UNIVERSITY of ARKANSAS
Turfgrass Field Day

UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE

Agriculture Research and Extension Center
Horticulture Field Lab
Fayetteville, AR

Wednesday, July 24, 2019

Welcome!

Welcome to the 2019 Turfgrass Field Day at the University of Arkansas! The University of Arkansas Turfgrass Research Program has been addressing problems that affect the Arkansas turfgrass industry for more than 20 years. Thanks to the Arkansas turfgrass industry, the United States Golf Association, the Golf Course Superintendents Association of America, the National Turfgrass Evaluation Program, the O.J. Noer Foundation, Turfgrass Producers International and Turfgrass Water Conservation Alliance for their generous gifts and grants and base funding provided by the University of Arkansas System's Division of Agriculture, we are making exciting discoveries that impact the turfgrass industries in the mid-south region. This year's program will highlight lawn care, golf course issues, and sports turf research that range from native grasses to drones. I wish you the best for an enjoyable day with lots of learning opportunities.

A continental breakfast will be served early morning next to the registration area. Bottled water will be made available throughout the research tours to help "beat the heat". Additionally, fans are located near the trade show and registration tents to help you cool off. Enjoy a delicious lunch of all you can eat catfish from Catfish Hole and a refreshing Kona Ice for dessert. Lunch will be served at the tent outside the Horticulture Field Laboratory following the research tours.

Thanks again for your attendance today and your support of the Turfgrass program at the University of Arkansas.

Enjoy!

Wayne A. Mackay
Professor and Head
Department of Horticulture

At today's Field Day, you may see pesticide use in research trials that does not conform to the pesticide label. These uses are not provided as recommendations. It is the responsibility of the pesticide applicator, by law, to follow current label directions for the specific pesticide being used. No endorsement is intended for products mentioned, nor criticism of products not mentioned. The authors and the University of Arkansas assume no liability from misuse of pesticide applications detailed in this report.

Arkansas' Turfgrass Science Home Page:

http://turf.uark.edu

To subscribe to program updates and turf tips Visit the website and sign up at:

https://goo.gl/uOIr6w

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Arkansas State Plant Board Pesticide Recertification

Pesticide recertification training is available for all interested parties. This program is coordinated through the Arkansas State Plant Board. **To receive pesticide recertification credit, attendees must sign in before the morning research tours begin and sign out after the afternoon pesticide recertification session.**

Missouri & Oklahoma Pesticide Recertification

If attendees are seeking Missouri or Oklahoma pesticide certification training credit please see Dr. Richardson or Dr. Bertucci during today's event.

GCSAA Education Points

Today's program has been approved for 0.*25* GCSAA educations points. These education points are applicable towards Class A and certification entry and renewal for GCSAA members. The Event Approval Code will be given after the research tours at lunch. To receive credit for today's attendance, GCSAA members must submit the Event Approval Code to GCSAA headquarters within the 30 days of the event.

University of Arkansas Turfgrass Research Cooperators

The University of Arkansas turfgrass research team is grateful for assistance in the form of donated equipment and product, and research grants from the following associations and companies. Our productivity would be significantly limited without this support.

Ace of Blades
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Carswell - OEI
Central Garden and Pet
Chase Turpin, Pinnacle Country Club
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John Streachek, Shadow Valley CC
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Syngenta
Target Specialty Products
Tiger-Sul Products
The Toro Company
Trimax Mowers
Troy Fink and Nic Brouwer, The Blessings Golf Club
Turfgrass Producers International
Turfgrass Water Conservation Alliance
United States Golf Association
University of Tennessee
Winfield Solutions

We regret that some individuals or companies may have been inadvertently left off of this list. If your company has provided financial or material support for the program and is not mentioned above, please contact us so that your company's name can be added in future reports.

A special thanks goes out to all of our trade show exhibitors and the following sponsors:

Breakfast	Lunch	Water
PENNINGTON® THE GRASS SEED PEOPLE®	syngenta	EWING® Irrigation Golf Industrial

This event would not be possible without your support!

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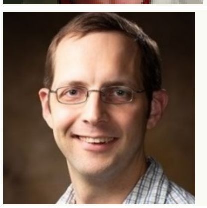

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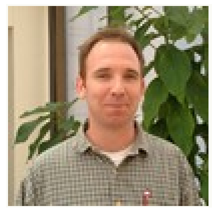

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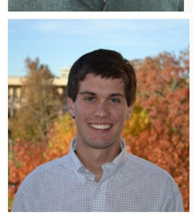

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How Do Various Wetting Agents Affect Water Movement and Retention in Sand-based Putting Green Profiles?

Doug Karcher

Many commonly used wetting agents are very effective in mitigating localized dry spot symptoms and improving moisture uniformity on sand-based putting greens. However, some may be hesitant to use certain wetting agent products because of the perceived negative consequence of excessive or insufficient moisture retention near the putting green surface. In addition many wetting agent manufacturers market some of their wetting agent lines as either a “penetrant” or “retainer”, with the idea that a penetrant is best suited to rootzones that are prone to being excessively wet (finer sand, high organic matter content, limited air movement, high rainfall, etc.); while a retainer is best suited to rootzones that are prone to having insufficient moisture (coarse sand, low organic matter, high sun and wind exposure, low rainfall, etc.). Examples of such wetting agent products are indicated in Table 1. Even though there is an industry-wide perception that various wetting agent products move or retain water through sand-based rootzones differently, there is a lack of research data to substantiate such differences.

Table 1. Example wetting agent products that are marketed for their water “penetrant” or “retainer” properties. This is not an exhaustive list.

Manufacturer	Penetrant	Retainer
Aquatrols	Dispatch	Primer Select
Precision Labs	Duplex	Magnus
Floratine	Pervade	Retain
Residex	Cleanse	Kraken
Harrell’s	Fleet	Symphony

An experimental lysimeter system is being developed at the University of Arkansas that is capable of precisely measuring subtle changes in moisture content at various depths within simulated putting green rootzones. Such a system would help validate whether certain wetting agent products act as either “penetrants” or “retainers” when added to sand-based rootzones. Therefore, the objective of this study is to precisely measure how moisture movement and retention in sand-based rootzones are affected by wetting agent products that are marketed as either “penetrants” or “retainers”, in a controlled setting. Products with significantly different effects on rootzone moisture will be tested in a field study to determine if controlled environment findings translate to field conditions on actual creeping bentgrass and ultradwarf bermudagrass putting greens.

Objective:

The objective of this study is to determine whether differences exist between wetting agent products commonly marketed as either “penetrants” or “retainers” in their effects on water movement through sand-based putting green rootzones.

Materials & methods:

This research will be conducted in two phases. **Phase 1,** a greenhouse lysimeter trial, is being conducted in a controlled environment utilizing lysimeters as simulated sand-based rootzones, whereas **Phase 2**, field putting green trials, are being on actual, mature sand-based ultradwarf bermudagrass (Tifeagle) and creeping bentgrass (L-93) putting greens.

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Greenhouse Lysimeter Trial

Lysimeters have been constructed using 4 inch PVC pipe (cut to 12.25 inch lengths), with fiberglass mesh screen and adjustable clamps attached to one end. Holes will be drilled in the side of each lysimeter at depths at 1, 3, and 5 and 8 inch depths to accommodate Vegatronix soil moisture sensors. Sensor holes are staggered/offset around each lysimeter, and each sensor is oriented with the edge upward to minimize the impedance of downward water movement (Image 1).

Lysimeters are packed with sand that conforms to USGA particle size specifications for putting green rootzone construction. Hydrophobic sand created using octadecylamine is blended with typical sand to create various levels of water repellency in the surface 4 inches of each lysimeter rootzone. The surface 4 inches of each lysimeter rootzone has either 0 or 20% hydrophobic sand (on a volumetric basis).

For each lysimeter soil moisture sensors will be connected to data logger that is programmed to record volumetric water content on 10 minute intervals.

Lysimeters will be saturated, allowed to drain, and then weighed to establish field capacity volumetric water content. Lysimeters will then be placed in constructed racks, equipped with leachate collection containers situated beneath each lysimeter.

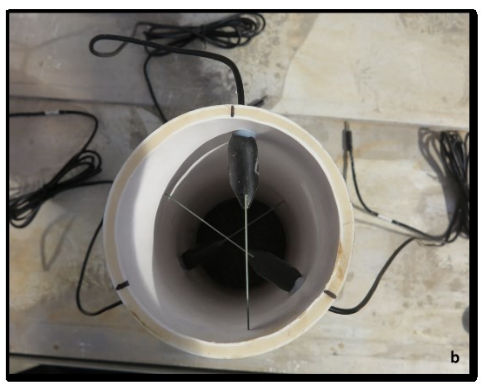


Image 1: (a) Prototype lysimeters used in pilot study to develop materials and methods for wetting agent/ET research. **(b)** Arrangement of WaterScout SM100 Soil moisture sensors within 4" PVC lysimeter

Wetting agent treatments (and an untreated control) will include products marketed as penetrants and retainers (Table 1), and have been applied at label rates in a spray volume of 2 gallons / 1000 ft^2. Within 30 minutes following treatment application, all lysimeters will receive 0.25 inches of irrigation.

Resulting water movement and subsequent rootzone dry-down will be monitored in three ways: *i)* collecting leachate/drainage from each lysimeter to quantify water moving through 12" profile entirely; *ii)* VWC logged (on minute by minute basis) for previously mentioned depths to quantify distribution within the profile; *iii)* lysimeters re-weighed regularly, and differences in weight used to quantify water lost to ET.

For the first two weeks following treatment application, irrigation will be applied three times weekly at 100% ET to monitor water distribution under typical moisture conditions. At three weeks following treatment application, a heavy rain event will be simulated by applying a 1.5 inches of irrigation to the lysimeters. Resultant leachate will be measured and then irrigation will be withheld to monitor moisture retention and distribution during a dry-down event over a two week period.

Initiation of the lysimeter greenhouse trial has been delayed significantly due to malfunctioning data loggers and a necessary overhaul of the irrigation system to ensure uniform irrigation volumes across all lysimeter. Treatments will be initiated in late summer of 2019.

Putting Green Trials

Experimental areas

Two separate experimental areas are utilized for Phase 2, a mature 'Tifeagle' ultradwarf bermudagrass putting green, and a mature L-93 creeping bentgrass putting green. Both experimental areas were constructed according to USGA recommendations, and the creeping bentgrass area has a history of localized dry spot development. Both putting greens are maintained using typical management practices for our region, including daily mowing at a height of 0.125 inches.

Treatment application and evaluation

Within each experimental area wetting agent treatments (Table 1) have been applied to three replicate plots (each 3 x 3 ft.), at label rates, in a spray volume of 2 gallons / 1000 ft^2. Within 30 minutes following treatment application the experimental areas will receive 0.25 inches of irrigation. In addition, replicated untreated control plots have been evaluated on each experimental area. An initial application was made in mid-October of 2018. The trail was initiated again in mid-May of 2019. In 2019, a second treatment application was made 28 days following the initial treatment application.

For the first two weeks following treatment application, irrigation is applied three times weekly at 100% ET_o to monitor rootzone moisture distribution under typical conditions. At three weeks following treatment application, a heavy rain event is simulated by applying 1.5 inches of irrigation to the experimental areas. Rootzone moisture distribution is estimated twice weekly (non-irrigation days) at depths of 1.5, 3, 5, and 8 inches using a Spectrum TDR 300 device. Five subsamples will be measured on each plot, at each depth. The same evaluation schedule will follow the second treatment application and the study will concluded on each experimental area after eight weeks.

Results:

In the fall of 2018, volumetric moisture readings were taken on both putting green trials on nine dates, volumetric c moisture readings have been taken on 15 dates on both trials this summer. As of yet, wetting agent treatments have not significantly affected average moisture content at any depth, on any date, on either trial. Therefore, we do not yet have field evidence that retainer and penetrant products affect water movement through a putting green profile differently. Both putting green trials will be repeated during the late summer / early fall season of 2019.

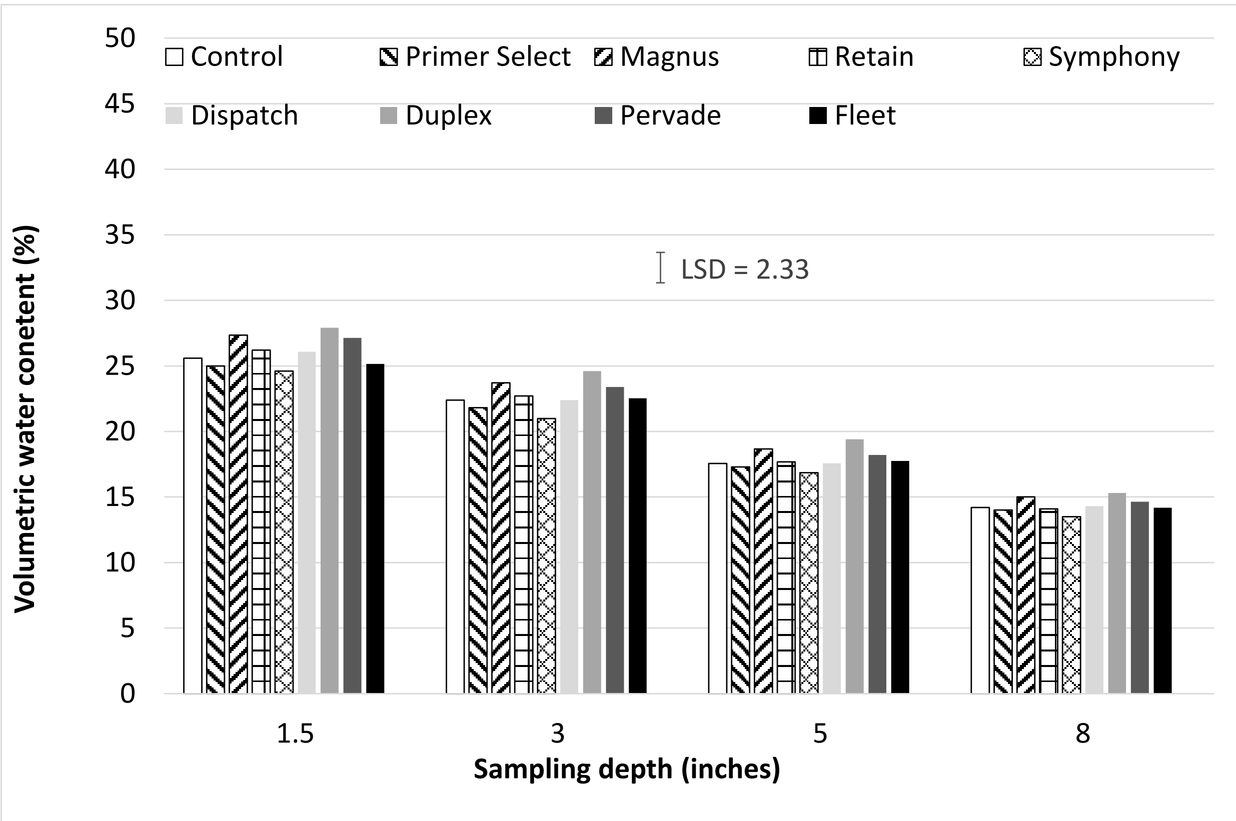


Figure 1. Volumetric water contents in a sand-based creeping bentgrass green at four sampling depths, averaged across the 2019 growing season. Patterned bars represent wetting agents marketed as retainers whereas solid bars represent wetting agents marketed as penetrants.

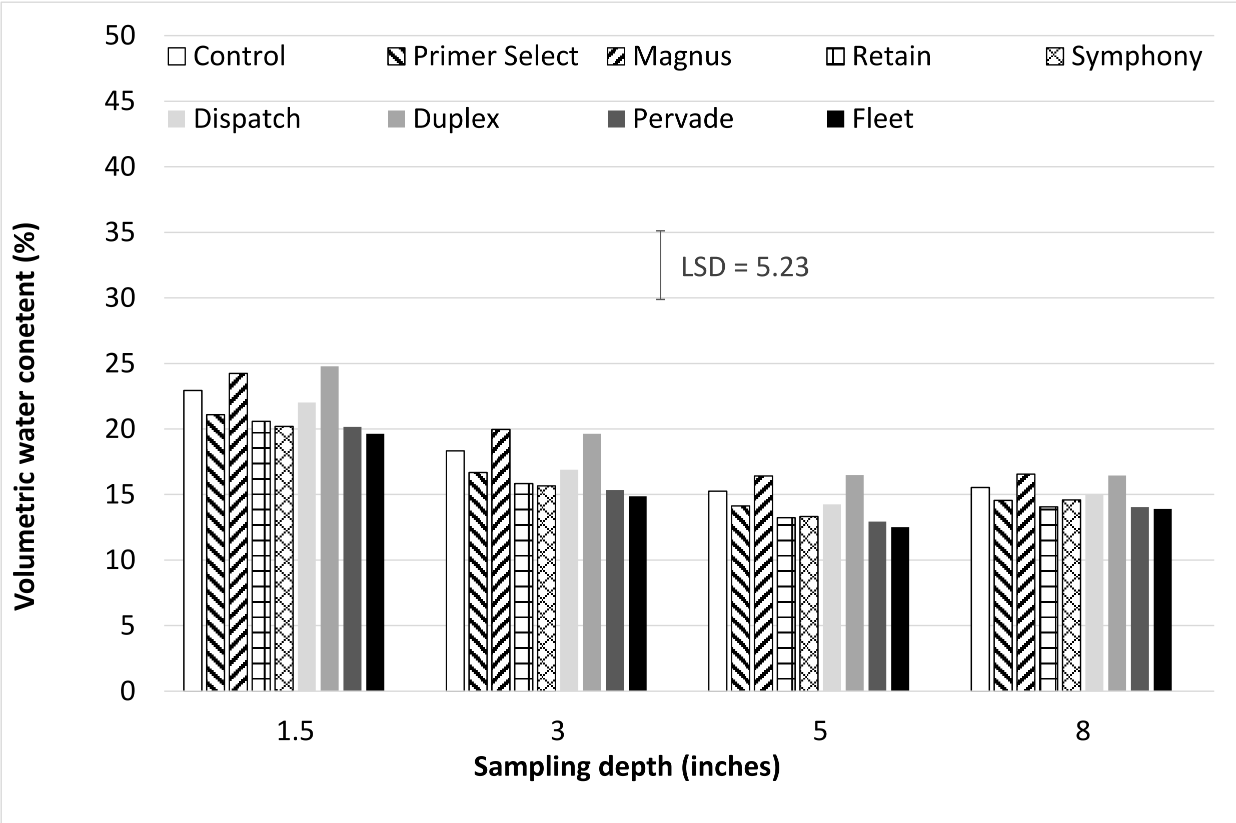


Figure 2. Volumetric water contents in a sand-based, 'Tifeagle' ultradwarf bermudagrass putting green at four sampling depths, averaged across the 2019 growing season. Patterned bars represent wetting agents marketed as retainers whereas solid bars represent wetting agents marketed as penetrants.

Long-term effect of irrigation with nanobubble oxygenated water on summer performance and stress tolerance of creeping bentgrass

Eric DeBoer

Background

Whether discussing plants, animals, humans, or microorganisms, oxygen is one of the raw ingredients required for life. For terrestrial plants, access to oxygen by aerial plant parts is rarely a limiting factor for healthy growth and development. Root systems, on the other hand, are often exposed to oxygen-deficient conditions when soils have poor porosity or become water-logged. Oxygen is sustained and replenished in the soil via diffusion of the gas from the atmosphere through the air-filled pore space. Providing ample oxygen to a plant root system is a constant concern in agricultural and horticultural production. Golf course superintendents often implement various methods of increasing soil oxygen in putting green rootzones such as, core aerification, solid-tine aerification, and sand topdressing. Aerification is time intensive, disrupts the putting surface, and is unpopular with golfers. Another method of delivering oxygen to the soil could be through oxygenated water.

As rainfall or irrigation water enters the soil, the water itself contains dissolved oxygen, which can be delivered to the soil and used for soil respiratory processes. Dissolved oxygen is the free, non-compound oxygen present in water. Tap water typically contains between 4-10 ppm dissolved oxygen, depending on the water temperature and salinity. Through the use of nanobubble technology, it is possible to achieve nearly 40 ppm dissolved oxygen in water. Nanobubbles are sub-micron, stable cavities of gas typically between 200-700 nm. The properties of nanobubbles allow for high gas dissolution rates resulting in super-saturation of oxygen in water.

In the transition-zone region of Arkansas, cultural and environmental factors can place creeping bentgrass (*Agrostis stolonifera*) under extreme amounts of stress during the summer period. This stress, coupled with the growth adaptation of bentgrass can result in shallow, poorly rooted stands of turf. Nanobubble technology may promote increased rooting of bentgrass putting greens during the stressful summer months and lead to a healthier, more vigorous playing surface.

Objectives

This research aims to compare the effects of long-term irrigation with nanobubble oxygenated water and regular irrigation water on creeping bentgrass putting green plant health characteristics as well as soil oxygen and nutrient content.

Materials and Methods

This study is being conducted at the University of Arkansas Agricultural Research and Extension Center in Fayetteville, AR on an experimental sand-based 'Pure Distinction' creeping bentgrass putting green, maintained at a .125" bench setting height of cut. Research is being conducted from 1 May through 31 October 2019 and 1 May through 31 October 2020.

Treatments include super-oxygenated water, containing more than 15 ppm dissolved oxygen, created using a nanobubble generator (Nano Bubble Technologies, Sydney, NSW, AU) as well as an untreated control consisting of standard potable irrigation water (Beaver Water District, Lowell, AR). Irrigation treatments are applied using a NorthStar 25 gal, 12-volt sprayer, delivering 5 gal/min from a Cool Shot Plus drenching nozzle. Irrigation treatments are applied every other day to replace 140% net evapotranspiration (ET). Individual plots measure 2 m by 2 m with 1 m alleys to account for subsurface water movement in the soil profile.

Total ppm dissolved oxygen, pH, and electrical conductivity (EC) of treatment water are recorded before each irrigation event. Turf color and quality are evaluated weekly using digital image analysis (DIA). Clipping yields are collected, dried and weighed, every second week. Root samples are collected monthly and analyzed for root length, size, and mass using WinRhizo scanning image analysis. Soil samples are extracted every second week and will be analyzed for a broad suite of elements and compounds, including ammonium, nitrite, nitrate, phosphorous, and up to 20 macronutrients or trace elements. Soil oxygen is recorded hourly at a depth of 7" and reported as the partial pressure of oxygen (kPa) using 8 Apogee SO-110 soil oxygen sensors (Apogee Instruments, Logan UT).

Results: This trial is currently ongoing. Some preliminary results are presented below:

- Root growth parameters including: length, surface area, average diameter, and volume did not differ between nanobubble oxygenated water and standard irrigation water when sampled on 31 May 2019 **(Table 1)**.
- Nanobubble oxygenated water increased partial pressure of soil oxygen at a 7" depth compared to standard irrigation water on multiple dates throughout the summer **(Fig. 1)**.
- Dry clipping weight did not differ between nanobubble oxygenated water and standard irrigation water on two sampling dates in June **(Fig. 2)**.
- Turf quality, green cover, and DGCI did not differ between nanobubble oxygenated water and standard irrigation water **(Data not shown)**.

Table 1. Effect of nanobubble oxygenated water on root growth of a creeping bentgrass putting green.

Treatment	Length (cm)	Surface Area (cm^2)	Avg. Diameter (mm)	Volume (cm^3)
Nanobubble	2316.6	357.3	.48	4.43
Control	2252.0	369.1	.5	4.83
LSD (0.05)	889.6	157.5	0.08	2.2

Figure 1. Effect of nanobubble oxygenated water on partial pressure of oxygen at a 7" on a creeping bentgrass putting green. Error bar indicates least significant difference for comparing treatments.

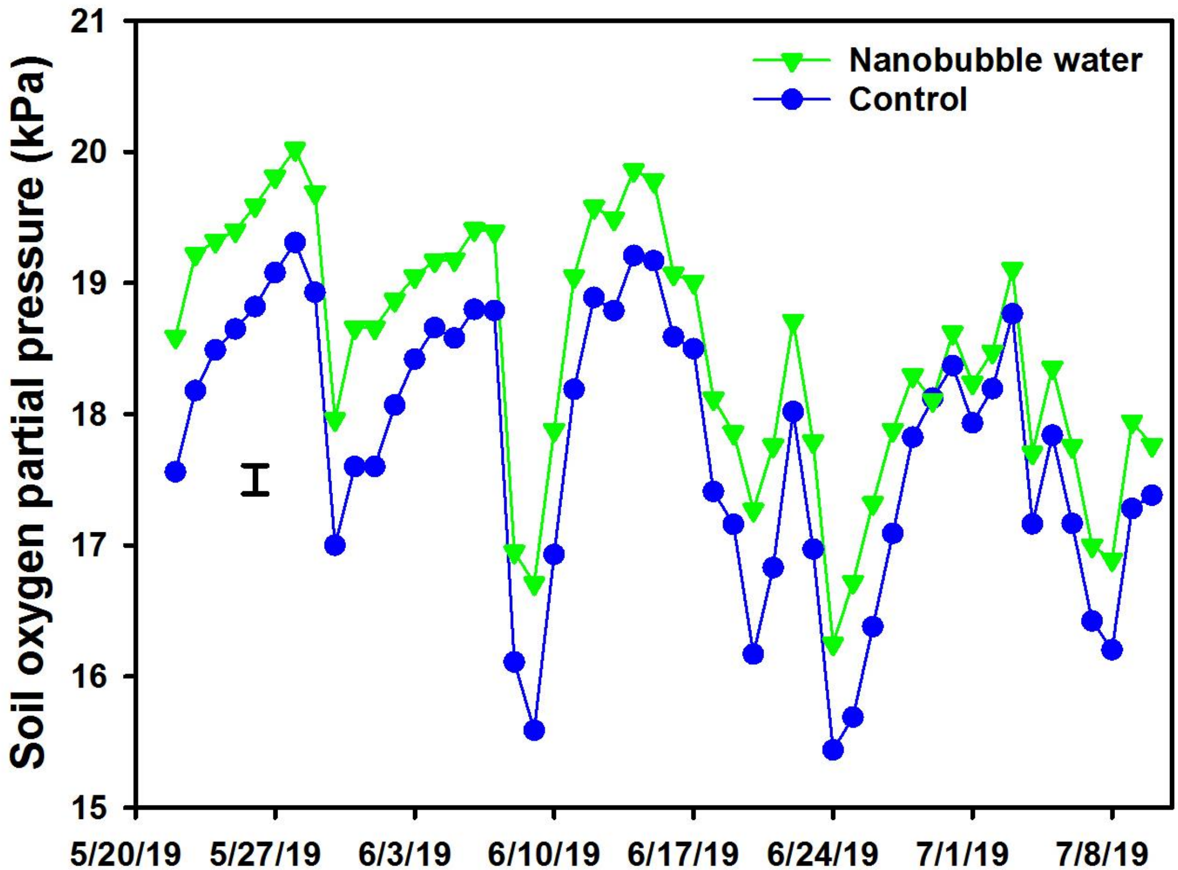
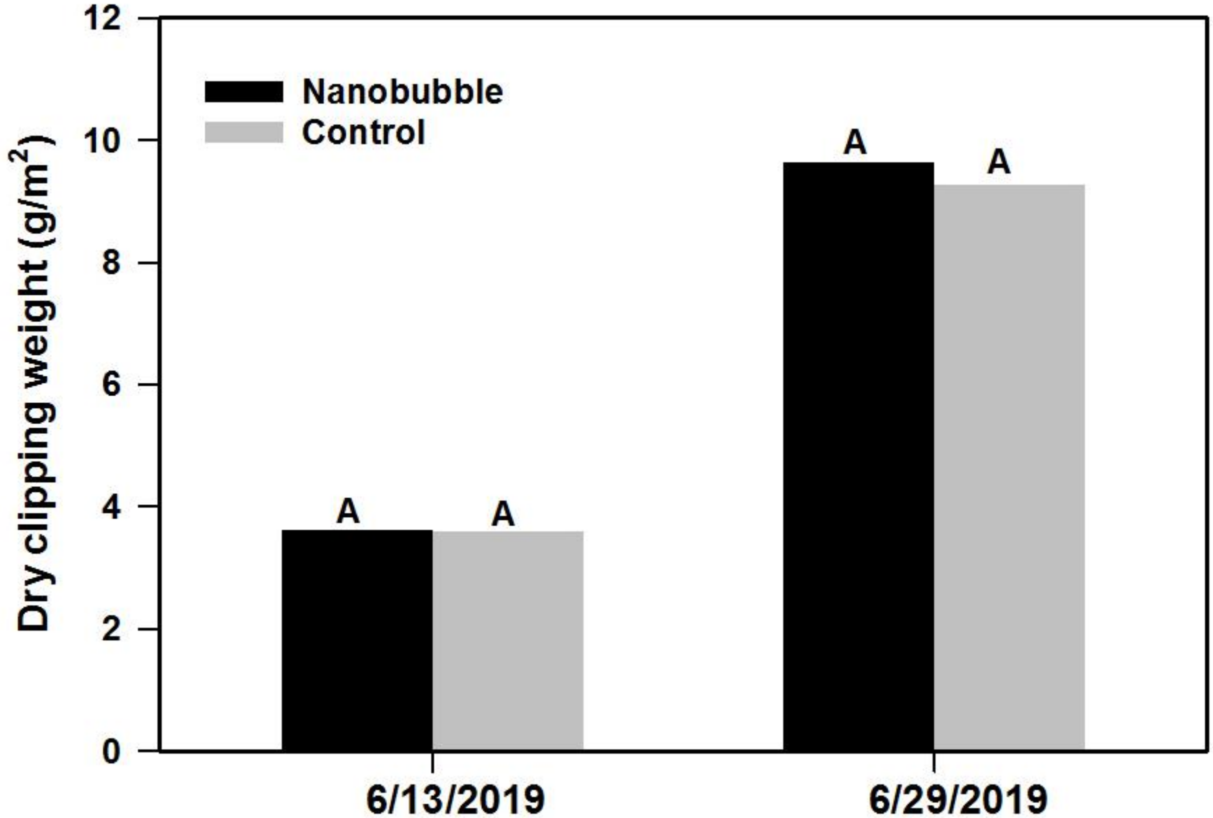


Figure 2. Effect of nanobubble oxygenated water on clipping yield of a creeping bentgrass putting green. Bars with same letter are not significantly different.



Fungicide Program Development on Golf Course Putting Greens

Lee Butler

Fungicide program development for golf course putting greens is challenging and maybe overwhelming at times. Golf course superintendents are bombarded with information from chemical manufacturers and distributors that could lead to unnecessary applications. In reality, golf course superintendents should be considering a few main diseases when putting together their fungicide program. What disease or diseases could cause significant turf loss? For example, on creeping bentgrass, Pythium root rot and summer patch might be your primary concern. Therefore, when building a program these should be the focus as all other diseases can be controlled with simple additions. Pythium root rot is a challenge because the fungicides used do not provide suppression of other diseases such as dollar spot, fairy ring, anthracnose, and brown patch. Yet including products that are effective against summer patch will control other diseases even when watered in.

For ultradwarf bermudagrass, there are more diseases to consider when developing a program. Diseases such as take-all root rot, spring dead spot, leaf spot, and Pythium diseases can be very destructive. This is especially true during the fall and spring when bermudagrass growth is dramatically reduced. However, not considering periodic fungicide applications during the summer months can predispose bermudagrass to diseases during the fall and spring. Although diseases are not as common during the summer on bermudagrass greens, it is likely that fungal pathogens are infecting and feeding on bermudagrass roots and foliage. Therefore, considering a routine fungicide application during the summer much like those applications that are made on creeping bentgrass when it is thriving in the fall and spring.

The best way to approach developing a program is to identify those key diseases that are a known problem at your course. After that, you can build your “backbone” program that specifically addresses these issues based on time of year as a rough rule of thumb. Ultimately, you will want to base your preventative applications on weather parameters such as low nighttime temperature for foliar diseases and average daily soil temperature for soilborne diseases. Finally, you can fill in the gaps with routine applications to improve turf quality and protect from minor diseases.

Creeping Bentgrass Fungicide Program Trial

Program	Turf Quality[1] Jun 22	Turf Quality Jul 9	% Dollar Spot May 17	% Dollar Spot May 31
1. NCSU Program 1	6.75 a[2]	7.00 a	5.8 c	1.3 c
2. NCSU Program 2	6.75 a	7.25 a	5.2 c	1.7 c
3. Golf Course Program 1	6.25 a	7.00 a	8.0 bc	16.0 b
4. Golf Course Program 2	1.00 c	1.00 c	21.6 ab	---------------
5. BASF Lexicon/Xzemplar	6.50 a	7.50 a	10.0 bc	2.0 c
6. BASF Maxtima/Navicon	6.00 a	7.25 a	32.5 a	18.0 b
7. Non-Treated Control	3.00 b	3.25 b	36.1 a	50.2 a

[1] Turf quality is measured on a 1-9 scale (9= best, 6=acceptable) based on color, density, and uniformity.
[2]Means within columns followed by the same letter do not significantly differ (P=.05, LSD).

Program Details – App Code letters = 7 days, e.g. A = day 1, B = 7 days later, C = 14 days later, etc.

Program	Product (rate/1,000 sq. ft.)	App Code		Program	Product (rate/1,000 sq. ft.)	App Code
NCSU 1	Tartan (2.0 fl oz)	A		NCSU 2	Torque (0.6 fl oz)	A
	Velista (0.7 oz)	C			Torque (0.6 fl oz)	C
	Segway (0.9 fl oz)	E			Subdue MAXX (1 fl oz)	E
	Lexicon Intrinsic (0.47 fl oz)	E			Xzemplar (0.26 fl oz)	E
	Daconil Ultrex (3.2 oz)	G			Daconil Ultrex (3.2 oz)	G
	Signature Xtra StressGard (4 oz)	G			Signature Xtra StressGard (4 oz)	G
	Segway (0.9 fl oz)	I			Segway (0.45 fl oz)	I
	Lexicon Intrinsic (0.47 fl oz)	I			Insignia SC (0.7 fl oz)	I
	Daconil Ultrex (3.2 oz)	K			Daconil Ultrex (3.2 oz)	K
	Signature Xtra StressGard (4 oz)	K			Signature Xtra StressGard (4 oz)	K
	Segway (0.9 fl oz)	M			Segway (0.45 fl oz)	M
	Briskway (0.72 fl oz)	M			Fame 480 (0.27 fl oz)	M
	Daconil Ultrex (3.2 oz)	O			Daconil Ultrex (3.2 oz)	O
	Signature Xtra StressGard (4 oz)	O			Signature Xtra StressGard (4 oz)	O
Golf 1	Daconil Action (3.5 fl oz)	A		Golf 2	Banner MAXX (4 fl oz)	A
	Signature Xtra StressGard (4 oz)	A			Aquaduct (4.5 fl oz)	A
	Bayleton FLO (2 fl oz)	C			Insignia SC (0.7 fl oz)	D
	Lexicon Intrinsic (0.5 fl oz)	C			Aquaduct (4.5 fl oz)	D
	Signature Xtra StressGard (4 oz)	F			Insignia SC (0.7 fl oz)	G
	Banol (2 fl oz)	F			Xzemplar (0.26 fl oz)	G
	Daconil Action (3.5 fl oz)	G			Aquaduct (3.2 fl oz)	G
	Revolution (6 fl oz)	H			Segway (0.45 fl oz)	I
	ProStar (3 oz)	H			Insignia SC (0.7 fl oz)	I
	Subdue MAXX (1 fl oz)	H			Aquaduct (3.2 fl oz)	I
	Fame + C (5 fl oz)	J			Signature Xtra StressGard (4 oz)	J
	Chipco 26GT (4 fl oz)	J			Chipco 26GT (4 fl oz)	J
	Fore Rainshield (6 oz)	K			Segway (0.45 fl oz)	K
	Signature Xtra StressGard (4 oz)	K			Aquaduct (3.2 fl oz)	K
	Revolution (6 fl oz)	M			Signature Xtra StressGard (4 oz)	L
	ProStar (3 oz)	M			Daconil Ultrex (3.4 oz)	L
	Segway (0.9 fl oz)	M			Segway (0.45 fl oz)	M

	Fore Rainshield (6 oz)	O			Insignia SC (0.7 fl oz)	M
	Signature Xtra StressGard (4 oz)	O			Aquaduct (3.2 fl oz)	M
	Daconil Action (3.5 fl oz)	Q			Signature Xtra StressGard (4 oz)	N
	Chipco 26GT	Q			Chipco 26GT (4 fl oz)	N
	Revolution (6 fl oz)	R			Daconil Ultrex (3.4 oz)	N
	ProStar (3 oz)	R			Segway (0.45 fl oz)	O
	Subdue MAXX (1 fl oz)	R			Aquaduct (3.2 fl oz)	O
	Signature Xtra StressGard (4 oz)	U			Signature Xtra StressGard (4 oz)	P
	Chipco 26GT (4 fl oz)	U			Daconil Ultrex (3.4 oz)	P
	Fore Rainshield (6 oz)	U			Segway (0.45 fl oz)	Q
					Aquaduct (3.2 fl oz)	Q
					Signature Xtra StressGard (4 oz)	R
					Chipco 26GT (4 fl oz)	R
					Daconil Ultrex (3.4 oz)	R
					Segway (0.45 fl oz)	S
					Aquaduct (3.2 fl oz)	S
					Signature Xtra StressGard (4 oz)	T
					Daconil Ultrex (3.4 oz)	T

Program Details (cont.)

Program	Product (rate/1,000 sq. ft.)	App Code		Program	Product (rate/1,000 sq. ft.)	App Code
BASF L/X	Xzemplar (0.21 fl oz)	A		BASF M/N	Maxtima (0.4 fl oz)	A
	Tourney (0.37 oz)	C			Xzemplar (0.21 fl oz)	C
	Lexicon Intrinsic (0.47 fl oz)	E			Navicon Intrinsic (0.85 fl oz)	E
	Signature Xtra StressGard (6 oz)	G			Signature Xtra StressGard (6 oz)	G
	Daconil Ultrex (3.2 oz)	G			Navicon Intrinsic (0.85 fl oz)	I
	Lexicon Intrinsic (0.47 fl oz)	I			Segway (0.9 fl oz)	K
	Chipco 26GT (4 fl oz)	K			Spectro 90 (5.76 oz)	K
	Daconil Ultrex (3.2 oz)	K			Navicon Intrinsic (0.85 fl oz)	M
	Lexicon Intrinsic (0.47 fl oz)	M			Secure (0.5 fl oz)	O
	Daconil Ultrex (3.2 oz)	M			Signature Xtra StressGard (6 oz)	Q
	Segway (0.9 fl oz)	O			Spectro 90 (5.76 oz)	Q
	Secure (0.5 fl oz)	O			Navicon Intrinsic (0.85 fl oz)	S
	Signature Xtra StressGard (6 oz)	Q				
	Daconil Ultrex (3.2 oz)	Q				
	Lexicon Intrinsic (0.47 fl oz)	S				
	Daconil Ultrex (3.2 oz)	S				

Preemergent and postemergent control options of crabgrass species

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Crabgrass species are among the most common weeds in turfgrass. Both smooth crabgrass (*Digitaria ischaemum*) and large crabgrass (*Digitaria sanguinalis*) can be found across the entire state of Arkansas. These weeds exhibit a summer annual life cycle, meaning that each spring crabgrass emerges from seed, grows to maturity and sets seed sometime in the summer or fall. Fortunately, annual weeds are susceptible to preemergent herbicides which kill weed seeds during or shortly after germination. Preemergent herbicides can be used to reliably prevent widespread infestations of annual weeds, but they do not always provide complete control. Preemergent herbicides may fail due to improperly calibrated equipment, blocked nozzles, missed or untimely applications, lack of an activating rainfall or irrigation events, or other reasons. Keep in mind, a preemergent herbicide may lose activity over time, necessitating a subsequent preemergent application or perhaps a postemergent application.

Fortunately, when preemergent herbicide applications fail (or cease providing control), selective postemergent herbicides are available to control crabgrass species without harming bermudagrass. Postemergent herbicides are a useful tool for spot spraying "escape" weeds that have persisted despite preemergent herbicide applications. Spot-spraying or even broadcasting of postemergent products should be timed when crabgrass are small and susceptible to herbicides. Postemergent applications will also pay dividends in subsequent summers by killing emerged crabgrass plants and preventing seed production.

Materials and Methods

This site on the AAREC research farm was selected due to a heavy crabgrass infestation in the previous year. However, to ensure uniformity, an additional 1.5 lbs of crabgrass seed was mixed with sand and drill-seeded across a 4000 sq ft area on March 11. The study was arranged in a split-plot design with 6 preemergent treatments and 6 postemergent treatments arranged in perpendicular strips 6 ft wide and 36 ft in length. Thus, each experimental unit was comprised of a 6 x 6 ft plot with 36 treatment combinations of preemergent and postemergent herbicides. Figure 1 provides a plot map and diagram of study design.

Five preemergent herbicide treatments, including three products (Table 1), were applied on March 11. Dimension applied as an early posteemergent (EPOST) application was made on May 3 when crabgrass were at the 2 to 3-tiller growth stage. Barricade applied as a split-application was applied initially on March 11 and again on May 3. All preemergent treatments were compared to an untreated check, receiving no preemergent herbicide. Five postemergent treatments, including three products (Table 1), were applied on July 7 when crabgrass were between 3 and 7 tillers. All herbicides were applied using a CO_2 pressurized backpack sprayer outfitted with 8002VS flat fan nozzles, calibrated to deliver 40 gallons per acre. Herbicide rates, surfactants, and treatment numbers are summarized in Table 2 and presented on a field map in Figure 1. Visual ratings of crabgrass control were assessed weekly following crabgrass emergence, relative to non-treated controls. Plots were rated on a 0 to 100 scale, with 0 indicating no crabgrass control and 100 indicating complete control.

Table 1. List of products, manufacturers and product details for chemicals used in this experiment.

Product Name	Manufacturer	Application Type	Active Ingredient	WSSA Group No.
Barricade	Syngenta	PRE	Prodiamine	3
Dimension	Syngenta	PRE, E-POST	Dithiopyr	3
Specticle FLO	Bayer	PRE	Indaziflam	29
Drive XLR8	BASF	POST	Quinclorac	4
Manuscript	Syngenta	POST	Pinoxaden	1
Q4-Plus	PBI Gordon	POST	2,4-D Dicamba Quinclorac Sulfentazone	4, 14
Adigor	Syngenta	Surfactant	-	-
Induce	Helena	Surfactant	-	-

Table 2. Herbicide treatments, application rates and plot numbers for crabgrass field trial.

Treatment Number	Treatment Name	Application Rate
PRE 1	No PRE	-
PRE 2	Specticle FLO	9 fl oz/acre
PRE 3	Barricade	1.5 lb/acre
PRE 4	Barricade fb Barricade	0.75 lb/acre 0.75 lb/acre
PRE 5	Dimension PRE	2 pt/acre
PRE 6	Dimension EPOST	2 pt/acre
POST 1	No POST	-
POST 2	Manuscript Adigor (MSO)	42 fl oz/acre 0.25% v/v
POST 3	Manuscript Adigor (MSO)	42 fl oz/acre 0.5% v/v
POST 4	Q4-Plus	8 pt/acre
POST 5	Q4-Plus Induce (NIS)	8 pt/acre 1% v/v
POST 6	Drive XLR8 Adigor (MSO)	64 fl oz/acre 0.5% v/v

Results and Discussion

All preemergent treatments exhibited complete crabgrass control (100%) over the course of assessments. Dimension applied as an early-postemergent treatment provided <75% control in all ratings after June 26. Some visible symptoms were observed in response to Dimension applied as an early postemergent product; however, other PRE treatments exhibited greater efficacy. These finding emphasize the importance of timely applications for PRE herbicides

Postemergent applications were timed such that symptomology would be most striking on field day. Thus, results are not available at the time of publication of this field book. Instead, please pay attention to our talk and note our assessments along with your personal observations below:

____

____

____

____

____

Drake Street

	POST 2	POST 1	POST 5	POST 3	POST 6	POST 4	
PRE 5	336	335	334	333	332	331	
PRE 2	325	326	327	328	329	330	
PRE 1	324	323	322	321	320	319	Rep 3
PRE 4	313	314	315	316	317	318	
PRE 3	312	311	310	309	308	307	
PRE 6	301	302	303	304	305	306	

	POST 6	POST 2	POST 3	POST 4	POST 5	POST 1	
PRE 5	236	235	234	233	232	231	
PRE 3	225	226	227	228	229	230	
PRE 1	224	223	222	221	220	219	Rep 2
PRE 6	213	214	215	216	217	218	
PRE 2	212	211	210	209	208	207	
PRE 4	201	202	203	204	205	206	

	POST 1	POST 2	POST 3	POST 4	POST 5	POST 6	
PRE 6	136	135	134	133	132	131	
PRE 5	125	126	127	128	129	130	
PRE 4	124	123	122	121	120	119	Rep 1
PRE 3	113	114	115	116	117	118	
PRE 2	112	111	110	109	108	107	
PRE 1	101	102	103	104	105	106	

North

Tennis Court

Figure 1. Field map of crabgrass herbicide trial (left). Recall that herbicides were applied in a strip-plot design with PRE and POST herbicides arranged in perpendicular strips (below). Each combination of herbicides was assessed in a 6 x 6 ft plot, based on combination of PRE and POST treatments.

PRE 6	136	135	134	133	132	131
PRE 5	125	126	127	128	129	130
PRE 4	124	123	122	121	120	119
PRE 3	113	114	115	116	117	118
PRE 2	112	111	110	109	108	107
PRE 1	101	102	103	104	105	106

Note: PRE herbicides applied in strips oriented East to West

POST 1	POST 2	POST 3	POST 4	POST 5	POST 6
136	135	134	133	132	131
125	126	127	128	129	130
124	123	122	121	120	119
113	114	115	116	117	118
112	111	110	109	108	107
101	102	103	104	105	106

Note: POST herbicides applied in strips oriented North to South

NebGuide

Nebraska Extension

Research-Based Information That You Can Use

G2302 · Index: Crops, Crop Production/Field Crops
Issued May 2018

Pulse-Width Modulation (PWM) Sprayers

What, Why, and How?

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Pulse-width modulation sprayers can be effective in pest management by reducing environmental contamination, reducing crop injury, and maximizing pesticide efficacy.

Pulse-width modulation (PWM) sprayers allow for variable rate control of flow through electronically actuated solenoid valves (fig. 1). The solenoid valves are pulsed a designated amount of times per second (standard = 10). The relative proportion of time each valve is open (duty cycle) determines the flow rate (fig. 2).

For example, a nozzle with 08 orifice size will emit 0.8 gallons per minute (gpm) when spraying water at 40 PSI at a 100 percent duty cycle. The same nozzle with the same solution and pressure at a 50 percent duty cycle will emit half the full duty cycle rate, or 0.4 gpm. The benefits of a PWM sprayer include:

- Individual nozzle control
- Overlap and turn compensation
- Quick, real-time flow rate changes while minimally impacting droplet size.

These PWM systems provide the opportunity for more precise and efficient pesticide applications through *reduced inputs and lower environmental contamination potential* as sprayer speed becomes independent from flow rate.

Figure 1. Solenoid valve equipped on PWM sprayer.

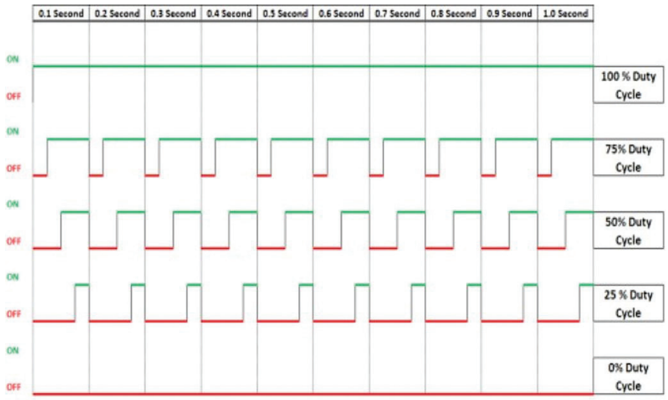

Figure 2. Illustration of a 10 Hz solenoid frequency operated at different duty cycles. Graphic courtesy of Brian Finstrom, Capstan Ag, Inc.

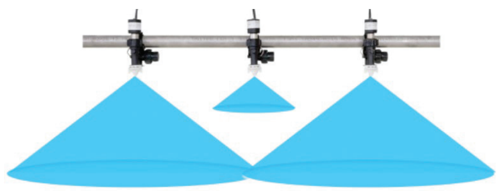

Figure 3. Illustration of blended pulse from a PWM sprayer. Graphic courtesy of Brian Finstrom, Capstan Ag, Inc.

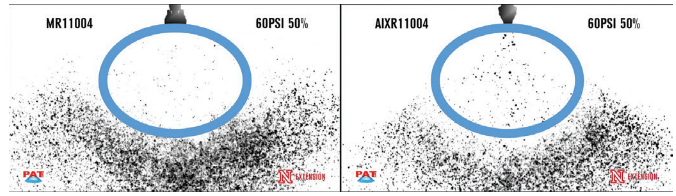

Figure 4. Non-air inclusion (MR11004—left) nozzle versus air inclusion (AIXR11004—right) nozzle when pulsed at a 50 percent duty cycle.

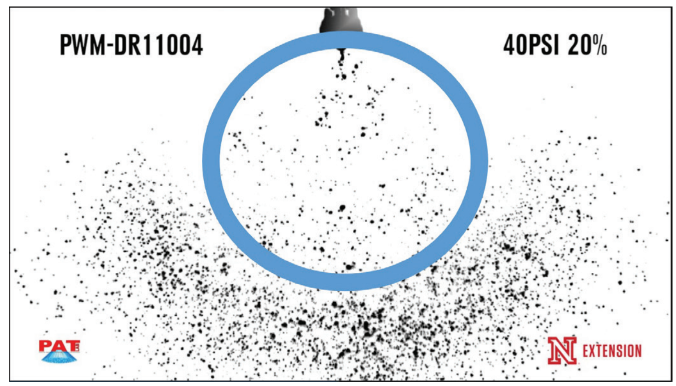

Figure 5. Non-air inclusion (DR11004) nozzle operated at a 20 percent duty cycle.

One concern frequently voiced regarding PWM sprayers is the potential for sprayer skips. Commercial PWM systems (e.g., Capstan PinPoint®, Case IH AIM Command®, John Deere ExactApply™, Raven Hawkeye®, TeeJet DynaJet®, etc.) use a blended pulse, in which every other nozzle operates on an alternate frequency to overcome this concern (fig. 3). This means that if operated at or above a 50 percent duty cycle, two adjacent nozzles will never be off at the same time.

To fully optimize the usage of PWM sprayers, several best use practices should be followed.

1. Air inclusion (AI) nozzles should not be used on pulsing systems. AI nozzles cause pattern deformities, droplet size variation, and nozzle tip pressure fluctuations when pulsed. Additionally, spray solution can be forced out of the AI ports, negating their drift reduction benefits. AI nozzles simply do not provide the same consistency and precision in spray pattern and droplet size as non-air inclusion-type nozzles (fig. 4).

2. Operate PWM sprayers at or above a 40 percent duty cycle. Lower duty cycles cause spray pattern and droplet size irregularities (fig. 5). Proper nozzle selection (specifically, orifice size) paired with appropriate sprayer speeds is critical to achieving this best use practice and optimizing a PWM sprayer application.

3. Operate PWM sprayers at or above 40 PSI. Solenoid valves contain an internal restriction that causes a pressure loss even when operated at a 100 percent duty cycle (fig. 6). As nozzle orifice size increases, the reduction in pressure across the solenoid valve increases. As can be seen in figure 6, the nozzles with 04 orifice sizes resulted in a pressure loss of 2–3 PSI, but when a nozzle with 08 orifice size was equipped and operated, the pressure drop across the solenoid valve was approximately 10–12 PSI. This pressure loss can affect nozzle performance by reducing pressure at the nozzle below manufacturer's recommended minimum pressures, especially if operated with system pressures less than 40 PSI.

PWM sprayers provide a unique approach to optimize spray applications as they allow sprayer speed to become independent from flow rate. Additionally, these sprayer systems can benefit applicators by reducing potential environmental contamination. For example, when spraying a field border, applicators with a PWM system could reduce sprayer speed to more effectively manage drift potential and still maintain the proper application rate without changing nozzles.

Site-specific management strategies could also be implemented as droplet size is relatively unaffected by PWM sprayers (no pressure-based changes required to maintain

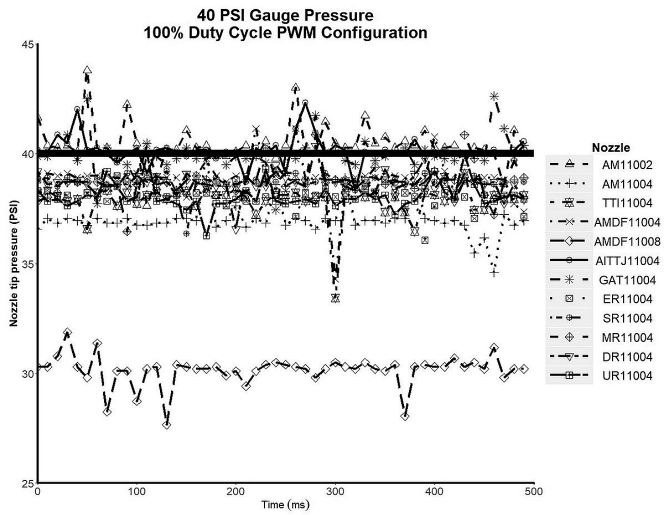

Figure 6. Pressure change across the solenoid valve observed for 12 nozzles operated at a 100 percent duty cycle. The black bar indicates the pressure (40 PSI) prior to the solenoid valve.

flow rates). Therefore, applicators could choose a nozzle and pressure combination to achieve a specific droplet size that would reduce drift potential while simultaneously maximizing efficacy of the given pesticide in their unique geographic and weed species environment.

If the best use practices outlined in this publication are followed, PWM sprayers can be effectively used in pest management strategies to reduce environmental contamination, reduce crop injury, and maximize pesticide efficacy.

For more information regarding PWM sprayers or other application technologies, visit the Pesticide Application Technology Laboratory's website at http://pat.unl.edu.

PAT LAB
Pesticide Application Technology Research and Extension

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Tallgrass Prairie Re-establishment at Ben Geren Golf Course
Ft. Smith AR
Jay Randolph, CGCS

Ben Geren Golf Course has recently been restoring remnant prairie areas and converting bermudagrass turf areas into native tallgrass prairie, re-establishing Massard Prairie, which once existed on the site of Ben Geren Golf Course. This project is ongoing and has the cooperation from Arkansas Game and Fish, Arkansas Natural Heritage Commission, Arkansas Audubon, Arkansas Master Naturalist and Arkansas Forestry Commission. We are essentially trying to duplicate the plants found on small remnants of virgin Massard Prairie and other prairies in the river valley. There are many reasons for converting out of play turfgrass areas or other non-native natural areas such as tall fescue to native-tall and shortgrass natives that include: budgetary savings, educational and multi-use opportunities, natural heritage significance, preserving rare native plants and increasing pollinator/wildlife habitat.

We started educating our golfers on the importance of taking turf areas out of high maintenance and replacing them with lower maintenance nativegrass and forbs. We wanted the golfer involved in the process by giving us feedback on placement, so we didn't put natives in and find out later they were in a high miss-hit area that would slow down play and frustrate golfers. We wanted these native areas to be aesthetically pleasing and strategically placed while providing for preservation of plants, wildlife and wildlife passage, public viewing and education. We started spraying proposed native area sites with red dye and outlining the areas with red flags in the winter months, so it was easily visible, to show the golfers where the proposed areas would be. Our immediate neighbors received a personal visit and pamphlet describing what we were proposing to do. Community support started to come in. The local Audubon Society agreed to come out and give us an initial bird inventory so we can have a baseline and document changes in the future. Numerous local newspaper articles and radio helped reinforce what we were doing within the community.

We have two different areas of native re-establishment on the course: degraded prairie areas already existing (prairie remnants) and turfgrass areas. Each has the same outcome of becoming a re-established prairie. The prairie remnants, mainly on Silo golf course, had been left unmowed for 40+ years and had several species of tallgrass, but had little in forbs. These areas also had weeds and other non-native invasives like sericea lespedeza. These remnant areas probably still have a large seed bank in the soil of prairie natives that are desirable. Imazapic (Plateau) herbicide, which many native grasses and forbs are tolerant to at varying rates, can help as the first step to native conversions. We sprayed our remnant areas with the herbicide in March and after seeding at lower rates for weeds. This application helped control some undesirables, including tall fescue and gave us an idea of the size of our native seed bank and if we needed to seed in the future. The second areas of conversion are the bermudagrass areas. These areas are large and out of play on most holes. These areas were maintained very similar to fairways, in terms of mowing, fertilization and herbicides, just at a higher height of cut. We spray these areas with glyphosate and fluazifop (Fusilade) herbicide starting in late April/early May and continue every 3 to 4 weeks till mid-September to kill the bermudagrass and other weeds. It takes several applications of glyphosate/Fusilade to kill the bermudagrass completely, so give a full growing season for results. Then we will scalp the areas with a mower, blow the area off and seed the native grasses and forbs with a Truax seeder then roll. We seed shorter nativegrass species like little bluestem, side-oats grama and blue grama on tee slopes and larger tallgrass native species like big bluestem and indiangrass along with other tall and shortgrass species in other out of play areas.

With remnants and turfgrass areas being converted to native grass at the same time, maintenance on each was different. This involved many different types of prescribed management techniques like prescribed fire, haying, laying fallow and selective and non-selective broadcast and spot herbicide applications for invasive weeds. Certain areas will receive prescribed burns every 2 to 3 years while other areas lay fallow for animal refugia. These management techniques will be followed to determine the most effective tools and regimes for our site and goals. Agencies like the Arkansas Natural Heritage Commission and The Nature Conservancy and university research will lend a hand in best management practices for prairie restoration as they become available.

The Arkansas Natural Heritage Commission has lists of plants that are native to our area and to all ecoregions of the state and will perform plant inventories. In the future, we want to be sure we are going in the right direction in terms of prescribed maintenance, native plants in our soil type and location, that no one grass of forb is dominating, that weeds are not encroaching and we are not disrupting sensitive or rare plants or animals. This is done through floral inventories and physical testing of soil and water, general walk through surveys and monitoring areas that may have sensitive plants.

Key points of discussion:

1. Establishment
    a. Site selection
        i. Out of play or in play
            1. Marking
            2. Plant mix
        ii. Soil type
            1. Wet or Dry
        iii. Surroundings
            1. Neighbors?
    b. Existing vegetation
        i. Remnant, tall fescue, bermudagrass
        ii. Herbicide
            1. Glyphosate
            2. Imazapic
            3. Fluazifop
    c. Seed selection
        i. Local/ Non-local seed stock
        ii. Incorporating forbs and legumes
        iii. Stratification
    d. Planting
        i. Seed drill
        ii. Broadcasting
            1. Carrier
        iii. Rolling/culti-pack
        iv. Overseeding

2. First Year Maintenance
    a. Mowing
        i. Height
            1. 6” to 8”
        ii. Frequency
        iii. Wildlife?
    b. Herbicide
        i. Imazapic
            1. Rate
            2. Timing
3. Long Term Maintenance

a. Prescribed burns
    i. Benefits
        1. Layers of dead debris
        2. Suppress shrub and tree growth
        3. Promotes native plant growth
        4. Bare ground for seeding
        5. Increases exposed soil for wildlife
    ii. Timing
        1. Spring
            a. Encourages native grass
        2. Winter
            a. Encourages forbs
        3. Fall
            a. Encourages forbs
    iii. Rotational burning
b. Haying
    i. Timing
        1. Wildlife

4. Considerations
    a. Reasons establishments fail
        i. Planted too deep
            1. No deeper than ¼”
        ii. Inadequate weed control
            1. Existing
            2. Post plant competition
        iii. Planted too late
            1. Stratification?
            2. April
        iv. Drill not calibrated or scattered thin
        v. No Patience
            1. Sleep, Creep, Leap
    b. Invasives
        i. Sericea lespedeza
        ii. Trees and shrubs
        iii. Japanese honeysuckle

For detailed information about native prairie plants, consult the following website:

Illinois Wildflowers - https://www.illinoiswildflowers.info/

Native Grasses

Michelle Wisdom and Jay Randolph

Native tallgrass prairies historically covered close to 170 million acres in North America, and are a complicated web of life. Eighty percent of the foliage in a tallgrass prairie is made up of grasses, from 40-60 different species (https://www.nps.gov/tapr/learn/nature/a-complex-prairie-ecosystem.htm) . Native grasses make up the foundation of prairie ecosystems, and are low-maintenance, drought tolerant, and add many benefits to the landscape, including:

- Wildlife habitat
- Erosion control and vegetative filtration
- Forage for livestock
- Ecosystem restoration
- Uses in ornamental landscaping

While these benefits may be well established, some may be unaware that native grasses also benefit pollinating insects. Big bluestem, Little bluestem, Indiangrass, Switchgrass, Sideoats grama, and Blue grama provide food and shelter for numerous species of butterfly and moth larvae (Narem & Meyer, 2017).

A native grass area was developed for Turfgrass Field Day 2019, to test viability of native grasses in Northwest Arkansas, and to gauge their growth and behavior patterns within assigned plots. Plants were started from seed, and transferred to the site in June 2018. Supplemental irrigation was applied weekly for one month but was withheld after July 2018. Fertility was not applied to the native grass display, although mechanical removal of weeds was/is conducted as needed. Three-foot alleyways are sprayed with glyphosate, if needed.

Observations include:

- Purple Lovegrass matures into a tidy clump with showy purple inflorescences
- Switchgrass has good fall color with impressive plumes
- Vine mesquite demonstrates invasive tendencies and spreads aggressively
- Blue and sideoats grama are compact with attractive seed heads
- Buffalograss established easily and tolerated a rainy winter

This information should be helpful to those who are interested in utilizing native grasses ornamentally, as foundations in prairie restoration, in out-of-play areas on golf courses or other recreational playing fields, or as forage sources for livestock.

Common and scientific names of grasses in native grass nursery

Common name	Botanical name	Common name	Botanical name
big bluestem	*Andropogon gerardi*	fall witchgrass	*Leptoloma cognatum*
little bluestem	*Andropogon scoparius*	vine-mesquite	*Panicum obtusum*
splitbeard bluestem	*Andropogon ternarius*	switchgrass	*Panicum virgatum*
sideoats grama	*Bouteloua curtipendula*	knotgrass	*Paspalum distichum*
blue grama	*Bouteloua gracilis*	indiangrass	*Sorghastrum nutans*
hairy grama	*Bouteloua hirsuta*	alkali sacaton	*Sporobolus airoides*
buffalograss	*Buchloe dactyloides*	purpletop	*Tridens flavus*
beaked panic grass	*Panicum anceps*	Texas bluegrass	*Poa arachnifera*
purple lovegrass	*Eragrostis spectabilis*		

Plot plan for native grasses

409 Big Bluestem	408 Switchgrass	407 Purpletop	406 Sideoats Grama	405 Splitbeard Bluestem	404 Little Bluestem	403 Fall Witchgrass	402 Purple Lovegrass	401 Sideoats Grama
301 Buffalograss	302 Indiangrass	303 Blue Grama	304 Vine Mesquite	305 Hairy Grama	306 Alkali Sacaton	307 Blue Grama	308 Knotgrass	309 Texas bluegrass
209 Purple Lovegrass	208 Fall Witchgrass	207 Vine Mesquite	206 Switchgrass	205 Knotgrass	204 Texas bluegrass	203 Alkali Sacaton	202 Beaked panic grass	201 Sideoats Grama
101 Big Bluestem	102 Little Bluestem	103 Splitbeard Bluestem	104 Blue Grama	105 Arrowfeather threeawn	106 Sideoats Grama	107 Blue Grama	108 Hairy Grama	109 Buffalograss

Pollinator-Friendly Landscape Plants

Michelle Wisdom and Jay Randolph

Pollinating insects create food for us as they move pollen from flower to flower. Unfortunately, pollinators have suffered severe population declines in recent years. Habitat loss and fragmentation is a major factor in disrupting pollinator life cycles. As humans continue to urbanize, we separate insects from nesting grounds, and food and water sources. Flowers are food for pollinating insects, and the incorporation of flowers into landscapes is an easy way for home and business owners to aid in pollinator recovery. It is worth noting that pollinators require a diversity of floral resources, as well as a season-long succession of flowers for nutrition.

A pollinator nursery was developed as a teaching garden for Turfgrass Field Day 2016, to demonstrate pollinator activity on flowers, and to establish viability and maintenance of plants in managed turfgrass systems. Eleven plants were selected for the pollinator nursery, three non-native annuals, and eight native perennials.

Non-Native Annuals

- Salvia
- Gomphrena
- Zinnia

Native Perennials

- Butterflyweed
- Coreopsis
- Hyssop
- Prairie Blazing Star
- Bee Balm
- Echinacea & Rudbeckia
- Common Milkweed

Annuals were selected as examples of common bedding plants. Native perennials were selected for color, hardiness, and as known forage sources for an array of pollinating insects. Of additional interest is that the native perennials in the teaching garden have all been identified as members of AR native tall-grass prairie ecosystems.

Although supplemental irrigation was applied weekly (for a two-month period) upon establishment of the pollinator nursery in 2016, it has been withheld since that time. Fertilizer and pesticides have not been applied to the nursery. As expected, the annual species did not emerge after 2016, and those plots have been colonized (or naturalized) over time by the native species.

This information should be helpful to those who are interested in incorporating pollinator-friendly native perennial plants into turfgrass systems.

Plot map for the pollinator nursery

605 Prairie Blazing Star	604 Naturalized area	603 Pale Indian Plantain	602 Common Milkweed	601 Coneflower Black-eyed Susan
501 Bee Balm	502 Naturalized area	503 Naturalized area	504 Butterflyweed	505 Hyssop
405 Hyssop	404 Coneflower Black-eyed Susan	403 Butterflyweed	402 Ironweed	401 Naturalized area
301 Bee Balm	302 Common Milkweed	303 Prairie Blazing Star	304 Coreopsis	305 Naturalized area
205 Naturalized area	204 Naturalized area	203 Common Milkweed	202 Coneflower Black-eyed Susan	201 Bee Balm
101 Butterflyweed	102 Naturalized area	103 Hyssop	104 Prairie Blazing Star	105 Pale Indian Plantain

Detailed information about the plants in the pollinator nursery. Please refer to plot numbers in the previous plot map.

Plot	Planting Information	Common Name	Scientific Name
101	Planted in butterflyweed 2016	Butterflyweed	*Asclepias tuberosa*
102	Naturalized area*	Milkweed, Coreopsis, Bee Balm	*Asclepias syriaca, Coreopsis lanciolata, Monarda fistulosa*
103	Planted in Hyssop 2016 – experiencing colonization	Hyssop, common milkweed, Bee Balm	*Agastache foeniculum, Asclepias syriaca, Monarda fistulosa*
104	Planted in Prairie Blazing Star 2016	Prairie Blazing Star	*Liatris pycnostachya*
105	Planted in Pale Indian Plantain 2016	Pale Indian Plantain	*Arnoglossum atriplicifolium*
201	Planted in Bee Balm 2016	Bee Balm	*Monarda fistulosa*
202	Planted in Coneflower, Black-eyed Susan 2016	Coneflower, Black-eyed Susan	*Echinacea, Rudbeckia*
203	Planted in Common Milkweed 2016	Common Milkweed	*Asclepias syriaca*
204	Naturalized area*	Bee Balm	*Monarda fistulosa*
205	Naturalized area*	Bee Balm	*Monarda fistulosa*
301	Planted in Bee Balm	Bee Balm	*Monarda fistulosa*
302	Planted in Common Milkweed 2016	Common Milkweed	*Asclepias syriaca*
303	Planted in Prairie Blazing Star 2016	Prairie Blazing Star	*Liatris pycnostachya*
304	Planted in Coreopsis 2016	Coreopsis, Coneflower	*Coreopsis lanceolata, Echinacea*
305	Naturalized area*	Milkweed, Coreopsis, Coneflower	*Asclepias syriaca, Coreopsis lanceolata, Echinacea*
401	Naturalized area*	Bee Balm, Coreopsis, Black-eyed Susan	*Monarda fistulosa, Coreopsis lanceolate, Rudbeckia*
402	Planted in Ironweed 2019	Ironweed	*Veronia fasciculata*
403	Planted in Butterflyweed 2016	Butterflyweed	*Asclepias tuberosa*
404	Planted in Coneflower, Black-eyed Susan 2016	Coneflower, Black-eyed Susan	*Echinacea, Rudbeckia*
405	Planted in Hyssop 2016	Hyssop	*Agastache pycnostachya*
501	Planted in Bee Balm 2016	Bee Balm	*Monarda fistulosa*
502	Naturalized area*	Coneflower, Prairie Blazing Star	*Echinacea, Liatris pycnostachya*
503	Naturalized area*	Coneflower, Prairie Blazing Star, Coreopsis, Bee Balm	*Echinacea, Liatris pycnostachya, Coreopsis lanceolata, Monarda fistulosa*
504	Planted in Butterflyweed 2016	Butterflyweed	*Asclepias tuberosa*
505	Planted in Hyssop 2016	Hyssop	*Agastache pycnostachya*
601	Planted in Coneflower, Black-eyed Susan 2016	Coneflower, Black-eyed Susan	*Echinacea, Rudbeckia*
602	Planted in Common Milkweed 2016	Common Milkweed	*Asclepias syriaca*
603	Planted in Pale Indian Plantain 2016	Pale Indian Plantain	*Arnoglossum atriplicifolium*
604	Naturalized area*	Bee Balm, Prairie Blazing Star, Coneflower	*Monarda fistulsa, Liatris pycnostachya, Echinacea*
605	Planted in Prairie Blazing Star 2016	Prairie Blazing Star	*Liatris pycnostachya*
*Naturalized areas were planted in annuals in 2016. Since annual plants complete their life cycle in one year, those plots were allowed to be colonized by native plant species over time.			

Does your golf course need a drone?
Daniel O'Brien

Let's be honest – the art (and science) of greenskeeping has endured & evolved for centuries without little flying cameras, mounted to miniature helicopters. So, to ask whether any golf course actually "*needs*" a drone seems to be a bit far-fetched. Yet, it is worth considering, how many years back we would have to go to encounter a similar conversation regarding moisture meters – both devices having similar price points, and both touting similar claims of a technological leap forward for managing turfgrass health…Perhaps a better way to frame this entire conversation is to start instead by asking the question - W*hat do golf course superintendents truly need to accomplish as a part of their job* - and then examine to what extent drones may be able to contribute towards addressing these needs.

Far be it for a research technician to tell a group of superintendents what their job is all about – the Q&A portion of this presentation will be a time where the audience can educate the author as to how to best categorize & articulate the demands of their job – and that is very much welcome…But for the purposes of this presentation, hopefully we can all agree, that in one way or another, all golf course superintendents need to: **1.** Make sound agronomic decisions; **2.** Be efficient mangers & effective communicators; and **3.** Create the best experience possible for those who come to play at their course. Whether or not a golf course needs a drone in order to do any of those things will be an individual decision, however drones definitely do have something to offer towards each of those ends.

In terms of the research currently being done at the University of Arkansas, the primary focus is on the first objective – making sound agronomic decisions, which will constitute the majority of this presentation, however it is also important to first say a few words regarding objectives 2 & 3 on the above list.

EFFECTIVE COMMUNICATION

Effective communication (via drones), is based on the simple notion that sometimes a picture truly is worth a thousand words. Drones offer a unique perspective for viewing a golf course, and the ability *to show rather than simply tell* people about the course has tremendous value for communicating with multiple audiences.

The first person to gain access to this perspective and reap the benefits of it is the one flying the drone. For a superintendent, regular drone flights have the potential to put them out in front of the curve when it comes to awareness of developing issues/problems on the course – whatever those may be. Additionally, the visuals drones provide are another piece of information which can be brought into the decision making process. As decisions are implemented, drone imagery offers assistance for precisely directing (and instructing) maintenance personnel. Presently, the value of drones is more scouting than diagnostic. Drones are capable of speaking much more to the question of *where* (the crew needs to go), than *what* (the issue is), but advances in the descriptive power of drone images is ongoing, and should be expected to increase with more widespread use of drones on golf courses. Beyond just the maintenance crew, drone images can potentially be very beneficial in conversations with greens committees, architects, and other management personnel who's vested interests are not directly involved with the day-to-day maintenance of the course.

There is no reason why the value of drone images has to stop with those who work on, or for, the golf course. In addition to their practical value, drone images also offer tremendous aesthetic value – both through photos, and especially videos – which may hold great appeal to the end users, the golfers.

CREATING A UNIQUE EXPERIENCE

Aerial images are something we have all come to expect when we watch golf on television, and now, the (relative) affordability of drones, and the quality of their cameras, offers course & clubs of all levels the opportunity to use similar images & videos for their own marketing and showcase purposes. Whether a single golfer improves their scorecard by a single stroke from watching hole-by-hole flyovers of a course they are going to play is not nearly as important as the fact that these golfers feel elevated, closer to the professionals they watch on television, because of the opportunity they've had to view the course, in this way. Furthermore, as companies such as Amazon continue to pioneer drone use in novel ways, golf courses may find additional ways to use their drones, beyond just providing striking visuals…

MAKING SOUND AGRONOMIC DECISIONS

There's a lot more to drone images than meets the eye. The true value of a drone comes not from the unique perspective or high resolution of the photos & videos it captures, but rather the numerical data embedded within (and extending beyond…) those striking visuals. To get the most out of a drone, it has to be appreciated that there is a real difference between "taking pretty pictures," and "taking measurements," from the air.

Photogrammetry is a systematic process of flying and collecting aerial images, in a way that allows those images to be analyzed, providing meaningful, valid data about what is contained within the imagery. Only by collecting a series of overlapping images, and subsequently knitting them together (using software), can superintendents have confidence that they are actually "seeing things for what they are," and basing their decisions on a consistent, accurate scale of measurement. To fly a drone without using photogrammetry is like using a stimpmeter without a tape measure – it reduces the process to mere observations & estimates, rather than true measurements.

The success of a drone flight is not just determined by what happens while it is in the air, it is defined largely by **1.** Pre-flight planning, and **2.** Post-flight processing. Pre-flight planning involves making decisions about exactly where the drone will fly, at what height, at what speed, and how it goes about capturing images. Post flight processing includes bringing the images together in the photogrammetric process, but may also involve analyzing individual pixels, as well as the data about the precise location of each image. There are multiple options for each of these processes.

It is important to remember that there is a limitation to what our eyes can see, and specialized drone sensors are capable of extending well-beyond this limitation. As energy from the sun is reflected by turfgrass leaves, some of that reflected energy is visible to us in the form of light, but some of it is reflected in ways our eyes simply cannot detect. Infrared drone sensors are capable of producing thermal images, based on reflected energy that exists outside the visible spectrum of light and color. Additionally, multispectral drone sensors are capable of measuring reflectance within multiple, isolated ranges, which can be used to calculate plant-health indices such as normalized difference vegetative index (NDVI), or normalized difference red edge (NDRE).

For any superintendent interested in drones, one of the key decisions to be made is – *how much of the process do I want to do myself, and how much do I want to contract out?* While there are multiple options for how to acquire and process images, the ultimate decision making still resides with the superintendent. Drone-based maps or reports can be a valuable resource, but that value is going to ultimately be dependent upon how well the information and imagery they contain can be understood in terms of what is being observed on the ground level – up close and hands on – the way greenskeeping has been done since it began…

REGULATIONS & RESOURCES

If seeking to own and operate a drone, it is important that superintendents follow appropriate regulations – just as they would with pesticide licensing & applications. The Federal Aviation Administration (FAA) holds the authority for overseeing drone use, and they define a acceptable drone as an unmanned aircraft weighing less than 55 lbs. Registration is required for all drones between 0.55 and 55 lbs., it may be completed online at a cost of $5, and is valid for 3 years. Anyone using a drone for commercial purposes must obtain Remote Pilot Certification by passing the Unmanned Aircraft General – Small (UAG) exam. The 2 hour exam consists of 60 multiple choice questions, the minimum passing score is 70%, and the license is valid for 2 years. Detailed study guides are available from the FAA (and other sources); some key points from those study guides:

- *Keep the unmanned aircraft within visual line-of-sight*
- *Fly at or below 400 feet*
- *Fly during daylight (or civil twilight)*
- *Yield right of way to manned aircraft*
- *Do not fly directly over people*

FAA Drone Zone registration - https://faadronezone.faa.gov/#/

FAA UAS Rule Part 107 summary - https://www.faa.gov/uas/media/Part_107_Summary.pdf

Code of Federal Regulations Title 14, Part 107 - https://www.ecfr.gov/cgi-bin/text-idx?SID=e331c2fe611df1717386d29eee38b000&mc=true&node=pt14.2.107&rgn=div5

Know B4UFly app - https://www.faa.gov/uas/where_to_fly/b4ufly/

Disease Diagnostics and Effects of Rain on Fungicides

Lee Butler

The absolute most important step in managing any pest is accurate identification of the pest you aim to control. With the plethora of information just an internet search away, many turfgrass managers can identify several turfgrass diseases on their own due to very unique stand symptoms as with a disease like fairy ring. However, there are many other turfgrass diseases that don't produce that unique stand or plant symptom that one could reference by looking at images. These situations require the use of a microscope to aid the diagnostician in pathogen identification. While some turfgrass managers have their own microscope, it's often best to submit samples to a reputable lab for assistance with an accurate diagnosis. You will want to consider the following tips below when you submit a sample to any lab -

1. **Cover All the Bases**

   Details, details, details! The more information, the better when it comes to making a diagnosis. Please provide the following information to your lab:

   - *Grass type and use*
     - Species, variety, when established, etc.
     - Putting green, fairway, athletic field, home lawn, etc.
   - *Recent chemical applications*
     - What/when/rates/etc.
     - Include fungicides, herbicides, insecticides, PGR's, etc.
     - Provide records from past 30 days if possible
   - *Recent cultural practices*
     - Aerification, verticutting, topdressing, etc.
     - Fertility inputs over past 30 days
     - Mowing height and frequency
   - *Symptom Description*
     - When did symptoms appear?
     - When was the sample collected?

    - Describe plant symptoms - i.e. leaf spots, chlorosis, wilted, etc.
    - Describe stand symptoms - i.e. spots, patches, rings, etc.
- *Symptom Distribution and Progression*
    - Describe the spatial pattern - i.e. localized, random, or widespread
    - Describe the microclimate - i.e. wet, dry, compacted, thatchy, etc.

2. **Make No Assumptions**

   It's very easy to assume the symptoms occurring in a stand of turf are due to a disease. Very often, this is not the case. In an average year, about half of all the turf samples submitted are not affected by a disease, but by an abiotic stressor or injury of some variety. Frequently, details that would pertain to disease control might be given, but an important maintenance detail has been left out that could help exactly pinpoint the root of the issue.

3. **Taking & Submitting the Sample**

   For golf course samples, most labs request two cup-cutter plugs no deeper than the root zone. For landscape samples, two 4-6" square plugs taken with a shovel no deeper than the root zone will suffice. Be sure to cut your samples so that the plug contains about ½ healthy and ½ diseased turf. Wrap the samples tightly with something like aluminum foil and package tightly in a box with newspaper to ensure the plugs stay intact during the shipping process. Overnight shipping is encouraged to ensure the samples arrive as fresh as possible to the lab.

4. **A Picture is Worth a Thousand Words**

   Having physical plugs of the affected turf is absolutely the most helpful aspect in reaching a confident diagnosis, but often a few good pictures can reveal further clues. Pictures can show the surroundings of the affected turf, as well as spatial patterns of symptoms or the progress of symptoms over an area. These photos can allow the diagnostician to reach a conclusion quicker and more accurately.

Tips for Taking Pictures and Observations Used in Diagnosis

1. **Get your head out of your grass!**
   Photos taken from standing height looking out across the affected area are typically more useful for diagnostics than close ups. Back up from the problem area and be sure to include affected and unaffected turf.

2. **Take pictures in overcast conditions if possible.**
   Diffused lighting is the best lighting for accurately observing details or differences in turf. Direct or partial sunlight can cause too much reflection or variability in color to make a clear observation of affected and unaffected turf. Take photos early in the morning, late in the evening, or just wait for a cloud to pass in front of the sun!

Remembering these small details will make a world of difference in receiving a diagnosis quickly and accurately! **However, keep in mind that accurate diagnostics cannot rely on pictures alone!**

Effects of Rain on Fungicides

One of the most common questions we receive from turfgrass managers is "I sprayed a fungicide this afternoon and it poured down rain 30 minutes later. Do I need to re-apply and how long should I expect this application to last?" The answer is – it depends. The majority of our fungicides are acropetal penetrants. This means that, after the fungicide is absorbed into the plant, it is translocated upward to the leaf tips through the vascular system. The rest are either contacts (not absorbed or translocated), localized penetrants (absorbed but not translocated), or true systemics (absorbed and translocated up and down). This plays a very important role in to answer the question stated above. If you had to guess, which fungicide type would stand the best chance after a rainfall event? If you guessed either acropetal penetrant and/or true systemics, you would be correct.

The following trial was set up to demonstrate this theory with brown patch control in tall fescue.

Trt. No.	Treatment	Rate/1,000 ft^2	Topical Mode of Action
1	Compass	0.25 oz	localized penetrant
2	Heritage	0.4 oz	acropetal penetrant
3	Pillar G	3 lb	localized + acropetal penetrant
4	Xzemplar	0.26 fl oz	acropetal penetrant
5	Velista	0.5 oz	acropetal penetrant
6	Untreated Control		--

The treatments were applied and either subjected to an irrigation event to simulate rainfall or not. The map below will help orient you today.

101	206	301	406
102	205	302	405
103	204	303	404
104	203	304	403
105	202	305	402
106	201	306	401

Plot	Treatment	Irrigation
101	Velista	No
102	Compass	Yes
103	Xzemplar	Yes
104	Heritage	Yes
105	Pillar G	No
106	UTC	No
201	UTC	Yes
202	Pillar G	Yes
203	Heritage	No
204	Xzemplar	No
205	Compass	No
206	Velista	Yes
301	Pillar G	No
302	Velista	No
303	Heritage	Yes
304	Compass	Yes
305	UTC	No
306	Xzemplar	Yes
401	Xzemplar	No
402	UTC	Yes
403	Compass	No
404	Heritage	No
405	Velista	Yes
406	Pillar G	Yes

Water use of cool-season lawn grasses

Tyler Carr

Background

The cool-season turfgrass species Kentucky bluegrass (*Poa pratensis* L.) (KBG) is a popular grass in the northern United States and transition zone, a geographic region best suited for neither warm- nor cool-season grasses. Cool-season grasses provide green coverage year-round, contrary to the straw-colored appearance of warm-season turfgrass during the dormancy period that occurs during the winter months. The elevated summer temperatures in the transition zone coupled with a lack of precipitation or irrigation create drought stress for cool-season grasses, which lowers quality and limits growth. Irrigation may be applied to a turfgrass system to alleviate drought stress symptoms.

Turfgrasses provide an aesthetically-pleasing benefit, but many users perceive these systems as only a visual benefit that requires significant water inputs. Many metropolitan areas in the western United States have created rebate programs to encourage homeowners to remove their grass lawns and install more “sustainable” plants. It is well documented that water availability in the United States has decreased, therefore, instead of eliminating turfgrass as a whole, there is a need for researchers to fine-tune irrigation recommendations in order to precisely irrigate the lower water-using grasses with only the volume of water required to maintain an acceptable quality turfgrass.

Objective

Differences in drought tolerance have been observed both among and within turfgrass species. Irrigation practices such as deficit irrigation have provided reductions in water use, but irrigation requirements may vary by soil texture or irrigation frequency. The objective of this study is to evaluate the effects of cultivar selection, soil texture, irrigation frequency and volume on the quality and water use of higher-cut Kentucky bluegrass lawn turf.

Materials and Methods

The field lysimeter experiment is conducted under a rainout structure to ensure consistent drought conditions. Two Kentucky bluegrass cultivars [Mallard (drought tolerant) and Geronimo (drought susceptible)], two soil textures (silt loam and loamy sand), two irrigation frequencies (1 and 3 times weekly), and two irrigation volumes (40% and 80% reference evapotranspiration replacement) were evaluated. Lysimeters were weighed before each irrigation, and actual evapotranspiration was calculated as the loss in weight between successive lysimeter weighing events. Turf quality was determined by evaluating green turf coverage weekly.

Results

Water Use

In 2019, water usage data was collected weekly for four weeks from June 10 to July 1 (Fig. 1). Throughout the four weeks, turf irrigated to volumes of 80% of reference evapotranspiration (ET_o) resulted in 1.3x greater water usage compared to turf irrigated at 40% ET_o replacement. These results were expected as the there is more water available in the lysimeters replacing 80% ET_o, therefore making those systems more susceptible to water losses via evaporation and transpiration.

Throughout the experiment, silt loam soils averaged 1.22” of water usage weekly while loamy sand soils used 1.15” of water per week. Soil texture had no significant effect on the water usage of the bluegrasses, supporting the theory that grasses under drought-stressed conditions may not need separate irrigation requirements when grown in varying soil textures.

Turfgrass Coverage

Green turfgrass coverage was collected weekly for five weeks in 2019 from June 6 to July 3. On July 8, all plots were irrigated to initiate recovery to ensure the experiment can be reconducted beginning in late July or early August. The results from the five-week study include:

1. Deficit irrigation at 40% ET_o replacement allowed the plots to maintain acceptable coverage (>50%) for only the first three weeks in June (Fig. 2).
2. For grasses irrigated at 80% ET_o, silt loam plots exhibited greater coverage than those in loamy sand only in the last week, once all grasses were well below the acceptable coverage threshold (Fig. 2).
3. For the same cultivars at the same irrigation volume replacement, there were no differences in coverage between irrigation frequencies. This could be due to summer temperatures causing heat stress on the bluegrasses instead of solely drought stress (Fig. 3).

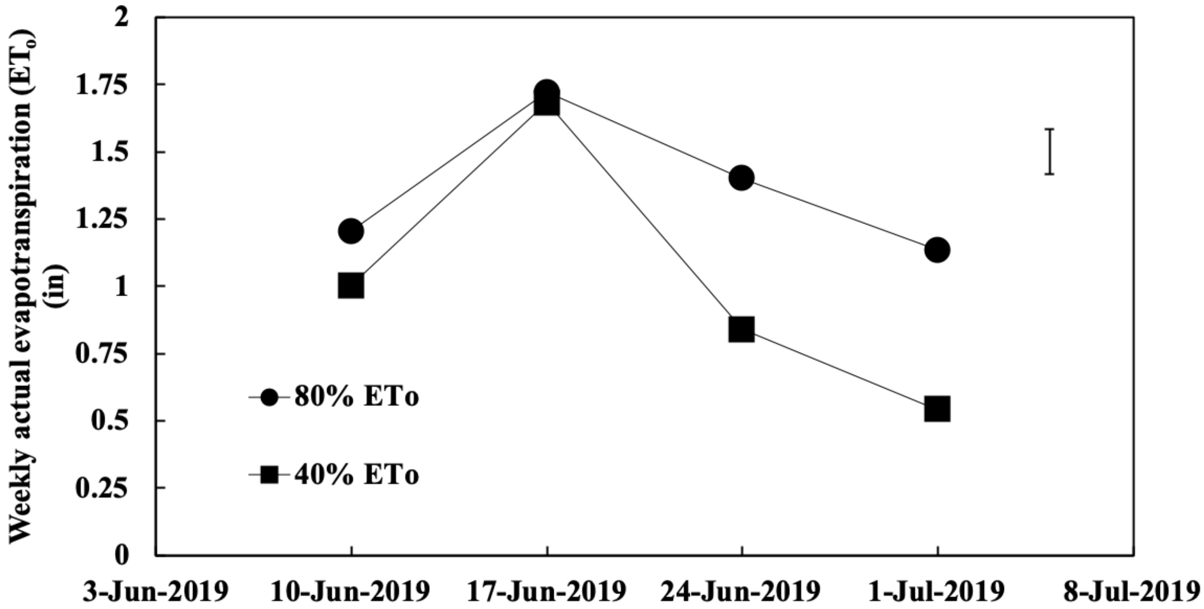


Figure 1. The effect of irrigation volume and date on weekly actual evapotranspiration.

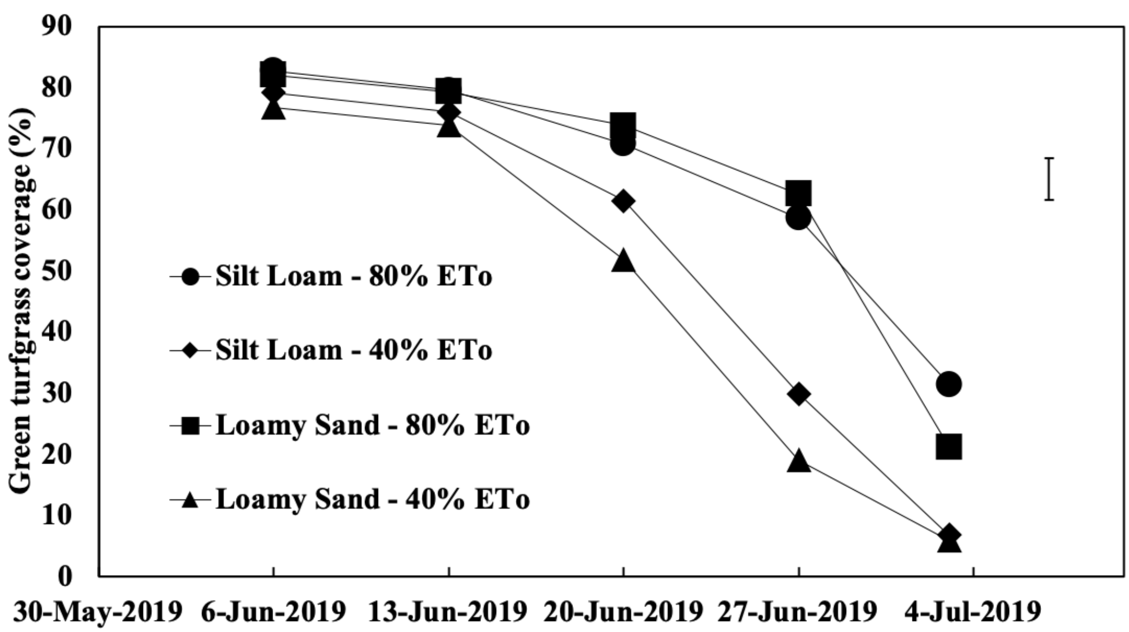


Figure 2. The effect of soil texture, irrigation volume, and date on green turfgrass coverage.

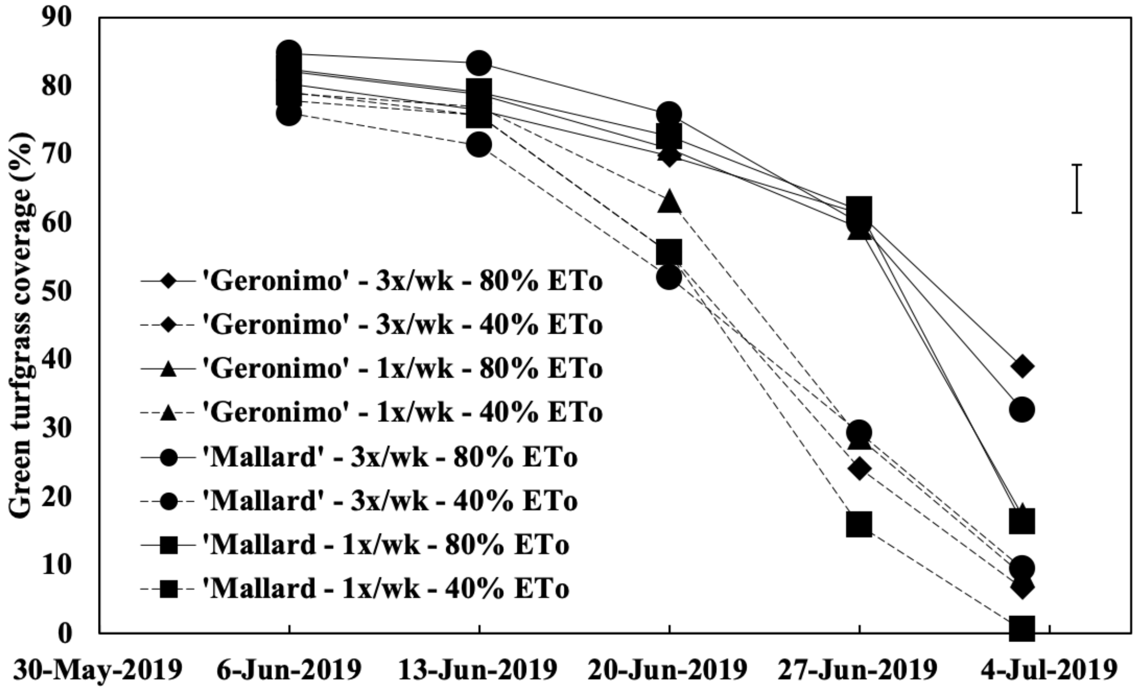


Figure 3. The effect of Kentucky bluegrass cultivar, irrigation frequency, irrigation volume, and date on green turfgrass coverage.

Postemergent control of yellow nutsedge in bermudagrass

Matthew Bertucci, University of Arkansas, bertucci@uark.edu

Yellow nutsedge (*Cyperus esculentus*) has been recognized as one of the most problematic weeds in the world. It commonly infests orchards, vegetable crops, row crops, pastures, and roadsides. Unfortunately, turfgrass is no exception, and yellow nutsedge is a persistent pest in lawns, sports fields, and other managed turf sites, particularly where water accumulates. This weed is especially problematic in turf because it can withstand mowing and reproduce via subterranean tubers borne on rhizomes. Each tuber can emerge into a new nutsedge plant, which will produce more rhizomes, generate more tubers, and spread across more of your property. Thus, a small nutsedge population can quickly become a major infestation without some sort of intervention.

Fortunately, selective herbicides are available to control this problematic weed. Typically, the selective herbicides registered for use in turf come from the Weed Science Society of America (WSSA) Group 2 ALS-inhibiting herbicides, which prevent production of branched chain amino acids. Some new herbicides have been registered which belong to WSSA Group 2, but come from a different chemical family, which could potentially offer new alternatives with herbicide resistant weeds. The present study was designed to evaluate efficacy and turf sensitivity to commercially available herbicides reported to offer acceptable levels of yellow nutsedge control.

Materials and Methods

To establish a uniform yellow nutsedge population, tubers were sown to a depth of 0.75 inches on May 20 at a density of 5 tubers ft^{-2} across the entire site. To simulate heavy infestations, tubers were sown at a density of 15 tubers ft^{-2} in the first replication of this trial. Once tubers were sown, the site was irrigated heavily to encourage emergence of all tubers. Mowing was initiated after all nutsedge shoots reached a minimum height of 4.25 inches.

Eight postemergent treatments including five products were applied on June 26 and compared to an untreated check (Tables 1, 2). All liquid treatments were applied using a CO_2 pressurized backpack sprayer with a handheld boom outfitted with 8002VS flat fan nozzles calibrated deliver 20 gallons per acre. Granular applications were made by pre-weighing the appropriate amount of product for each plot then spreading by hand in two directions. All treatments were replicated 5 times.

Table 1. List of products, manufacturers and product details for chemicals used in this experiment.

Product Name	Manufacturer	Active Ingredient	Chemical Family	WSSA Group No.
Celero	Valent	Imazosulfuron	Sulfonylurea	2
Dismiss	FMC	Sulfentrazone	Triazolinone	14
Prosedge	Nufarm	Halosulfuron	Sulfonylurea	2
Vexis	PBI Gordon	Pyrimisulfan	Sulfoanilide	2
Aethon	PBI Gordon	Pyrimsulfan Penoxsulam	Sulfoanilide Triazolopyrimidine	2 2
Induce	Helena	Non-ionic surfactant	NA	NA

Table 2. Herbicide treatments, application rates and plot numbers for yellow nutsedge field trial.

Treatment number	Treatment Name	Application rate	Rep1	Rep2	Rep3	Rep4	Rep5
1	Untreated	-	102	207	304	401	505
2	Celero NIS	8 fl oz/acre 0.25% v/v	109	201	310	403	502
3	Celero NIS	14 fl oz/acre 0.25% v/v	104	210	303	405	506
4	Prosedge NIS	1.3 oz/acre 0.25% v/v	108	206	309	406	504
5	Celero Dismiss South NIS	8 oz/acre 1 fl oz/acre 0.25% v/v	107	202	308	407	510
6	Celero Dismiss NIS	8 oz/acre 2 fl oz/acre 0.25% v/v	101	209	301	404	507
7	Vexis	187 lb/acre 187 lb/acre[1]	105	203	307	402	503
8	Aethon	187 lb/acre 187 lb/acre[1]	110	204	302	408	509

1- *Second applications for Vexis and Aethon will be made on August 7.*

Results and Discussion

Herbicide applications were timed such that symptomology would be most apparent for field day demonstration, so results were not available at the time of publication of this field book; however, preliminary evaluations showed no turfgrass injury resulting from herbicide selection.

At the termination of this trial, data will be made public via the University of Arkansas Division of Agriculture extension website or other publications. In the meantime, please use this space below to record your own impressions and thoughts as we look at the plots:

Figure 1. Field map of yellow nutsedge trial. For reference, the nearest gravel road is south of this trial.

110	201	310	401	510
109	202	309	402	509
108	203	308	403	508
107	204	307	404	507
106	205	306	405	506
105	206	305	406	505
104	207	304	407	504
103	208	303	408	503
102	209	302	409	502
101	210	301	410	501

Bermudagrass response to bleaching herbicides applied with and without iron sulfate

Matthew Bertucci, University of Arkansas, bertucci@uark.edu

Herbicides are generally classified as selective or non-selective. Selective herbicides kill weed species while leaving the desirable species unharmed. Common examples of selective turf herbicides include 2,4-D or dicamba. Non-selective herbicides include products such as glyphosate, diquat, or glufosinate, which kill plants indiscriminately, both weeds and desirable species. However, selectivity can also be rate-dependent, meaning that a herbicide may be safely applied at low rates but cause unacceptable injury at high rates.

One example of rate-dependent selectivity is topramezone (tradename Pylex) in bermudagrass. At higher rates (1 to 1.3 fl oz/acre) and with multiple applications, Pylex may be used to control bermudagrass in certain cool season grasses. However, the herbicide label also provides instructions for low-rate applications (0.5 to 0.75 fl oz/acre) of Pylex in bermudagrass, which is identified as "marginally tolerant". Thus, tompramezone may be used for weed control in bermudagrass, particularly for problematic weeds species such as goosegrass (*Eleusine indica*).

Topramezone is a bleaching herbicide, belonging to the Weed Science Society of America (WSSA) Group 27. These herbicides are photosynthetic inhibitors which disrupt activity of the 4-hydroxyphenylpyruvate dioxygenase (HPPD) enzyme in plants, causing sensitive species to turn white. Another common turf herbicide from WSSA Group 27 is mesotrione (tradename Tenacity). Both can cause striking symptoms in sensitive plants: foliage is turned completely white in sensitive species. However, a marginally tolerant species, such as bermudagrass, may recover from temporary symptoms when treated with a reduced rate of a bleaching herbicide. A final consideration is whether supplementary products, such as ferrous sulfate, may enhance turf color and potentially be used to mask bleaching symptoms following treatment with bleaching herbicides. Thus, the present trial was designed to test bermudagrass sensitivity to Tenacity and Pylex herbicides, evaluate efficacy of iron sulfate applications to mask bleaching symptoms, and to demonstrate bermudagrass recovery potential over a 3 week span following application.

Materials and Methods

Three herbicide treatments were tested in this trial, including two products (Table 1): Tenacity and Pylex. Two rates were included for Pylex to demonstrate the approved rate for cool-season grasses as well as the reduced rate suggested for bermudagrass (Table 2). Herbicide applications were applied using a CO_2-pressurized backpack sprayer with a single-nozzle boom outfitted with an 8002EVS flat fan nozzle calibrated to deliver 40 gallons per acre. All herbicide applications were applied using a 4 x 4 ft spray shield to ensure product did not drift into adjacent plots. Herbicides were applied in sequential timings: 3, 2, and 1 wk prior to our field day to demonstrate bermudagrass recovery at each timing following herbicide applications (Table 2). Treatments were arranged in a randomized complete block design and replicated three times (Figure 1).

Table 1. List of products, manufacturers, and product details for chemicals used in this experiment.

Product Name	Manufacturer	Active Ingredient	WSSA Group No.
Pylex	BASF	Topramezone	27
Tenacity	Syngenta	Mesotrione	27
Ferrous sulfate	Crown Technology	$FeSO_4$	-
Adigor	Sygenta	MSO	-
Induce	Helena	NIS	-

Results and Discussion

- Tenacity exhibited greatest bleaching symptoms in bermudagrass
- Pylex at cool season rates showed unacceptable levels of bleaching
- Iron sulfate enhanced green color when present in applications
- Ratings are not yet available for later herbicide timings

Please take time to record personal observations and discussion in the lines below:

Figure 1. Field map of bleaching herbicide trial. Plots are 4 x 4 ft, with reps blocked in north to south pattern. For reference, the nearest gravel path is south of this trial.

320	319	318	317	316
311	312	313	314	315
310	309	308	307	306
301	302	303	304	305
220	219	218	217	216
211	212	213	214	215
210	209	208	207	206
201	202	203	204	205
120	119	118	117	116
111	112	113	114	115
110	109	108	107	106
101	102	103	104	105

Table 2. Herbicide treatments, application rates, timings, and plot numbers for bleaching trial.

Treatment Number	Treatment Name	Application Rate	Application Timing	Rep 1	Rep 2	Rep 3
1	Untreated	-	-	111	212	311
2	Untreated $FeSO_4$	- 5 oz/acre	3 wk ago	113	201	320
3	Pylex $FeSO_4$ MSO	1.5 fl oz/acre 5 oz/acre 0.5% v/v	3 wk ago	101	203	304
4	Pylex $FeSO_4$ MSO	0.75 fl oz/acre 5 oz/acre 0.5% v/v	3 wk ago	108	216	309
5	Tenacity $FeSO_4$ NIS	5 fl oz/acre 5 oz/acre 0.5% v/v	3 wk ago	119	215	313
6	Pylex MSO	1.5 fl oz/acre 0.5% v/v	3 wk ago	114	202	306
7	Pylex MSO	0.75 fl oz/acre 0.5% v/v	3 wk ago	109	214	302
8	Tenacity NIS	5 fl oz/acre 0.5% v/v	3 wk ago	117	220	316
9	Pylex $FeSO_4$ MSO	1.5 fl oz/acre 5 oz/acre 0.5% v/v	2 wk ago	115	217	319
10	Pylex $FeSO_4$ MSO	0.75 fl oz/acre 5 oz/acre 0.5% v/v	2 wk ago	118	204	303
11	Tenacity $FeSO_4$ NIS	5 fl oz/acre 5 oz/acre 0.5% v/v	2 wk ago	106	207	301
12	Pylex MSO	1.5 fl oz/acre 0.5% v/v	2 wk ago	103	209	305
13	Pylex MSO	0.75 fl oz/acre 0.5% v/v	2 wk ago	110	218	307
14	Tenacity NIS	5 fl oz/acre 0.5% v/v	2 wk ago	116	208	312
15	Pylex $FeSO_4$ MSO	1.5 fl oz/acre 5 oz/acre 0.5% v/v	1 wk ago	105	213	318
16	Pylex $FeSO_4$ MSO	0.75 fl oz/acre 5 oz/acre 0.5% v/v	1 wk ago	104	219	308
17	Tenacity $FeSO_4$ NIS	5 fl oz/acre 5 oz/acre 0.5% v/v	1 wk ago	102	206	314
18	Pylex MSO	1.5 fl oz/acre 0.5% v/v	1 wk ago	112	211	310
19	Pylex MSO	0.75 fl oz/acre 0.5% v/v	1 wk ago	107	210	317
20	Tenacity NIS	5 fl oz/acre 0.5% v/v	1 wk ago	120	205	315

Jon Zawislak uaex.edu/bees DIVISION OF AGRICULTURE RESEARCH & EXTENSION University of Arkansas System

Best Management Practices to Protect Pollinators in Landscapes

Insect Pollinators in Trouble

Many of the plants we use for both food and aesthetic landscaping benefit from pollinators. Research increasingly shows that many types of insect pollinators are disappearing from the environment at alarming rates. The disappearance of bees and other pollinators can be linked to loss and degradation of natural habitats, exotic diseases and pests, and pesticide use. All of these stress factors combine and play a role in pollinator declines. Likewise they must all be addressed to promote pollinator recover.

Declines in pollinators affect all of us. Some are important for our food supply, while other help maintain the balance of terrestrial ecosystems by ensuring plant reproduction, and improving seed, fruit and nut production. The pollination services of these insects also improves our quality of life by supporting wildlife habitat and their food web, and helping to keep the landscape healthy and beautiful.

Aside from providing valuable ecological services, bees, butterflies and other insects are wildlife, and deserving protection and appreciation. With a little forethought and planning, we can help improve pollinator habitats to sustain their populations while improving the aesthetics of the world around us.

Create and Improve Pollinator Habitat

An ideal landscape supports healthy and diverse insect pollinators and other beneficial species. Plants can provide abundant food and nesting habitats, while appealing to aesthetics. Diverse habitats encourage pollinators to survive and thrive, increasing food for songbirds and other wildlife, decreasing erosion and improving soil and water health. These landscapes attract many other beneficial insects, include predators that help to naturally control insect pests.

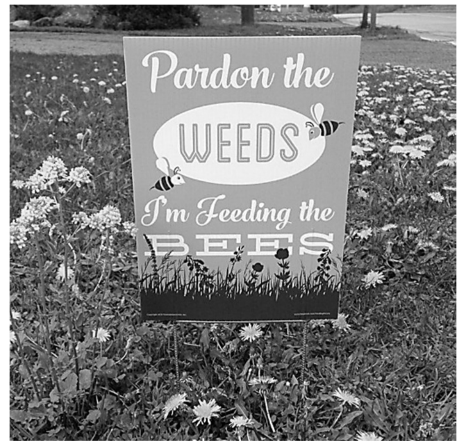
- Actively increase pollinator-friendly sanctuary habitat within managed landscapes such as urban lawns, golf courses, and commercial landscaping.
- Choose plants with a variety of floral shapes, sizes and colors to attract a variety of pollinators, including bees, butterflies and hummingbirds.
- Placing plants in groups of at least 3-8 together encourages visits from pollinators, which efficiently seek out patches of identical plants to visit rather than isolated flowers.
- Incorporate a variety of plants so that some will be blooming throughout the year (especially in early spring and late fall) to keep pollinators returning to the landscape continually.
- Maintain a mixture of trees, shrubs, and both annual and perennial forbs to increase potential food and nesting habitat for multiple species.
- Consider native plants that grow well in your climate and soil conditions, and avoid exotic plants that may become invasive, displace native vegetation, and decrease biodiversity.
- Incorporate pollinator corridors with patches of attractive vegetation that connect larger habitat areas, to encourage movement of pollinators between these areas.

Maintain and Conserve Pollinator Nesting Habitat

Abundant flowers for nutrition are only part of what pollinators need. Very few bee species actually live in large colonies like honey bees and bumble bees do. Most are solitary, and require undisturbed habitat areas for raising young and overwintering. Most precise nest in the ground, in patches of bare, well-drained soil. Others nest in hollow stems, leaf litter, dead logs, or cracks in rock walls. These nesting habitats should remain undisturbed to ensure the survival of dormant and hibernating species.

Bee-Friendly Lawns

A uniform turf lawn may be a suburban tradition, but these represents a food desert to pollinators. The maintaining our lawns as dense monocultures of manicured grasses restricts pollinator populations and discourages their visiting our yards.



https://www.etsy.com/listing/232890464

Plants such as dandelions and clovers are highly attractive to bees and can be important sources of early season nectar and pollen nutrition. Homeowners are becoming increasingly more accepting of these "weeds" as news of the pollinator crisis continues to make headlines. Decorative signs announcing "Bee Friendly" lawns are also becoming more prominent.

Mowing frequency, mower height, and the timing of lawn maintenance can all be adjusted to improve pollinators' access to important sources of nutrition, especially during the early spring.

Bee-friendly lawns are composed of a tight mix of grasses and low growing perennials that can be used and treated much like a regular lawn, are attractive, and provide high-quality nutrition to pollinators. Introducing flowers to a lawn not only helps the local bee population, but can improve the resilience of the lawn by promoting deeper roots.

Any grassy areas that are not heavily used for foot traffic or recreation can be incorporated into excellent pollinator habitat, especially steep challenging slopes or easements and right-of-ways. Low-growing flowers that can tolerate mowing can add variety and provide food for multiple pollinators. Lawns with fine fescue have thinner blades and give flowers the best chance to establish.

Over-seed a traditional lawn by mowing as short as possible, then removing clippings to expose as much soil as possible. Aerating the soil is recommended, but not necessary, to improve seed contact with soil and improve germination conditions.

- **White Clover** (*Trifolium repens*) is a short-lived perennial that will reseed itself under favorable conditions. Like other legumes, it improves soil by fixing nitrogen, reducing need for fertilizers. Clover grows well in many conditions, tolerating sun or partial shade. Seed at 3.2 oz per 100 ft^2.
- **Creeping Thyme** (*Thymus serphyllum*) grows well in nutrient-poor soil with good drainage, and can make an excellent bank cover or border for sunny areas. Seed at 1 oz per 100 ft^2.
- **Lanceleaf Coreopsis** (*Coreopsis lanceolate*) grows slightly higher than grasses, but tolerates mowing. Bright yellow flowers are attractive to many pollinators, and will self-seed. A hardy native plant, it prefers full sun and well-drained soils, tolerating heat, drought and humidity. Seed at 1.5 oz per 1000 ft^2.

Pollinators and Pesticides

Bees and other pollinators are highly susceptible to pesticide sprays. Even when not immediately toxic to them, many chemicals cause a range of sub-lethal effects on bees, compromising their immune systems and shortening their lifespans. Many insecticides act as neurotoxins that affect learning and memory processing in bees, which is vital for them to efficiently perform important pollination tasks.

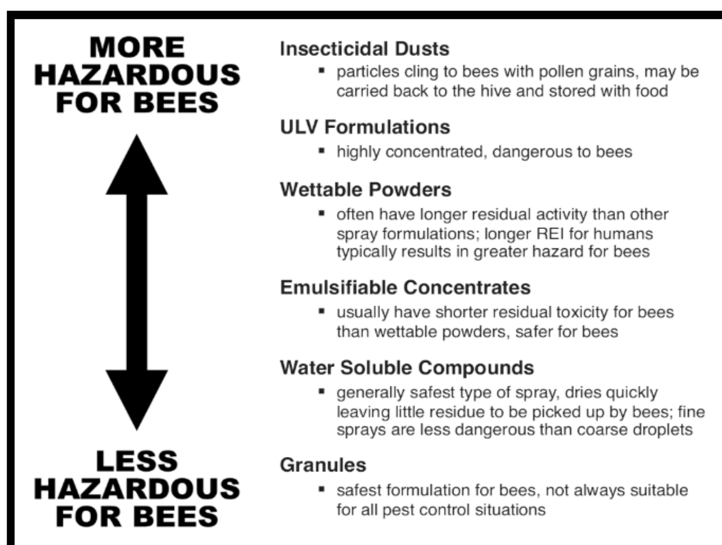
- **Insecticides** are designed to kill insects, and make no distinction between pests and beneficial species such as pollinators and the many predators that help reduce pest populations. Be judicious in the use of safer products, and target pests when and where they occur, rather than relying on broad-spectrum applications across the landscape on a calendar schedule.
- **Herbicides** are usually not acutely toxic to bees, although they affect the delicate balance of beneficial microbes that live in the bees' digestive system, causing nutritional stress and impairing their immune response to other harmful microbes. And by removing potential food sources from the landscape, herbicides degrade pollinator habitat and worsen nutritional stress.
- **Fungicides** are generally considered non-toxic to bees in small doses, but will also disrupt their beneficial microbes and cause other health problems. Fungicides also synergize with other chemicals, making them more toxic, and can make bees more susceptible to pathogens.

Reduce Pesticide Impact on Pollinators

Before you apply pesticides to the landscape, understand the problem you seek to correct. For instance, make sure dead patches of lawn are due to grubs before applying a systemic insecticides that can be absorbed by other plants, and make their way into pollinator diets. Where appropriate, select products that have minimal toxicity to bees. Apply pesticides only when and where necessary. Make applications when bees are not actively foraging (usually late afternoon or evening). Employ spot-treatments to target pests rather than area-wide applications. Be willing to accept minor cosmetic insect damage that does not cause significant harm to plants. Read the labels of all products before use, and pay particular attention to specific pollinator hazards and restrictions. ***The label is the law!***

Formulations matter

The formulation of an insecticide can affect it's toxicity to pollinators, even when the active ingredients are the same. Dust formulations can be very toxic because the particles are the same size as pollen grains, and are easily transported back to nesting sites. Granules are generally safer, because they fall to the soil where pollinators are not likely to encounter them. However, systemic treatments can be taken up by plants and become available in the nectar or pollen. Oily carrier agents may be more dangerous to pollinators than the active ingredients because the bees cannot clean it off.



www.uaex.edu/publications/pdf/mp144/mp144.pdf?p=27

Planting for Pollinators

GET IT ON Google Play
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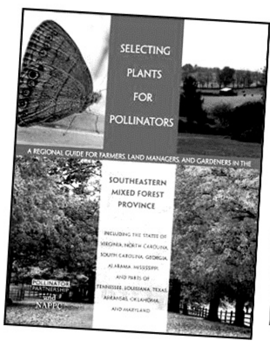
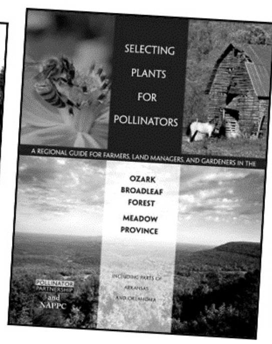
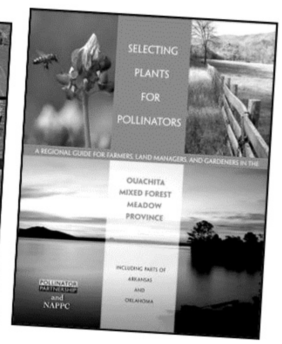
There are many lists of pollinator-friendly plants available in print and online. However, most of these lists are hihgly generalized or may be very region-specific for other areas of the country with different growing conditions and different native vegetation.

The *Pollinator Partnership* (**pollinator.org**) provides lots of resources for helping you to plan wildlife-friendly landscapes that attracts all types of native pollinators. Their website features free region-specific planting guides to help you select appropriate trees, shrubs, vines and other flowering plants that will thrive in your geographical area.

Download their **BeeSmart** phone app to generate a list of beneficial plants for your zip code. Customize your search by soil type, sun/shade conditions, plant type, flower shape and color, and specific pollinator groups you want to attract.







Initiatives for Golf Course Managers

Golf courses are expansive green spaces that can be useful in creating pollinator-friendly spaces. Numerous programs have been developed to help golf course managers incorporate environmentally friendly practices with their daily management decisions. Minimally used areas of the property can be maintained as functional wildlife habitat without interfering with playing areas. Several organizations offer guidelines and/or certifications for wildlife and pollinator conservation efforts:

- **Audubon Society's Cooperative Sanctuary Program**
  auduboninternational.org/acsp-for-golf
- **USGA Wildlife Links**
  www.usga.org/content/dam/usga/pdf/Water%20Resource%20Center/usga-wildlifelinks.pdf
- **Syngenta's Operation Pollinator**
  https://www.syngenta.com/what-we-do/the-good-growth-plan/help-biodiversity-flourish/operation-pollinator
- **NCIPMC Best Management Practices for Turf Care and Pollinator Conservation**
  www.ncipmc.org/action/bmpturf.pdf
- **World Golf Foundation**
  http://www.worldgolffoundation.org/industry-initiatives/golf-the-environment/
- **The NRCS offers technical assistance to private landowners for pollinator conservation habitat**
  https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/technical/

Plant growth regulators (PGRs) for lawn management

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Plant growth regulators have been widely-used in the golf and sports turf industries for over 2 decades. PGRs can provide many benefits in turfgrass maintenance systems, including:

- suppress growth rates
- extend mowing intervals
- improve mowing quality
- reduce clipping volume
- reduce scalping
- reduce edging
- enhance longevity of paint
- improve drought tolerance
- improve shade tolerance

There are several PGRs that are labelled for use on lawn grasses, but their use in lawns remains small relative to golf or athletic fields. The PGRs that are labelled for use in lawns are detailed in Table 1.

Table 1. Plant growth regulators labelled[1] for use on warm-season and cool-season lawns.

Company	**Product**	**Active Ingredient**	**General Lawn Application**	**Edging**
NuFarm	Anuew	prohexadione calcium	X	
SePro	Cutless MEC	flurpimidol		X
Syngenta	Primo Maxx	trinexapac-ethyl	X	X
Various	Podium	trinexapac-ethyl	X	X
Quali-Pro	T-Nex	trinexapac-ethyl	X	X
Advanced Turf	Armor Tech	trinexapac-ethyl	X	X
UPI	GoldWing	trinexapac-ethyl	X	X
Andersons	Governor G	trinexapac-ethyl	X	
Sipcam Agro	Groom	trinexapac-ethyl	X	X
Makhteshim Agan	PrimeraOne	trinexapac-ethyl	X	X
Lesco	RegiMax	trinexapac-ethyl	X	X
Regal Products	Solace	trinexapac-ethyl	X	X
SePro	Legacy	flurpimidol + trinexapac-ethyl		X

[1] – read and follow all label directions carefully

The two areas of lawncare management where plant growth regulators can really be beneficial are in the **reduction of mowing requirements** and their use to **edge hard surfaces** such as sidewalks or landscape beds.

Mowing management

Mowing remains the most important cultural practice for lawns and other turfgrass sites. Mowing must be done frequently to maintain high-quality lawns, as removing too much of the leaf area (scalping) when mowing can have detrimental effects on the quality of the lawn. How often to mow is determined by the growth rate of the grass and the height of cut that the lawn is being maintained. Regardless of the type of grass, growth rate, or height of cut, it is always best to **follow the "1/3 rule"** when determining mowing frequency. The 1/3 rule states that you should never remove more than 1/3 of the leaves with any single mowing to avoid scalping and leave enough active leaf area for the plant to look good and perform well. An example of this would be if the lawn is currently 3 inches tall, the lowest mowing height for that day should be at 2 inches. To determine the maximum height that you should let a lawn grow before it needs to be mowed, multiply your desired mowing height (example - 2") x 1.5 and that will tell you the maximum height that the turf can be mowed to stay within the 1/3 rule. For this example, the maximum height would be 3 inches (2" x 1.5 = 3"). Table 2 provides scenarios of how adjusting the mowing height or growth rate affects the mowing frequency.

Table 2. Two scenarios demonstrating how a PGR might affect mowing frequency of a lawn[1]

Growth rate	Mowing Height	Max Height of Lawn	Mowing Frequency
		(Mowing ht x 1.5)	(Max Ht – Mowing Ht) ÷ Growth Rate
inches / day	*inches*	*Inches*	*days*
Example of a well-fertilized bermudagrass lawn in mid-summer			
0.2	1.0	1.5	2.5
0.2	2.0	3.0	5
0.2	3.0	4.5	7.5
0.2	4.0	6.0	10
If a growth regulator were added to the same lawn and slowed the growth rate from 0.2 to 0.1 inches / day			
0.1	1.0	1.5	5
0.1	2.0	3.0	10
0.1	3.0	4.5	15
0.1	4.0	6.0	20

[1] These are hypothetical scenarios and the degree of regulation will depend on the grass species and time of year

The first benefit from using a PGR (Table 2) would be that you could extend the number of days between mowings without breaking the 1/3 rule and scalping the lawn. However, even if you maintained the same mowing frequency, say once per week, the PGR would likely **enhance the quality of the lawn** because much less of the leaf area is being removed with each mowing. In addition, **clipping volume can be greatly reduced**, which could reduce cost of collection and disposal. Having a lawn regulated can also be extremely beneficial if persistent rains prevent the lawn from being mowed for extended periods.

Edging management

In Arkansas and across the transition zone and south, warm-season grasses such as bermudagrass, zoysiagrass, and St. Augustine remain the most popular choices for home lawns. All of these grasses produce modified stems that are commonly called stolons (above-ground) or rhizomes (below-ground). These stems result in a "spreading" growth habit, which is great when the lawn is damaged and recovery is needed, but can also be a maintenance problem when those stems grow onto the sidewalk or into the landscape beds. It is routine for homeowners or landscape managers to trim these stems as often as they mow the lawn, especially if you are managing a fast-growing species like bermudagrass. This can add significantly to the cost of maintaining a lawn, as string-trimmers or edgers become necessary tools to adequately remove the stems and there is additional labor costs associated with the operation of these tools.

Plant growth regulators can be very effective tools for band applications to areas where unwanted growth of stems must be managed with the use of edging equipment. As was discussed in the mowing management section, a PGR can slow the growth rate of the turfgrass leaves and the turfgrass stems of warm-season grasses. If the growth rate of those stems can be reduced to the point where edging would not be required every time the lawn is mowed, then significant cost and labor savings can be realized.

Treatments in Demonstration plots:

Product	Active Ingredient	Rate (Bermuda)	Rate (KY Blue)	Application Interval
Anuew	Prohexadione Calcium	0.55 oz / acre	0.37 oz / acre	3 wk
Primo Maxx	trinexapac-ethyl	0.38 fl oz. / 1000 ft2	0.6 fl oz. / 1000 ft2	3 wk
T-Nex	trinexapac-ethyl	0.38 fl oz. / 1000 ft2	0.6 fl oz. / 1000 ft2	3 wk

Rebound effects and re-application of PGRs

It has been well-documented that turfgrasses that are under suppression from PGRs can experience a period of "surge growth" after the effects of the PGRs have worn off. This is often called the "rebound effect" (Figure 1). In order to avoid this rebound in growth, PGRs should be applied frequently enough to maintain suppression of the turf.

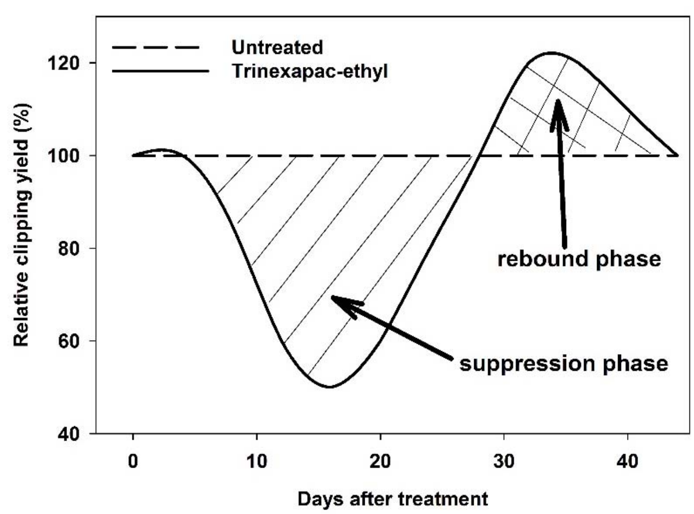


Figure 1. Rebound effect commonly seen when PGRs are applied to turf

Historically, most PGRs were re-applied based on a calendar interval that was related to the rate of the product used, with the idea that higher rates would give longer periods of growth suppression and lower rates would suppress the turf for shorter intervals. Although most labels retain a calendar-based application interval, many PGRs can be most effectively re-applied based on a growing-degree-day model. For **trinexapapc-ethyl, the optimum interval for reapplication is around 230 GDD units and for Anuew, it is approximately 280 GDD units.** Be aware that the growing degree day units reported are **calculated using degrees C** with the following equation:

$$\text{Daily GDD Units} = \frac{\text{Daily High Temp (°C)} + \text{Daily Low Temp (°C)}}{2} - \text{Base Temp (0 °C)}$$

There are several programs that can be used to calculate GDD accumulation, but Dr. Bill Kreuser at the University of Nebraska has developed a mobile/desktop program called "GreenKeeper" that will automatically calculate accumulated GDDs for you and even provide warnings when PGRS should be re-applied based on weather since the previous application date. Information about GreenKeeper can be found at www.greenkeeperapp.com.

Caution statements

- PGRs can cause phytotoxity and turfgrass injury if the turf is under severe stress at application.
- Some discoloration (bronzing) can be observed soon after application, especially with taller-cut bermudagrasses
- Tank-mixing with small amount of soluble N or Fe can reduce the bronzing effect
- Discontinue PGR use if turf is experiencing significant stress

Calibrating Turf Hose Reel Sprayers

Jason Davis

Introduction

Calibration of spray equipment is the foundation of any pesticide application. Labeled rates and uniform coverage of turf products are only achieved when **equipment output, applicator speed, and appropriate overlap** are known and maintained throughout an application. To quote Dr. Fred Whitford from the Purdue Pesticide Program, "There is a science to calibration and an art to application." In other words, it is important to get the math of sprayer output and tank mixing down to a science. It is just as important to have applicators and technicians practice the art of applying pesticides with consistent walking speeds and uniform arm movements. It is this art and science balance that creates consistently successful turf applications.

1. Calibrating equipment output

The first step to hose reel sprayer calibration is to know your sprayers output. This is a simple two-part process of selecting the desired nozzle and then verifying its output with a catch test. Nozzles are rated in gallons per minute (GPM) of flow and often color coated. For this example we will assume a nozzle that is rated at 2 GPM is selected.

Next, verify the 2 GPM flow from this nozzle on your sprayer. Start by marking one gallon increments in a five gallon bucket. Add exactly one gallon of water to an empty bucket and use a bold sharpie to mark its level. Repeat with two, three, and four gallons of water in the same bucket.

Next, using your sprayer, spray for one minute into the bucket. Be careful to capture all of the spray and time the catch accurately. It is recommended to repeat this step a couple more times to ensure an accurate reading. If the flow captured in the bucket is consistently lower than the GPM, increase the spray pressure. If the captured flow is consistently higher, decrease the spray pressure.

2. Pace yourself by calibrating walking speed

Calibrating an applicator to cover a certain amount of lawn in a specified amount of time takes practice. Start by marking a 20' by 50' rectangle on a dry parking lot creating a 1,000 ft^2 area to spray. Have the applicator attempt to uniformly spray the 1000 ft^2 area in one minute at a comfortable pace using parallel swaths. Perform this step a few times so that the pace can be increased or decreased as needed to cover the area in one minute. This pace should be able to be maintained throughout actual applications that are much larger than 1000 ft^2.

Remember that the sprayer has a flow rate in this example of 2 GPM. If the applicator can reliably cover the 1000 ft^2 in one minute, then the application volume would be calibrated at 2 gal/1000 ft^2.

3. Uniformity through calibrated arm motions

Moving at the right pace may cover the lawn but it does not ensure uniform coverage of products. An applicators arm motion must throw the spray at a uniform width, pace, and overlap. Similar to walking pace, this takes practice.

Tips for uniform overlap:

1. Focus on a point in the distance so that you walk strait.
2. Practice holding the spray gun level, out, and spraying forward instead of down at your feet.
3. Swing your arm (not wrist) at a brisk pace throwing approximately an 8' wide swath.
4. Individual weeds should receive about three swings of product as you walk forward.

5. At the end of a pass, take two steps over (approximately 6') to make the next parallel pass.

It is easy to identify if adjustments need to be made by practicing these steps with water on a paved surface. After the practice application is completed, uniformity can be observed as the pavement dries. Areas that dry quickly received a lighter rate than areas that remain wet longer. Look for patterns and tweak techniques to produce a uniform application. Remember that this is a process and it takes practice.

4. Tank Mixing

With a known sprayer output and an applicator that can consistently and uniformly cover the needed ground, we can now determine how much product to mix. Remember that in this example we are applying 2 gal / 1000 ft^2. If our spray tank can hold 500 gallons of solution then we simply divide tank volume by output to get the area covered by one tank.

$$\frac{Tank\ Volume}{Sprayer\ Output} = Area\ covered\ by\ one\ tank \qquad \frac{500\ gal}{2\ gal}\ x\ 1000ft^2 = 250{,}000\ ft^2$$

Most labels specify how much product to apply per 1000 ft^2. So the next step would be to determine how many 1,000 ft^2 we can cover with one tank. This can be calculated by dividing the "area covered by one tank" by 1000.

$$\frac{Area\ covered\ by\ one\ tank}{1000\ ft^2} = \#\ of\ 1000\ ft^2 \qquad \frac{250{,}000\ ft^2\ covered}{1000\ ft^2} = 250$$

Finally, refer to the product label to determine the rate per 1,000 ft^2. As an example, we'll assume that the rate is 3 oz./1000 ft^2. We know that we can cover 250 – 1000 ft^2 blocks and that each of them should receive 3 oz. of product. Therefore 250 times our rate should give us the total amount of product we should put in the tank in ounces.

$$(\#\ of\ 1000\ ft^2\ areas\ covered) \times (rate\ per\ 1000\ ft^2) = product\ per\ tank$$

$$250 \times 3\ oz. = 750\ oz.\ of\ product\ needed\ per\ tank$$

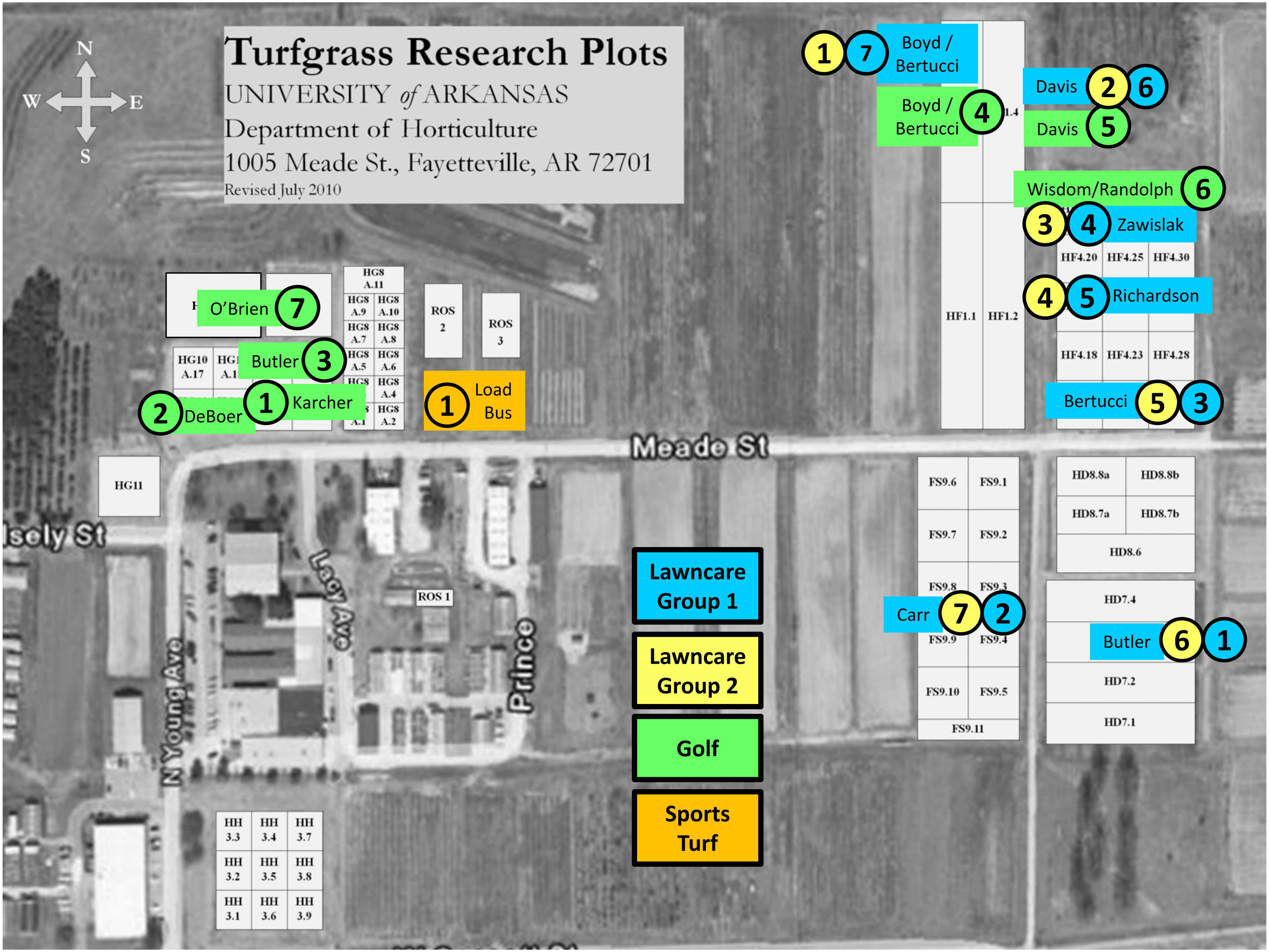
Ensure proper mixing by filling tank half full, adding product slowly, agitating the solution, and then filling the remainder of the tank.

Conclusion

Sprayer calibration in turf is essential to making responsible and economical applications. Hose reel sprayer applications are a balance of art and science that take practice and periodic system checks to ensure accurate and uniform applications. These checks should be repeated throughout the spray season, anytime changes are made to equipment, and with new applicators. Over and under applying pesticides can be costly, ineffective, bad for business, and environmentally hazardous. Calibrate, practice, and apply with confidence.

References

Whitford, F., Hardebeck, G., Becovitz, J., Avenius, B., and Blessing, A. (2009). *Calibrating the hose reel lawn care sprayer.* West Lafayette, IN: Purdue University Cooperative Extension Service.



Turfgrass Research Plots
UNIVERSITY of ARKANSAS
Department of Horticulture
1005 Meade St., Fayetteville, AR 72701
Revised July 2010
N
W
E
S
1 7 Boyd / Bertucci
Boyd / Bertucci 4
Davis 2 6
Davis 5
Wisdom/Randolph 6
3 4 Zawislak
HF4.20
HF4.25
HF4.30
4 5 Richardson
HF1.1
HF1.2
HF4.18
HF4.23
HF4.28
Bertucci 5 3
O'Brien 7
HG10 A.17
Butler 3
2 DeBoer
1 Karcher
HG8 A.11
HG8 A.9
HG8 A.10
HG8 A.7
HG8 A.8
HG8 A.5
HG8 A.6
HG8 A.4
HG8 A.2
ROS 2
ROS 3
1 Load Bus
Meade St
HG11
Isely St
Lacy Ave
ROS 1
Prince
N Young Ave
FS9.6
FS9.1
FS9.7
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Lawncare Group 1
Lawncare Group 2
Golf
Sports Turf
HH 3.3
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HH 3.1
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HH 3.9

Agenda for 2019 Turfgrass Field Day - Fayetteville AR, July 24, 2019
Registration: 7:00 - 9:00 am
Trade Show and Breakfast: 7:30-8:40 am
Opening comments: 8:40-9:00 am
FIELD TOURS (9:00 am -11:30 am)

Golf	Topic	Start	End	Flag Colors & Numbers: Red w/ White Nos.
Doug Karcher	GCSAA wetting agent talks	9:00	9:20	1
Eric Deboer	Nanobubbles	9:20	9:40	2
Lee Butler	Fungicide programs for bentgrass greens in the transition zone	9:40	10:00	3
John Boyd and Matt Bertucci	Weed control options and post crabgrass control	10:00	10:20	4
Jason Davis	Applicator issues / sprayer technology	10:20	10:40	5
Jay Randolph & Michelle Wisdom	Native plants and pollinators	10:40	11:00	6
Daniel O'Brien	Does your golf course need a drone?	11:00	11:20	7

Lawncare - Group 1	Topic	Start	End	White w/ Red Nos.
Lee Butler	Disease diagnostics and effects of rain on fungicides	9:00	9:20	1
Tyler Carr	Water use of cool-season lawn grasses	9:20	9:40	2
Matt Bertucci	New herbicide options for lawn care operators	9:40	10:00	3
Jon Zawislak	Best management practices to protect pollinators in landscapes	10:00	10:20	4
Mike Richardson	Plant growth regulators and mowing management	10:20	10:40	5
Jason Davis	Applicator issues / sprayer technology	10:40	11:00	6
John Boyd and Matt Bertucci	Weed control options and post crabgrass control	11:00	11:20	7

Lawncare - Group 2	Topic	Start	End	Yellow w/ Black Nos.
John Boyd and Matt Bertucci	Weed control options and post crabgrass control	9:00	9:20	1
Jason Davis	Applicator issues / sprayer technology	9:20	9:40	2
Jon Zawislak	Best management practices to protect pollinators in landscapes	9:40	10:00	3
Mike Richardson	Plant growth regulators and mowing management	10:00	10:20	4
Matt Bertucci	New herbicide options for lawn care operators	10:20	10:40	5
Lee Butler	Disease diagnostics and effects of rain on fungicides	10:40	11:00	6
Tyler Carr	Water use of cool-season lawn grasses	11:00	11:20	7

Sports Turf	Topics	Start	End
Pat Berger	Tour of Razorback Athletics	9:00	11:15

Innovative equipment demonstrations (12:15-1:30 pm)

Jamie Kizer (Trimax) - Trimax Snake Mower
Tim Schwierjohn (Redexim) - SpeedSeed drop seeder
Jim Steele (Carswell/OEI) - Battery-powered mowing options
Josh Landreth (Ace of Blades and Husqvarna) Autonomous mowers

Pesticide recertification (1-3 pm)
Located across Hwy 112 / Garland Avenue in the new Don Tyson Center for Agricultural Sciences

Pesticide Safety (20 min)– Matt Bertucci
Sprayers & Calibration (30 min) – Jason Davis
Drift Minimization (30 min)– Jason Davis
Regulations Update (15 min) – Seth Dunlap
Environmental Concerns (25 min) – Matt Bertucci