in soil C and N content or mineralization between fairway-rough or north-south.
- Overall the average soil C content was 27.7 tons A^{-1} and average soil N was 2.6 tons A^{-1}.
- Soil organic C and N both increased with time at rates of 237 lbs A^{-1} for soil C and 16.7 lbs A^{-1} (Figure 1).
- Soil C and N contents differed between the silt-associated fraction and the other three fractions (Table 1).
- The silt-associated fraction contained the greatest quantity of soil C and N.
    - About 40% of the soil C and N were found in the silt and clay associated pools, compared to about 60% in the sand associated pool.

- Management, defined as fairway or rough and land use history did not influence the soil C and N content of the fractions.
- Age of site was important in the sand associated fractions, where the quantity of sand associated C and N appeared to increase with age.
- There was no influence of age on silt or clay associated soil C and N.

CONCLUSIONS AND FUTURE RESEARCH

The turfgrass systems of Wisconsin accumulate soil C and N with time. Soil fractions showed a large silt-associated fraction, and an increasing sand-associated pool with age. As the turfgrass systems age, we expect silt and clay associated pools to saturate or fill while the sand associated pool increases with time, which was demonstrated by our research. Current work is attempting to determine what soil N level correlates with saturation and if turfgrass soils in Wisconsin are saturated, which could eventually be used to set fertilizer recommendations.

Table 1. Soil organic C and soil organic N in soil fractions of Wisconsin golf course soils.

Fraction	C in soil fraction	N in soil fraction
	oz lb soil^{-1}	
Coarse sand	0.074 B	0.0058 B
Fine sand	0.098 B	0.0084 B
Silt	0.187 A	0.0158 A
Clay	0.054 B	0.0043 B
$LSD_{0.05}$	0.051	0.0048

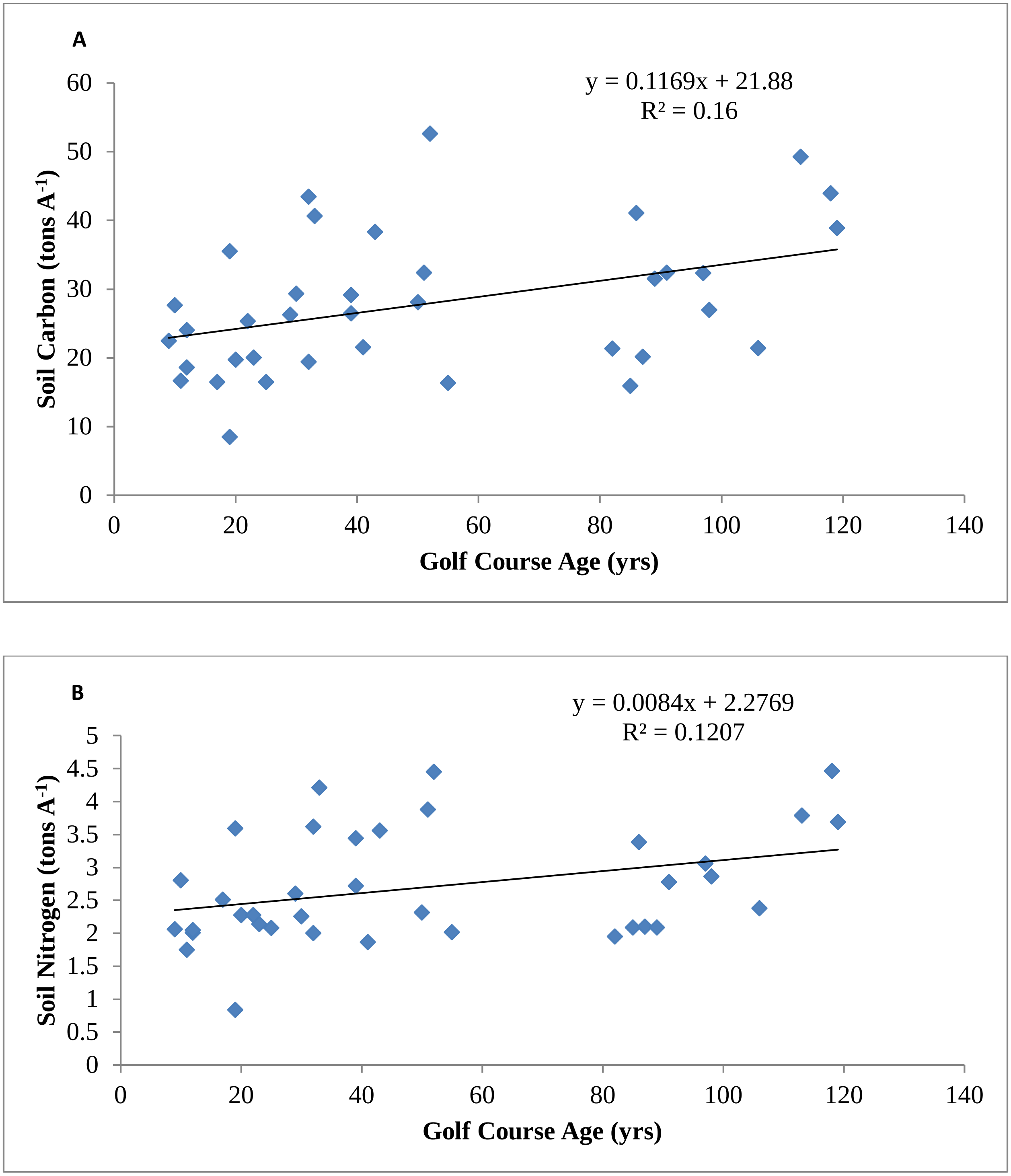

Figure 1: Soil organic C (A) and soil organic N (B) in turfgrass across gradient in age on Alfisols in Wisconsin.

Drought Trial of Fine Fescues Managed as Golf Course Fairways

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INTRODUCTION

Our worldwide water resources are declining at an alarming rate, both in quantity and quality. Because of this, legislation has been enacted to restrict our water use and the cost of water is increasing. In addition, global climate change assessments predict that our drought events will continue to increase in both frequency and magnitude. We must manage our turfgrass in a way that maintains performance and playability in order to cope with these trends of reduced water availability.

Golf course fairways in the North Central region primarily consist of species that require high inputs of water, pesticides, and nitrogen fertilizer. We believe that future restrictions will impact golf course management in a very significant way and that the solution to the problem of inputs on golf course fairways will not be changes in management practices, but instead the use of lower-input grasses. Low-input fine fescue species should be able to withstand the pressure from typical turfgrass stresses while producing acceptable turf and excellent playing quality—all with fewer overall inputs. Due to limited research on these species in fairway settings, superintendents are wary to begin using fine fescues. This research project is investigating an area where research-based information is lacking

The objective of this study is to determine if fine fescues can survive when managed as fairways under acute drought. We have field trials in Saint Paul and Madison evaluating fine fescue species and cultivars under acute drought. The trials are located under a rainout shelter. The rainout shelter is a state-of-the-art device that allows us to withhold precipitation and impose an experimentally controlled drought on the research area. Our shelter is a structure that will move to cover the test area during a rainfall event and remains off the area during fair weather. The species and mixtures will be evaluated under acute drought for a 60-day period.

METHODS

The trial consists of 25 mixtures of single cultivars representing five fine fescue species (‘Radar’ Chewings, ‘Beacon’ hard, ‘Navigator II’ strong creeping red, ‘Shoreline’ slender creeping red, and ‘Quatro’ sheep). The plots were established in fall 2014 in St. Paul and Madison. Data is collected before, during, and after the 60-day drought period. Before the drought begins, the entire area is irrigated to uniformly wet the soil. For the next 60 days, the turf plots receive no water from irrigation or precipitation. After the drought, the area is irrigated with 1 inch of water per week and recovery data is collected for 45 days. Data collected through the entire experiment includes visual ratings of turfgrass quality, digital images for color analysis, and chlorophyll index readings to quantify plant tissue health. All plots are mowed at 0.5 inches.

CONCLUSIONS

This research will result in information vital to golf course superintendents as they continue to deal with increased regulations imposed by government. Additionally, this research could result in tremendous environmental and economic benefit for golf courses as a result of overall reduced water inputs. Finally, the fine fescue species are known to have a slower vertical growth rate, which will result in further reductions in energy use on golf courses.

PLOT MAP

South

22	22	2	9	18	8	3	25	14	16
5	4	8	8	20	5	23	19	22	11
10	19	13	15	19	21	17	23	17	8
16	6	16	22	2	19	15	9	18	17
4	10	15	4	14	22	6	10	3	13
17	2	24	1	25	12	7	6	20	2
21	6	14	6	11	10	4	4	12	10
24	15	9	7	17	2	18	7	25	1
11	7	23	13	21	11	25	2	21	4
19	20	11	23	5	13	1	21	18	24
8	1	12	3	12	9	13	20	15	6
23	18	25	21	10	16	15	24	19	3
12	9	1	5	16	24	1	5	9	7
13	3	18	7	3	20	11	12	22	23
25	14	17	20	24	14	8	16	5	14

North

Species	**Cultivar**
Chewings fescue (CHF) *Festuca rubra ssp. fallax*	Treazure II
Hard fescue (HF) *Festuca trachyphylla*	Beacon
Sheep fescue (SHF) *Festuca ovina*	Quatro
Slender creeping red fescue (SLCRF) *Festuca rubra ssp. litoralis*	Shoreline
Strong creeping red fescue (STCRF) *Festuca rubra ssp. rubra*	Navigator II

Mixture identification and species proportions					
Mixture	**CHF**	**HDF**	**SHF**	**SLCRF**	**STCRF**
1					1
2				0.50	0.50
3				1	
4			0.33	0.33	0.33
5			0.50		0.50
6			0.50	0.50	
7			1		
8		0.33		0.33	0.33
9		0.33	0.33	0.33	
10		0.50			0.50
11		0.50		0.50	
12		0.50	0.50		
13		1			
14	0.20	0.20	0.20	0.20	0.20
15	0.25	0.25	0.25		0.25
16	0.33			0.33	0.33
17	0.33		0.33		0.33
18	0.33		0.33	0.33	
19	0.33	0.33		0.33	
20	0.33	0.33	0.33		
21	0.50				0.50
22	0.50			0.50	
23	0.50		0.50		
24	0.50	0.50			
25	1				

Cultural and chemical weed management in native fine fescue roughs

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INTRODUCTION

As native fine fescue rough areas grow, finding effective chemical and cultural management of weeds is becoming a high priority (Figure 1). These areas are intended or are perceived to reduce maintenance costs and environmental impact; however, a solid understanding of how to manage them is lacking which has led to possibly excessive inputs of chemicals and labor to obtain the desired visual effect. The objective of this project is to evaluate various cultural and chemical management strategies in a fine fescue rough.

MATERIALS AND METHODS

This project is being conducted at Hawks Landing Golf Club in Madison, WI. At Hawks Landing, we have initiated two separate trials, with plans to initiate a third trial in spring 2015. The first trial investigates the impact of three cultural management strategies (mowing and removing material, mowing and returning material, and not mowing) on weed and desirable grass composition. Each strategy is evaluated either with or without chemical control. The second trial evaluates the performance of five different herbicides on weed composition. The third trial will evaluate the efficacy of various rates and timings of glyphosate on spring weed control. The hypothesis is that glyphosate at low rates will be useful for controlling early season weeds (i.e. quackgrass) without harming the fine fescue. For all three studies plot size is 6 ft. by 10 ft. with each treatment replicated four times and arrayed in a randomized complete block design. Visual estimates of plant populations are made in spring, summer, and fall. The trials will continue for at least three years.

For the cultural management trial, only chemical treatments significantly affected plot composition (Table 1); however, differences related to mowing are likely to be slow to develop and may manifest in coming years. The chemical efficacy trial showed good control of broadleaf weeds (Table 2). Grassy weeds were relatively low to begin with, and were not significantly affected by the herbicides. The third trial was conducted in an overgrown area with fescue, grassy and broadleaf weeds (Table 3).

RESULTS

Table 1. Grass and Weed composition of plots under various mowing and chemical management in July, 2015. Mowing treatments and chemical applications were made in May 2014 and 2015.

Mowing	Herbicide* Applied	Desirable Grasses	Bare Soil	Grassy Weeds	Broadleaf Weeds	Total Weeds	Playability Score**
Mowed, Returned	Yes	89 A	7 A	5 AB	0 B	5 B	1.5 ABC
Mowed, Returned	No	46 B	6 A	8 AB	39 A	48 A	2.0 AB
Mowed, Removed	Yes	84 A	12 A	4 AB	0 B	4 B	1.3 BC
Mowed, Removed	No	51 B	8 A	3AB	39 A	42 A	2.3 A
Not Mowed	Yes	80 A	7 A	10 A	3 B	13 B	2.3 A
Not Mowed	No	82 A	10 A	0 B	8 B	8 B	1.0 C

* Herbicide treatment included Barricade (1 lb/A), SpeedZone (1.5 oz/1000 sq. ft.), and Milestone (4.0 oz/1000 sq. ft.) in sprayed at 2 gallons/1000 sq. ft.

** 1 = playable, 2 = intermediate, 3 = unplayable

Table 2. Grass and Weed composition in July 2015 as affected by herbicide application. Chemical applications were made in May 2014 and 2015.

Herbicide Treatment	Desirable Grasses	Bare Soil	Grassy Weeds	Broadleaf Weeds	Total Weeds	Playability Score*
Exp. Tmt 1 (4 pts/A)	89 A	9 A	2 AB	1 B	3 C	1.5 AB
Confront (2 pts/A)	87 A	6 A	6 AB	2 B	7 BC	1.75 AB
Confront (4 pts/A)	73 A	4 A	25 A	0 B	3 C	2.5 A
Milestone (6 oz/A)	88 A	9 A	0 B	3 B	3 C	1.0 B
SpeedZone (2 pts/A)	87 A	4 A	3 AB	6 B	9 BC	2.25 A
Non-treated control	32 B	6 A	16 AB	46 A	63 A	2.5 A

* 1 = playable, 2 = intermediate, 3 = unplayable

Table 3. Impact of glyphosate + Barricade, ForeFront, and Chaparral on stand composition in July 2015.

Herbicide Treatment	Application Date	Desirable Grasses	Bare Soil	Grassy Weeds	Broadleaf Weeds	Playability* Score
ForeFront	Fall 2014	82 A	4.3 CD	11 A	2.8 D	2.5 ABC
Chaparral	Fall 2014	79 AB	5.0 BCD	7 A	9 CD	2.8 AB
glyphosate 1# AI/A	April 2015	36 C	3.8 CD	5 A	55 A	2.8 AB
glyphosate 2# AI/A	April 2015	45 C	6.3 BCD	9 A	40 AB	3.0 A
glyphosate 1# AI/A	May 2015	75 AB	10 B	8 A	7.8 CD	1.8 C
glyphosate 2# AI/A	May 2015	57 ABC	21 A	3 A	19 BCD	2.0 BC
glyphosate 1# AI/A	June 2015	63 ABC	8 BC	5 A	24 BCD	2.8 AB
Non-treated control	N/A	78 AB	2.3 D	10 A	8.8 CD	3.0 A

* 1 = playable, 2 = intermediate, 3 = unplayable

Use of Drones for Turfgrass Management and Research

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The advent of relatively inexpensive unmanned aerial vehicles (UAVs) or drones has led to many creative ways gain new perspective of the world. Thousands of amazing videos can be found on YouTube with drones flying over spectacular landscapes, historical landmarks, and even though a fireworks display. This amazing technology can also be used as tool to benefit turfgrass managers and researchers.

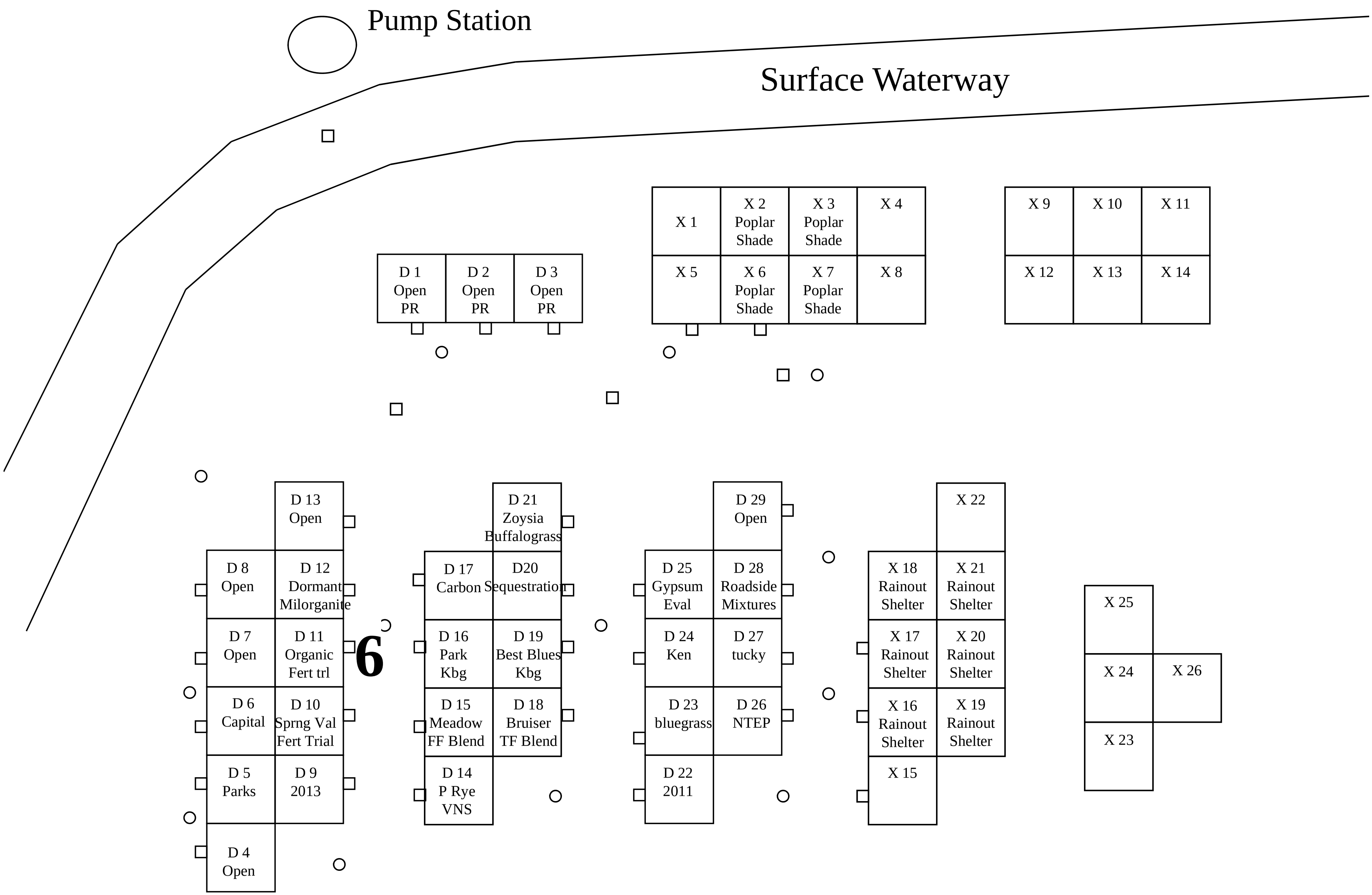
Golf course superintendents fly their UAVs over the course to get a birds-eye view of their property. They use them to scout for problems that are difficult to see from the ground (i.e. irrigation distribution and nutrient deficiencies), monitor progress of renovation and construction projects and provide members and clients photos and videos of the course. Researchers are also using UAVs to monitor plant nutrient status, record canopy temperature, compare treatments, and estimate instantaneous ET rate.

The FAA is still developing regulations for UAVs. This limits use of UAVs to hobby or recreational activities. This basically means that you can fly your drone system for fun and not for commercial benefit. Government agencies/universities and licensed pilots can apply for one of two exemptions from the FAA to operate for commercial purposes. The FAA expects formal rules to be set later in 2015, including rules specific to micro UAVs. These light weight drones (<4.4 lb) typically range from $400 to $1200 and are used solely for aerial photography. Micro UAVs may be common tools of turfgrass management in the near future.

Hobby drone recommendations:

- Fly less than 400’ and less than 100 mph
- Maintain visual contact with your drone at all times
- Avoid manned aircraft at all times
- Contact a local air traffic control tower when flying within 5 miles of an airport (Omaha, Lincoln, Offutt, Sioux City or Grand Island airports in Nebraska
- Avoid people not involved with the operation of the drone
- Flights within 3 nm of a sporting event with more than 30,000 people is illegal
- Never fly in a careless or reckless manner
- Check locals codes or laws before flight

Learn more about safe flying at knowbeforeyoufly.org



Pump Station
Surface Waterway
D 1 Open PR
D 2 Open PR
D 3 Open PR
X 1
X 2 Poplar Shade
X 3 Poplar Shade
X 4
X 5
X 6 Poplar Shade
X 7 Poplar Shade
X 8
X 9
X 10
X 11
X 12
X 13
X 14
D 13 Open
D 8 Open
D 12 Dormant Milorganite
D 7 Open
D 11 Organic Fert trl
D 6 Capital
D 10 Sprng Val Fert Trial
D 5 Parks
D 9 2013
D 4 Open
6
D 21 Zoysia Buffalograss
D 17 Carbon
D20 Sequestration
D 16 Park Kbg
D 19 Best Blues Kbg
D 15 Meadow FF Blend
D 18 Bruiser TF Blend
D 14 P Rye VNS
D 29 Open
D 25 Gypsum Eval
D 28 Roadside Mixtures
D 24 Ken
D 27 tucky
D 23 bluegrass
D 26 NTEP
D 22 2011
X 22
X 18 Rainout Shelter
X 21 Rainout Shelter
X 17 Rainout Shelter
X 20 Rainout Shelter
X 16 Rainout Shelter
X 19 Rainout Shelter
X 15
X 25
X 24
X 26
X 23

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