WELCOME TURF INDUSTRY

Welcome to Clemson University's Turf Field Day! Thank you for taking time out your schedules to participate in this informative and educational activity. Our faculty, staff and students have worked diligently to showcase our research and demonstrations to update the technical knowledge of turfgrass managers and educators. South Carolina is very fortunate to have a national award winning turf faculty that provides excellent service in our research and educational programs. Clemson University invests nearly a million dollars annually in salaries and facilities to support the Turf research and education programs. Thank you for supporting this Field Day and Clemson University's Turfgrass Program.

Ted Whitwell
Associate Dean for Academic Programs
College of Agriculture, Forestry & Life Sciences (CAFLS)
Interim Director of the School of Agricultural, Forest and Environmental Sciences (SAFES)

Clemson University Turfgrass Research & Education Field Day

August 5, 2015
8:30 am

Sponsored By:
Clemson University College of Agriculture, Forestry, and Life Sciences, SC Public Service Activities, Carolinas Golf Course Superintendents Association, and The Walker Golf Course

ITINERARY

8:00 - 8:30am	Gathering at Owen Pavilion, 100 Madren Center Drive, Clemson, SC 29634 (just off Old Stadium Road, behind Martin Inn).
8:30 - 9:00am	Welcome and Explanation of the Field Day events and locations, -Ted Whitwell, Associate Dean for Academic Programs, CAFLS, -Tom Dobbins, Director, CU Cooperative Extension Service -Tim Kreger, Executive Director, CGCSA -Bert McCarty, Professor of SAFES - Horticulture
9 – 10am	**Stop 1** – Pest Control/IPM Updates at the Owen Pavilion.
10 – 11am	**Stop 2** – Soil & Water Updates – Turf Plots
11am – 12pm	**Stop 3** – Turfgrass Nutrient Management – Walker GC Maintenance Facility/Turf Plots
12 – 1pm	Lunch (on your own)
1:15 - 3pm	**Stop 4** – Turfgrass/Agronomic Management of CU Athletic Fields/Golf Facility *or* play golf at Walker GC *or* resume self-guided tour of the research plots.

NOTE: SC Pesticide Recertification, CPAg, CCA and PTI Credits will be offered. Those with more than 1 SC pesticide license (e.g., Private, Commercial or Noncommercial) should list all license numbers on the recertification sign-in forms to receive credit for each license. Four CPAg/CCA CEU credits will be offered: 1 each for Soil & Water Management, Integrated Pest Management, Nutrient Management, and Crop Management.

<u>**Stop 1. Integrated Pest Management Updates**</u> – Bert McCarty & Alan Estes

Pesticide Regulatory Update – Bob Bellinger
Spring Dead Spot Disease Update – Alejandro Canegallo, B. Martin, L. Tredway, J. Kerrigan, B. McCarty
Controlling SU-Resistant *Poa annua* - Bob Cross, B. McCarty, T. Whitwell, N. Tharayil, B. Bridges.
Insect Integrated Management, Especially Stunt Mites – J. C. Chong
Diamond Zoysiagrass Greens Management – D. Garrett, B. McCarty, J. Brown, A. Estes
PGRs to Reduce Mowing of Bermudagrass – Spencer Young, A. Gore, B. McCarty, W. Totten.
PRE and POST control of American Burnweed - Alan Estes, B. McCarty, A. Charles
POST Crabgrass and Goosegrass Control - Alan Estes, B. McCarty
PRE Crabgrass Control with Various Products - Nathan Gambrell, A. Estes, B. McCarty

<u>**Stop 2. Soil & Water Management**</u> – Dara Park.

Water Quality Flow Chart, A New Way to Assess Agronomic Water Quality – Dara Park, S. White
New Tools to Measure and Quantify Soil Moisture Levels for Turfgrass Managers – Dara Park**I-Mol Thatch Control study on Champion Bermudagrass Green to Improve Irrigation Efficiency** - Nick Menchyk, F. Bethea, H. Liu
Aerification Trends to Improve Moisture & Soil Management – Ray Hubbard, B. McCarty

<u>**Stop 3. Turfgrass Nutrient Management**</u> – Haibo Liu

Mini-Verde foliar fertilizer study -,<u>H. Liu</u>, N. Menchyk, and F. Bethea
Diamond zoysiagrass putting green responses to various fertility programs - Nick Menchyk, F. Bethea, B. Martin, and <u>H. Liu</u>
I-Mol product on thatch control studies on TifEagle and Champion bermudagrass greens - <u>F. Bethea</u>, Nick Menchyk, Mohan Li, and H. Liu
Winter traffic on creeping bentgrass greens – <u>M. Li,</u> F. Bethea, L.B McCarty, and H. Liu
Carbon fertilizer burning potentials on Tifway bermudagrass –<u>Nickles Mirmow</u>, Mohan Li, F. Bethea, and H. Liu
A short update on soil chemistry/nutrient trends for the turfgrass industry – <u>Haibo Liu</u>
Doveweed Biology and Control - Jeff Atkinson, B. McCarty, S. McElroy, F. Yelverton

12pm – Lunch (on your own)

<u>**Stop 4. Turfgrass Crop Management**</u> – Bert McCarty (meet at DV West Endzone at 1:15pm)

Managing Turfgrass Programs on Death Valley – Mike Echols, B. McCarty
Renovation of Doug Kingsmore Baseball Field – Mike Echols, B. McCarty
Managing an Indoor Artificial Turfgrass Playing Surface – Mike Echols

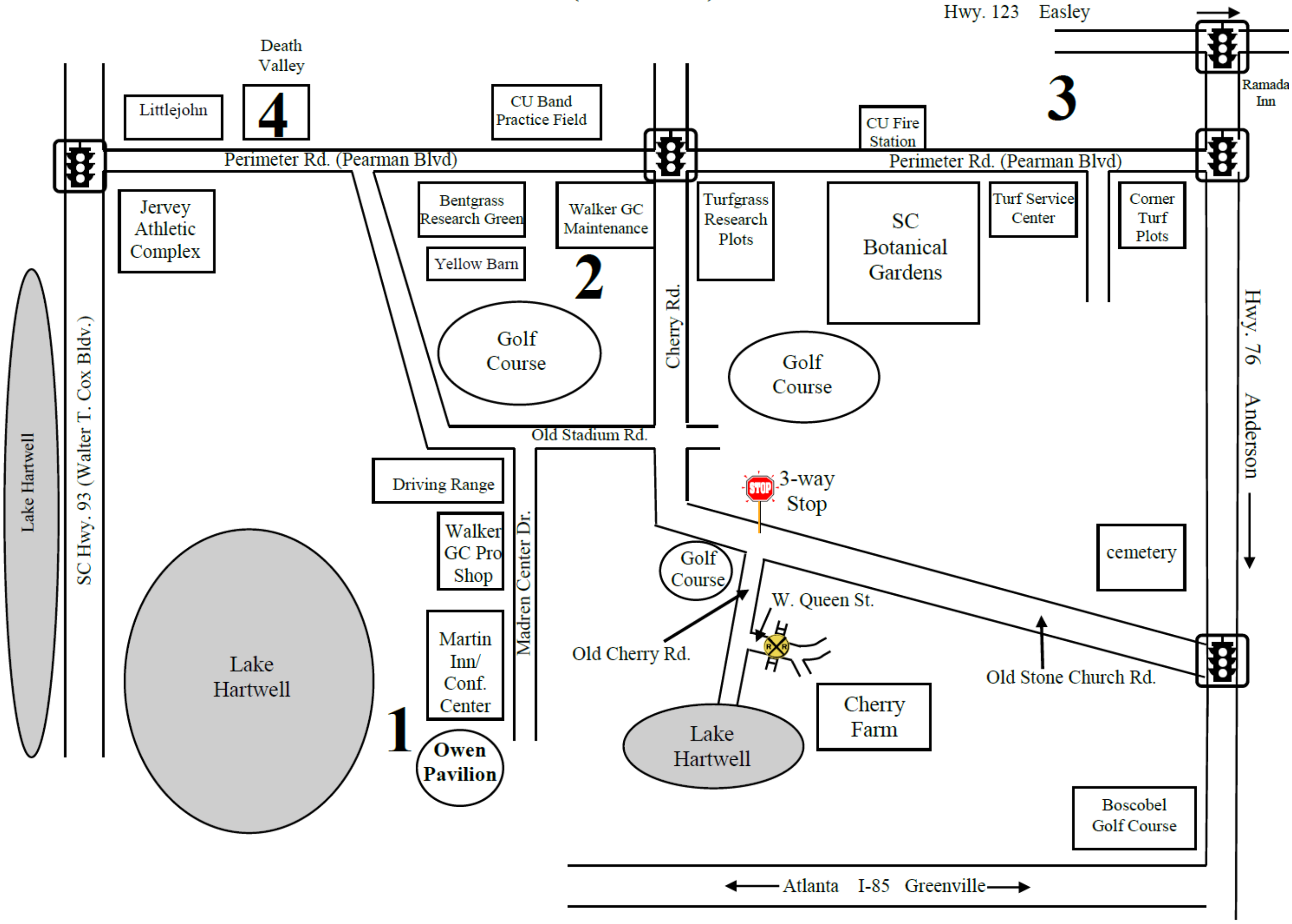
or

-Continued Self-guided Tours of the Turfgrass Research Facilities.

or

-Play Golf at Walker Golf Course

AREA MAP (not to scale)



Cooperator Acknowledgements

Without the generous support of the following cooperators, no turf program would be successful. The Clemson University Turfgrass Team sincerely appreciates their continued support.

Agro-Culture Liquid Fertilizers
Andersons
Arysta LifeScience
Augusta Country Club
Ayus Industries
Barenbrug USA
BASF
Bayer Crop Science
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Boscobel Golf Course
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Cleary Chemical
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Modern Turf
Monsanto Chemical
Nature Safe Fertilizer
NewLife Turf
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Ponderosa Country Club
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SePRO Corp.
Sisis INC
Smith Turf and Irrigation – Toro
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Syngenta Crop Protection
Sulvaris, Canada
Terra Max, INC
Textron Golf, Turf, and Specialty Products
The Cliffs Communities
The Creek Club
The Preserve at Verdae
The Rock at Jocassee
The Scotts Company
Tri-State Pumping Systems – Jacobson
Turf Pro *Plus*
USDA (US Dept of Agriculture)
USGA (US Golf Association)
Valent USA
VitAg Corp
Walker Golf Course Staff
Wild Dunes Golf Courses

Approval Code Notice

For an External Education Program

Event Name: 2014 Clemson University Turfgrass Research & Field Day

Event Approval Code: 999-12885-19395

Event Location: Clemson, SC

Event Date(s): August 05, 2014

Education Points: .30

Sponsor Instructions:

Please provide **copies of the Approval Code Notice** to all GCSAA members in attendance towards the **end** of your program.

Member Instructions for Submitting the Event Approval Code:

To receive .30 education points for attending this event, you must submit the approval code of 999-12885-19395 to GCSAA within 30 days of the event. You can record your attendance by using the online Education Point Affidavit in the Submit Points area of www.gcsaa.org. By using the online affidavit, your education points will automatically populate your educational history. If you do not have access to the Internet, you can call GCSAA at (800)472-7878 and submit the code by phone.

South Carolina Sports Turf Managers Association

www.scstma.org

Membership Form

Date:_______________________________________ Invoice #___________ Purchase Order #__________

Name:_______________________________________ E-Mail:_________________________

Company/Organization:_________________________ Phone:_________________________

Address:____________________________________

____

- Please be sure to write your correct e-mail address in a clearly legible manner so that we may contact you about future events. Your e-mail address will not be used for any other purpose or redistributed to third parties. For multiple memberships please duplicate form.

Please circle one of the following

Option	Annual Benefits Include	Cost	Total
Professional Membership	Attendance and lunch at all SC events	$30	
Commercial Membership	Attendance and lunch at all SC events (2 Members)	$100	
Student Membership	Attendance and lunch at all SC events	$15	FREE
SCSTMA Polo Shirt	Size:	$25	
SCSTMA Hat	Flex Fit Size: S/M L/XL	$12.50	

Method of Payment:

Cash_________________________________

Visa_________________________________

Mastercard___________________________

Check________________________________

Checks are made payable to: SCSTMA
PO Box 161023
Boiling Springs, SC 29316

Questions may be addressed to Bruce Suddeth (864)503-5514 or BSuddeth@uscupstate.edu

Thank you for your interest in the SCSTMA and we look forward to serving you.

THIS WILL BE THE ONLY INVOICE YOU WILL RECEIVE

Carolinas Golf Course Superintendents Association
P.O. Box 210
Liberty, SC 29657-0210
800-476-4272 / 864-843-1149 (Fax)
www.carolinasgcsa.org

For Office Use Only	
Class	
Member #	
Amount Pd.	
Entered	
Note	

Membership Application

Last Name | First Name | Middle Name | Preferred Name

Club or Company Name | Date of Birth

Home Mailing Information	Club or Company Mailing Information
Home Mailing Address	Club or Company Mailing Address
City / State / Zip	City / State / Zip
Home Phone / Home Fax	Work Phone / Work Fax
Job Title	Mobile Phone / Club/Co. Phone
Preferred Mailing Location: Home [ ] Club/Co. [ ]	Work E-Mail
GCSAA Class & Number:	Applicant Signature

The Carolinas GCSA is an Affiliate Chapter of the Golf Course Superintendents Association of America (GCSAA) and all Class A or SM Member Applicants must also be a member of GCSAA.

Years in Current Position: ________

Employment History Prior to Current Position

From: Mo. & Yr.	To: Mo. & Yr.	Title	Place of Employment

See reverse for an explanation of classifications. Membership dues are good for the initial twelve months after which renewal will be on an annual basis.
Dues: Class A $180; Class SM $180; Class C $90; Class AF $180; Class AS $90; Student $30; Class AF1 $440; Class AF2 $880; Class AF3 $1,300

I hereby apply for membership in the Carolinas Golf Course Superintendents Association and herewith attach my dues of $____________ for one year. I understand that this application will be reviewed by a representative of the board of directors and if rejected for any reason, my dues remittance will be refunded. If accepted for membership I agree to observe and abide by the Constitution and By-laws of the association. I also affirm that I have read, understand and will abide by the association Code of Ethics on the reverse side of this application.

Credit Card # (We accept Visa, MasterCard & Discover) *If paying by credit, provide 3 digit v-code located on back of card in signature strip

Name on Credit Card | Attester Signature

Expiration Date | Attester Printed Name

CGCSA or GCSAA Class & Member # ________

North and South Carolina Applicants must have their application signed by a Class AA, A or SM member of the Carolinas Golf Course Superintendents Association. Out of state applicants must have their application signed by a Class AA, A or SM member of the Golf Course Superintendents Association of America.

Poa Herbicide Resistance Research Update

R. B. Cross, L. B. McCarty, J. S. McElroy, N. Tharayil, T. Whitwell, B. Bridges

Annual bluegrass (*Poa annua* L.) remains the most problematic winter annual weed for managed turfgrass. Over the last 5 years, control has steadily become more difficult to obtain, especially in the southeastern U.S., where resistant populations have evolved to several important herbicide mechanisms of action.

In South Carolina, the most widespread resistance issues are to ALS-inhibitors (sulfonylureas) and glyphosate. Resistance to sulfonylureas (e.g., foramsulfuron, trifloxysulfuron, rimsulfuron, flazasulfuron) is mostly from the coast up to the I-20 corridor, with the epicenter being near Hilton Head Island and Savannah, GA. Most resistance to glyphosate occurs north and west of I-20 where bermudagrass is fully dormant for longer periods of time.

Other resistance issues in SC include mitosis-inhibitors (e.g., prodiamine, dithiopyr) which mainly occur along the coast where applications of these herbicides have occurred prior to overseeding for many years. Some tolerance to ethofumesate has been reported at one SC location after 13 years of applications, but widespread resistance has not been documented.

Resistance to simazine is also less widespread in SC, although several locations in coastal and midlands regions have indicated poor control. This is probably due to other mechanisms of action becoming more popular over the past 10-15 years, especially the sulfonylureas, resulting in reduced use of simazine. It is likely more resistance will evolve to simazine in the foreseeable future, especially in coastal areas, as resistance to sulfonylureas becomes more widespread simazine is more extensively used for control.

Previous research determined most sulfonylurea resistance in Poa occurs from a gene mutation which changes the ALS enzyme such that herbicides will no longer bind and inhibit enzyme activity. This results in an extremely high level of resistance. Research into the mechanism of glyphosate resistance is underway and should be completed by the end of the year. Most glyphosate resistance occurs at a lower level than sulfonylurea resistance, but is enough such that plants can survive and reproduce after typical field applications of glyphosate (e.g., 16-32 oz/acre of 4L formulation). The genetics of Poa are extremely complicated, and we are working to understand how these genetic characteristics influence the development and maintenance of resistance in the field.

Computer models to predict the spread of Poa herbicide resistance have recently been developed at Clemson. As has been observed in the field, the models suggest resistance can develop in as quickly as 6 years with only one application of a sulfonylurea herbicide per year. If applications are made for 12 consecutive years, the predicted risk of developing resistance is >90%. For glyphosate, resistance develops at a slightly slower rate, although applications for about 16 consecutive years results in a predicted resistance risk of >90%. These numbers are important to consider, especially for turf managers who are already dealing with resistant populations. For example, a golf course with glyphosate-resistant Poa that exclusively uses sulfonylureas for control could potentially have a resistant population to both mechanisms of action in a short period of time.

The future of Poa resistance in turfgrass appears to be heading in a similar direction as other cropping systems, (e.g., Palmer amaranth in glyphosate-tolerant crops, rigid ryegrass in Australian grain crops). The problem with these is resistance to multiple mechanisms of action (termed multiple resistance). For example, a single population of rigid ryegrass in Australia is resistant to seven different mechanisms of action. At this point, control with herbicides is essentially eliminated. The first report of a multiple resistant population of Poa came this year at a golf course in west Tennessee to both simazine and sulfonylureas. For turf managers, multiple resistance will be an increasing problem if herbicides are not used cautiously.

Table 1. Listing of currently used herbicides in the turfgrass market based on their timing and mechanism-of-action (courtesy, L. B. McCarty).

Timing	**Mechanism of Action**	**Active Ingredient***
Preemergence	Cellulose biosynthesis inhibition	Indaziflam (Specticle)
	Mitotic inhibition	Benefin (Balan)
		Dithiopyr (Dimension)
		Oryzalin (Surflan)
		Pendimethalin (Pendulum)
		Prodiamine (Barricade)
		Trifluralin (Treflan)
Pre/Postemergence	Mitotic inhibition	Dimethenamid (Tower)
		Pronamide (Kerb)
	Photosystem II inhibition	Atrazine (Aatrex)
		Metribuzin (Sencor)
		Simazine (Princep)
	Lipid biosynthesis inhibition	Ethofumesate (Prograss)
	Protoporphyrinogen oxidase (PPO) inhibition	Flumioxazin (SureGuard)
Postemergence	Acetolactate synthase (ALS) inhibition	Bispyribac-sodium (Velocity)
		Chlorsulfuron (Corsair)
		Flazasulfuron (Katana)
		Foramsulfuron (Revolver)
		Imazaquin (Image)
		Metsulfuron (Manor)
		Rimsulfuron (TranXit)
		Sulfosulfuron (Certainty)
		Trifloxysulfuron (Monument)
	Carotenoid biosynthesis inhibition (HPPD inhibitors)	Mesotrione (Tenacity)
		Topramezone (Pylex)
	Enolpyruvyl Shikimate-3 Phosphate (EPSP) synthase inhibition	Glyphosate (Roundup)
	Glutamine synthetase inhibition	Glufosinate (Finale)
	Photosystem I inhibition	Diquat (Reward)
	Photosystem II inhibition	Amicarbazone (Xonerate)

*Additional trade names are available for many products but due to space limitations, only one was provided for each.

The computer models suggest rotating mechanisms of action provides short-term resistance management by itself, but is not an effective long-term management solution. For example, models predicted the appearance of resistance after 12 years when sulfonylureas were rotated for two years and about 17 years when rotated for 3 years. Therefore, as many mechanisms of action as possible should be used in rotation or herbicides should be used as combinations, and cultural practices should be implemented so as to limit growth and spread of Poa populations. Table 1 shows pre- and postemergence products currently used in the turf market and their mechanisms of action.

Only three mechanisms of action currently labeled for Poa control in turfgrass remain where resistance has not been reported. These include cellulose biosynthesis inhibition (indaziflam, Specticle), PPO inhibition (oxadiazon, Ronstar; flumioxazin, Sureguard), and glutamine synthetase inhibition (glufosinate, Finale). It is extremely important for turfgrass managers to develop integrated control programs to prevent further resistance development or multiple resistant populations.

Clemson University

Trial ID: Protocol ID:
Location: Study Director:
Project ID: Investigator: L. B. McCarty
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Other Rate	Appl Code	Appl Description	Rep 1	2	3	4	Notes
1	Untreated								101	302	404	201	
2	Plateau	1	L	4	FL OZ/A				207	102	306	408	
	Trinexapac-ethyl	1	L	22	FL OZ/A								
3	Glyphosate	1	L	4	FL OZ/A				103	303	402	206	
4	Stronghold	1	L	38	FL OZ/A				307	104	205	401	
5	Trinexapac-ethyl	1	L	22	FL OZ/A				208	105	304	405	
6	Aneuw	1	L	27.5	OZ/A				203	407	305	106	
7	Plateau	1	L	4	FL OZ/A				403	107	202	308	
8	Plateau	1	L	8	FL OZ/A				406	301	204	108	

Sort Order: Replicate 1

Clemson University

Evaluate Anuew against standard for season long growth regulation and turf quality.

Trial ID: Anuew 14-1 Location: Clemson, SC Trial Year: 2014
Protocol ID: Anuew 14-1 Investigator: L. B. McCarty
Project ID: Study Director:
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Appl Description	Rep 1	2	3	Notes
5	Primo Maxx		L	6	fl oz/a	INT	105	201	301	
	Primo Maxx		L	6	fl oz/a	3 WAIT				
7	Cutless		L	20	fl oz/a	INT	103	202	304	
	Cutless		L	20	fl oz/a	3 WAIT				
4	Anuew	27.5	DG	16	oz/a	INT	102	203	305	
	Anuew	27.5	DG	16	oz/a	3 WAIT				
1	Untreated						101	204	306	
6	Primo Maxx		L	12	fl oz/a	INT	107	205	303	
	Primo Maxx		L	12	fl oz/a	3 WAIT				
3	Anuew	27.5	DG	8	oz/a	INT	104	206	307	
	Anuew	27.5	DG	8	oz/a	3 WAIT				
2	Anuew	27.5	DG	4	oz/a	INT	106	207	302	
	Anuew	27.5	DG	4	oz/a	3 WAIT				

Sort Order: Replicate 2

Clemson University

Bermudagrass and Goosegrass Control in Bentgrass Greens

Trial ID: Pylex Bent 14-1 Location: Clemson, SC Trial Year: 2013
Protocol ID: Investigator: L. B. McCarty
Project ID: Study Director: N.J. Gambrell
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	Appl Code	Appl Description	Rep 1	2	3	Notes
1	Non-Treated								101	202	306	
2	Pylex	2.8	SC	0.25	oz/a	POST	A	July 30, 2014	102	205	307	
	MSO		L	0.5	% v/v							
	Pylex	2.8	SC	0.25	oz/a	2 WAIT	B					
	MSO		L	0.5	% v/v							
3	Pylex	2.8	SC	0.5	oz/a	POST	A	July 30, 2014	103	209	305	
	MSO		L	0.5	% v/v							
	Pylex	2.8	SC	0.5	oz/a	2 WAIT	B					
	MSO		L	0.5	% v/v							
4	Pylex	2.8	SC	0.25	oz/a	POST	A	July 30, 2014	104	206	302	
	Velocity	17.6	SC	1	oz/a	POST						
	MSO	100	L	0.5	% v/v	POST						
	Pylex	2.8	SC	0.25	oz/a	2 WAIT	B					
	Velocity	17.6	SC	1	oz/a	2 WAIT						
	MSO	100	L	0.5	% v/v	2 WAIT						
5	Pylex	2.8	SC	0.5	oz/a	POST	A	July 30, 2014	105	207	309	
	Velocity	17.6	SC	1	oz/a	POST						
	MSO	100	L	0.5	% v/v	POST						
	Pylex	2.8	SC	0.5	oz/a	2 WAIT	B					
	Velocity	17.6	SC	1	oz/a	2 WAIT						
	MSO	100	L	0.5	% v/v	2 WAIT						
6	Pylex	2.8	SC	0.25	oz/a	POST	A	July 30, 2014	106	201	308	
	Turflon Ester	4	L	8	oz/a	POST						
	MSO	100	L	0.5	% v/v	POST						
	Pylex	2.8	SC	0.25	oz/a	2 WAIT	B					
	Turflon Ester	4	L	8	oz/a	2 WAIT						
	MSO	100	L	0.5	% v/v	2 WAIT						
7	Pylex	2.8	SC	0.25	oz/a	POST	A	July 30, 2014	107	204	301	
	Acclaim Extra	0.94	L	3	oz/a	POST						
	MSO	100	L	0.5	% v/v	POST						
	Pylex	2.8	SC	0.25	oz/a	2 WAIT	B					
	Acclaim Extra	0.94	L	3	oz/a	2 WAIT						
	MSO	100	L	0.5	% v/v	2 WAIT						
8	Acclaim Extra	0.94	L	3	oz/a	POST	A	July 30, 2014	108	203	304	
	Turflon Extra	4	L	8	oz/a	POST						
	MSO	100	L	0.5	% v/v	POST						
	Acclaim Extra	0.94	L	3	oz/a	2 WAIT	B					
	Turflon Extra	4	L	8	oz/a	2 WAIT						
	MSO	100	L	0.5	% v/v	2 WAIT						
9	Acclaim Extra	0.94	L	6	oz/a	POST	A	July 30, 2014	109	208	303	
	MSO	100	L	0.5	% v/v	POST						
	Acclaim Extra	0.94	L	6	oz/a	2 WAIT	B					
	MSO	100	L	0.5	% v/v	2 WAIT						

Sort Order: Replicate 1

Clemson University

Goosegrass Control with F6482

Trial ID: FMC 14-5 Location: Trial Year:
Protocol ID: FMC 14-5 Investigator: L. B. McCarty
Project ID: PS14 BW27 Study Director:
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	Appl Code	Rep 1	2	3	Notes
1	Check							101	204	303	
2	F6482 NIS	45 	DG L	8 0.25	oz/a % v/v	POST	A	102	203	302	
3	F6482 NIS	45 	DG L	16 0.25	oz/a % v/v	POST	A	103	202	301	
4	MSMA + Sencor	6.6 75	L DF	2 0.25	lb ai/a lb/a	POST	A	104	201	304	

Sort Order: Replicate 1

Clemson University

Plant Health Field Studies

Trial ID: Protocol ID:
Location: Study Director: Adam Gore
Project ID: Investigator: L. B. McCarty
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Other Rate	Appl Code	Appl Description	Rep 1	2	3	4	Notes
1	Untreated								101	204	301	407	
2	Turf Screen	1	L	2.5	FL OZ/1000 FT2				102	208	305	408	
3	PAR	1	L	0.37	FL OZ/1000 FT2				103	201	307	401	
4	Title Phyte	1	L	4	FL OZ/1000 FT2				104	202	303	406	
5	Turf Screen	1	L	2.5	FL OZ/1000 FT2				105	206	302	405	
	Title Phyte	1	L	4	FL OZ/1000 FT2								
6	PAR	1	L	0.37	FL OZ/1000 FT2				106	207	306	404	
	Title Phyte	1	L	4	FL OZ/1000 FT2								
7	Signature	80	WG	6	OZ/1000 FT2				107	203	308	402	
8	Aliette	80	WG	4	OZ/1000 FT2				108	205	304	403	

Sort Order: Replicate 1

Clemson University

Preemergence Crabgrass Control

Trial ID: Crab 14-1 Location: Turf Plots Trial Year:
Protocol ID: Investigator: L. B. McCarty
Project ID: Study Director: A. G. Estes
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	Appl Code	Appl Description	Rep 1	2	3	4	Notes
1	Untreated								101	209	306	405	
2	Tower	6	L	32	oz/a	PRE	A	March 18, 2014	102	211	305	406	
	Tower	6	L	32	oz/a	8 WAIT	B	May 23, 2014					
3	Pendulum	3.8	L	2	lb ai/a	PRE	A	March 18, 2014	103	204	308	404	
	Tower	6	L	32	oz/a	PRE							
	Pendulum	3.8	L	2	lb ai/a	8 WAIT	B	May 23, 2014					
	Tower	6	L	32	oz/a	8 WAIT							
4	Pendulum	3.8	L	3	lb ai/a	PRE	A	March 18, 2014	104	202	307	408	
5	Barricade	4	L	1	lb ai/a	PRE	A	March 18, 2014	105	207	302	410	
6	Surflan	4	L	3	qt/a	PRE	A	March 18, 2014	106	203	304	403	
7	Ronstar Flo	3.2	L	3	lb ai/a	PRE	A	March 18, 2014	107	206	309	411	
8	Echelon	4	L	1.25	lb ai/a	PRE	A	March 18, 2014	108	210	311	401	
9	Specticle	0.622	SC	9	oz/a	PRE	A	March 18, 2014	109	201	310	402	
10	Dimension	2	SC	0.5	lb ai/a	PRE	A	March 18, 2014	110	205	301	407	
	Dimension	2	SC	0.5	lb ai/a	8 WAIT	B	May 23, 2014					
11	SureGuard	51	WDG	12	oz/a	PRE	A	March 18, 2014	111	208	303	409	

Sort Order: Replicate 1

Clemson University

Weed Control with Tenacity and Pylex

Trial ID: Crab 14-2 Location: Turf Plots Trial Year:
Protocol ID: Crab 14-2 Investigator: L. B. McCarty
Project ID: Study Director:
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	Appl Code	Rep 1	2	3	4	Notes
1	Check							101	207	304	408	
2	Tenacity		L	5	oz/a	POST	AB	102	206	309	402	
3	Tenacity + Princep		L L	5 8	oz/a oz/a	POST	AB	103	210	308	410	
4	Tenacity + Turflon Ester		L L	5 8	oz/a oz/a	POST	AB	104	201	306	404	
5	Tenacity + Spotlight		L L	5 21	oz/a oz/a	POST	AB	105	203	307	403	
6	Pylex		L	1	oz/a	POST	AB	106	209	305	401	
7	Pylex + Princep		L L	1 8	oz/a oz/a	POST	AB	107	204	310	407	
8	Pylex + Turflon Ester		L L	1 8	oz/a oz/a	POST	AB	108	202	303	405	
9	Pylex + Spotlight		L L	1 21	oz/a oz/a	POST	AB	109	205	302	409	
10	MSMA + Sencor	6.6	L L	2 0.33	lb ai/a lb/a	POST	AB	110	208	301	406	

Sort Order: Replicate 1

Clemson University

Crabgrass/Goosegrass Control with Pylex

Trial ID: Goose 14-2 Location: Trial Year:
Protocol ID: Goose 14-2 Investigator: L. B. McCarty
Project ID: Study Director: A. G. Estes
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	Appl Code	Appl Description	Rep 1	2	3	4	Notes
1	Untreated								101	208	312	413	
2	Pylex	2.8	SC	1.5	oz/a	POST	AB	July 10, 2014	102	211	303	406	
	NIS		L	0.25	% v/v								
3	Pylex +	2.8	SC	1.5	oz/a	POST	AB	July 10, 2014	103	215	307	412	
	Princep	4	L	8	oz/a								
	NIS		L	0.25	% v/v								
4	Pylex +	2.8	SC	1.5	oz/a	POST	AB	July 10, 2014	104	201	310	408	
	Velocity	17.6	WDG	6	oz/a								
	NIS		L	0.25	% v/v								
5	Pylex +	2.8	SC	1.5	oz/a	POST	AB	July 10, 2014	105	213	306	414	
	Revolver	0.19	SC	13	oz/a								
	NIS		L	0.25	% v/v								
6	Revolver	0.19	SC	26	oz/a	POST	AB	July 10, 2014	106	216	304	403	
	NIS		L	0.25	% v/v								
7	Pylex +	2.8	SC	1.5	oz/a	POST	AB	July 10, 2014	107	210	314	411	
	Dismiss	4	L	6	oz/a								
	NIS		L	0.25	% v/v								
8	Pylex +	2.8	SC	1.5	oz/a	POST	AB	July 10, 2014	108	212	315	405	
	Xonerate	4	L	5	oz/a								
	NIS		L	0.25	% v/v								
9	Pylex +	2.8	SC	1.5	oz/a	POST	AB	July 10, 2014	109	202	308	401	
	Revolver +	0.19	SC	13	oz/a								
	Dismiss	4	L	6	oz/a								
	NIS		L	0.25	% v/v								
10	Revolver +	0.19	SC	13	oz/a	POST	AB	July 10, 2014	110	204	313	407	
	Sencor	75	WG	0.25	lb/a								
	NIS		L	0.25	% v/v								
11	Pylex +	2.8	SC	1.5	oz/a	POST	AB	July 10, 2014	111	203	302	416	
	Sencor	75	WG	0.25	lb/a								
	NIS		L	0.25	% v/v								
12	MSMA	6.6	L	2	lb ai/a	POST	AB	July 10, 2014	112	205	316	410	
	Sencor	75	WG	0.25	lb/a								
	NIS		L	0.25	% v/v								
13	Dismiss +	4	L	12	oz/a	POST	AB	July 10, 2014	113	209	311	402	
	Sencor	75	WG	0.25	lb/a								
	NIS		L	0.25	% v/v								
14	Dismiss +	4	L	6	oz/a	POST	AB	July 10, 2014	114	206	305	415	
	Sencor	75	WG	0.25	lb/a								
	NIS		L	0.25	% v/v								
15	Dismiss South +	4	L	7.25	oz/a	POST	AB	July 10, 2014	115	214	301	409	
	Sencor	75	WG	0.25	lb/a								
	NIS		L	0.25	% v/v								
16	Pylex +	2.8	SC	1.5	oz/a	POST	AB	July 10, 2014	116	217	309	417	
	Dismiss South	4	L	7.25	% v/v								
	NIS		L	0.25	% v/v								
17	Pylex +	2.8	SC	1.5	oz/a	POST	AB	July 10, 2014	117	207	317	404	
	Dismiss South +	4	L	7.25	oz/a								

Clemson University

Crabgrass/Goosegrass Control with Pylex

Trial ID: Goose 14-2
Protocol ID: Goose 14-2
Project ID:

Location: Trial Year:
Investigator: L. B. McCarty
Study Director: A. G. Estes
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	Appl Code	Appl Description	Rep 1	2	3	4	Notes
	Sencor	75	WG	0.25	lb/a								

Sort Order: Replicate 1

Clemson University

Crabgrass Control with Tenacity, Princep, and Pennant Magnum

Trial ID: Syngenta 14-4 Location: Turf Plots Trial Year: 2014
Protocol ID: Syngenta 14-3 Investigator: L. B. McCarty
Project ID: LPT-2014-T25 Study Director: A. G. Estes
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	Appl Code	Appl Description	Rep 1	2	3	4	Notes
1	Untreated								101	202	310	406	
2	Tenacity +	4	SC	5	oz/a	POST	AB	July 8, 2014	102	201	309	403	
	Princep	4	SC	8	oz/a			July 22, 2014					
	NIS		L	0.25	% v/v								
3	Tenacity +	4	SC	5	oz/a	POST	AB	July 8, 2014	103	205	306	409	
	Princep +	4	SC	8	oz/a			July 22, 2014					
	Pennant Magnum	7.6	SC	21	oz/a								
4	Tenacity +	4	SC	5	oz/a	POST	AB	July 8, 2014	104	206	301	402	
	Princep	4	SC	16	oz/a			July 22, 2014					
	NIS		L	0.25	% v/v								
5	Tenacity +	4	SC	5	oz/a	POST	AB	July 8, 2014	105	207	303	401	
	Princep +	4	SC	16	oz/a			July 22, 2014					
	Pennant Magnum	7.6	SC	21	oz/a								
	NIS		L	0.25	% v/v								
6	Tenacity +	4	SC	5	oz/a	POST	AB	July 8, 2014	106	203	305	407	
	Sencor	75	WG	0.33	lb/a			July 22, 2014					
	NIS		L	0.25	% v/v								
7	Tenacity +	4	SC	5	oz/a	POST	AB	July 8, 2014	107	204	308	405	
	Princep +	4	SC	8	oz/a			July 22, 2014					
	Sencor	75	WG	0.33	lb/a								
	NIS		L	0.25	% v/v								
8	Dismiss +	4	L	12	oz/a	POST	AB	July 8, 2014	108	209	302	408	
	Sencor	75	WG	0.33	lb/a			July 22, 2014					
	NIS		L	0.23	% v/v								
9	Dismiss South +	4	L	7.25	oz/a	POST	AB	July 8, 2014	109	210	304	410	
	Sencor	75	WG	0.33	lb/a			July 22, 2014					
	NIS		L	0.25	% v/v								
10	MSMA +	6.6	L	2	lb ai/a	POST	AB	July 8, 2014	110	208	307	404	
	Sencor	75	WG	0.33	lb/a			July 22, 2014					
	NIS		L	0.25	% v/v								

Sort Order: Replicate 1

Clemson University

Kylinga Control with F7127

Trial ID: FMC 14-6
Protocol ID: FMC 14-6
Project ID:

Location: Trial Year:
Investigator: L. B. McCarty
Study Director:
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	Appl Code	Rep 1	2	3	Notes
1	Check							101	203	302	
2	F 7127	3.5	SC	0.156	lb ai/a	POST	A	102	204	303	
	NIS		L	0.25	% v/v						
3	F 7127	3.5	SC	0.280	lb ai/a	POST	A	103	201	304	
	NIS		L	0.25	% v/v						
4	MSMA	6.6	L	2	lb ai/a	POST	A	104	202	301	
	NIS		L	0.25	% v/v						

Sort Order: Replicate 1

Clemson University

Plant Health Field Studies

Trial ID: Protocol ID:
Location: Study Director: Adam Gore
Project ID: Investigator: L. B. McCarty
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Other Rate	Appl Code	Appl Description	Rep 1	2	3	4	Notes
1	Untreated								101	204	301	407	
2	Turf Screen	1	L	2.5	FL OZ/1000 FT2				102	208	305	408	
3	PAR	1	L	0.37	FL OZ/1000 FT2				103	201	307	401	
4	Title Phyte	1	L	4	FL OZ/1000 FT2				104	202	303	406	
5	Turf Screen	1	L	2.5	FL OZ/1000 FT2				105	206	302	405	
	Title Phyte	1	L	4	FL OZ/1000 FT2								
6	PAR	1	L	0.37	FL OZ/1000 FT2				106	207	306	404	
	Title Phyte	1	L	4	FL OZ/1000 FT2								
7	Signature	80	WG	6	OZ/1000 FT2				107	203	308	402	
8	Aliette	80	WG	4	OZ/1000 FT2				108	205	304	403	
9	Civitas	1	L	16	OZ/1000 FT2				109	309	210	410	
10	Civitas	1	L	16	OZ/1000 FT2				209	409	110	310	
	Harmonizer	1	L	1	OZ/1000 FT2								

Sort Order: Replicate 1

Clemson University

Preemergence Crabgrass Control with Quali-Pro Formulations

Trial ID: Quali Pro 14-1 Location: Trial Year: 2014
Protocol ID: Quali Pro 14-1 Investigator: L. B. McCarty
Project ID: Study Director:
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	Appl Code	Appl Description	Rep 1	2	3	4	Notes
1	Untreated								101	207	304	403	
2	QP Dithopyr	2	EC	16	oz/a	PRE	A	March 11, 2014	102	209	307	409	
	QP Dithopyr	2	EC	16	oz/a	8 WAIT	B	May 23, 2014					
3	QP Dithopyr	2	EC	32	oz/a	PRE	A	March 11, 2014	103	205	302	401	
4	QP Oxadiazon	3.17	SC	121	oz/a	PRE	A	March 11, 2014	104	202	308	406	
5	QP Prodiamine	4	L	32	oz/a	PRE	A	March 11, 2014	105	203	301	405	
6	Dimension	2	L	16	oz/a	PRE	A	March 11, 2014	106	204	309	408	
	Dimension	2	L	16	oz/a	8 WAIT	B	May 23, 2014					
7	Dimension	2	EW	32	oz/a	PRE	A	March 11, 2014	107	206	303	404	
8	Ronstar Flo	3.17	SC	121	oz/a	PRE	A	March 11, 2014	108	201	305	402	
9	Barricade	4	L	32	oz/a	PRE	A	March 11, 2014	109	208	306	407	

Sort Order: Replicate 1

Clemson University

Specticle Products for Control of Crabgrass

Trial ID: Bayer 14-5
Protocol ID: Bayer 14-4
Project ID: HE14USAMQA

Location: The Rock Trial Year:
Investigator: L. B. McCarty
Study Director: A. G. Estes
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	Appl Code	Appl Description	Rep 1	2	3	4	Notes
1	Untreated								101	202	303	402	
2	Specticle .0142% on Fert	0.0142	GR	271.8	lb/a	PRE	A	March 19, 2014	102	201	305	404	
3	Specticle .0142% on Fert	0.0142	GR	200	lb/a	PRE	A	March 19, 2014	103	204	302	405	
4	Specticle Flo		SC	8	oz/a	PRE	A	March 19, 2014	104	205	301	403	
5	Barricade .22% + Fert	0.22	GR	200	lb/a	PRE	A	March 19, 2014	105	203	304	401	

Sort Order: Replicate 1

Clemson University

Split Applications of Specticle for Crabgrass Control

```
   Trial ID: Bayer 14-7          Location:   Trial Year:
Protocol ID: Bayer 14-6      Investigator: L. B. McCarty
 Project ID: HE14USAMQD    Study Director: A. G. Estes
                          Sponsor Contact:
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Trt No.	Treatment Name	Form Type	Rate	Rate Unit	Growth Stage	Appl Code	Appl Description	Rep 1	2	3	4	Notes
1	Untreated							101	204	306	403	
2	Specticle FLO	SC	9	oz/a	PRE	A	March 18, 2014	102	201	307	402	
3	Specticle FLO	SC	6	oz/a	PRE	A	March 18, 2014	103	205	302	406	
	Specticle FLO	SC	3	oz/a	30 DAPA	B	April 21, 2013					
4	Specticle FLO	SC	4.5	oz/a	PRE	A	March 18, 2014	104	203	305	404	
	Specticle FLO	SC	4.5	oz/a	30 DAPA	B	April 21, 2013					
5	Specticle FLO	SC	3	oz/a	PRE	A	March 18, 2014	105	206	301	407	
	Specticle FLO	SC	3	oz/a	30 DAPA	B	April 21, 2013					
	Specticle FLO	SC	3	oz/a	30 DAPA	C	May 23, 2014					
6	Specticle FLO	SC	3	oz/a	PRE	A	March 18, 2014	106	207	303	405	
	Specticle FLO	SC	1.5	oz/a	30 DAPA	B	April 21, 2013					
	Specticle FLO	SC	1.5	oz/a	30 DAPA	C	May 23, 2014					
	Specticle FLO	SC	1.5	oz/a	30 DAPA	D	June 26, 2014					
	Specticle FLO	SC	1.5	oz/a	30 DAPA	E	July 23, 2014					
7	Specticle FLO	SC	3	oz/a	PRE	A	March 18, 2014	107	202	304	401	
	Specticle FLO	SC	1	oz/a	30 DAPA	B	April 21, 2013					
	Specticle FLO	SC	1	oz/a	30 DAPA	C	May 23, 2014					
	Specticle FLO	SC	1	oz/a	30 DAPA	D	June 26, 2014					
	Specticle FLO	SC	1	oz/a	30 DAPA	E	July 23, 2014					
	Specticle FLO	SC	1	oz/a	30 DAPA	F	TBD					
	Specticle FLO	SC	1	oz/a	30 DAPA	G	TBD					

Sort Order: Replicate 1

Clemson University

Postemergence doveweed control - Clemson

Trial ID: Clemson 14-1 Location: Clemson, SC Trial Year: 2014
Protocol ID: Clemson 14-1 Investigator: L. B. McCarty
Project ID: Study Director: J. L. Atkinson
Sponsor Contact:

Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Other Rate	Other Rate Unit	Appl Code	Rep 1	2	3	4	Notes
1	Untreated								101	206	308	407	
2	Celsius	68	WG	3.7	oz wt/a	176	g ai/ha	A	102	205	302	408	
	NIS			0.25	% v/v			A					
3	Tribute Total	60.5	WG	3.2	oz wt/a	136	g ai/ha	A	103	211	305	409	
	NIS			0.25	% v/v			A					
4	Blindside	66	WG	0.413	lb ai/a	463	g ai/ha	A	104	201	309	404	
	NIS			0.25	% v/v			A					
5	Speedzone	2.2	L	3	pt/a	920	g ai/ha	A	105	208	301	411	
	NIS			0.25	% v/v			A					
6	Atrazine	4	L	2	lb ai/a	2240	g ai/ha	A	106	209	310	403	
7	Celsius	68	WG	3.7	oz wt/a	176	g ai/ha	A	107	202	311	401	
	NIS			0.25	% v/v			A					
	Celsius	68	WG	3.7	oz wt/a	176	g ai/ha	B					
	NIS			0.25	% v/v			B					
8	Tribute Total	60.5	WG	3.2	oz wt/a	136	g ai/ha	A	108	210	303	406	
	NIS			0.25	% v/v			A					
	Tribute Total	60.5	WG	3.2	oz wt/a	136	g ai/ha	B					
	NIS			0.25	% v/v			B					
9	Blindside	66	WG	0.413	lb ai/a	463	g ai/ha	A	109	203	307	402	
	NIS			0.25	% v/v			A					
	Blindside	66	WG	0.413	lb ai/a	463	g ai/ha	B					
	NIS			0.25	% v/v			B					
10	Speedzone	2.2	L	3	pt/a	920	g ai/ha	A	110	204	306	405	
	NIS			0.25	% v/v			A					
	Speedzone	2.2	L	3	pt/a	920	g ai/ha	B					
	NIS			0.25	% v/v			B					
11	Atrazine	4	L	2	lb ai/a	2240	g ai/ha	A	111	207	304	410	
	Atrazine	4	L	2	lb ai/a	2240	g ai/ha	B					

Sort Order: Replicate 1

Doveweed (*Murdannia nudiflora* (L.) Brenan) biology, ecology, and control

J. L. Atkinson*, L. B. McCarty, W. Bridges, F. Yelverton, S. McElroy

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Traditional measures for summer annual weed management in fine turf have provided little doveweed control because of doveweed's late germination period and limited post-emergence control options. Doveweed's germination period begins ~1 to 2 months after summer annual weeds traditionally targeted by early-spring pre-emergence herbicide application. Further, field reports of postemergence control are inconsistent.

Research in Clemson, South Carolina and Augusta, Georgia aimed to identify environmental conditions that favor doveweed germination, growth, and spread in addition to herbicide selection and application strategies to improve the understanding of this species.

Greenhouse and growth chamber research has focused on identifying soil and environmental conditions that promote doveweed seed germination and plant growth. The effect of soil water availability, salt concentration, pH, and nitrate level on doveweed germination was evaluated by adding 5 mL of each treatment solution to a 9 cm diameter petri dish containing two sheets of filter paper and 50 doveweed seeds. Germinated seeds were counted every 2 d for 14 d after first germinated seed was observed.

Environmental conditions evaluated included mowing height and effect of soil moisture on doveweed growth and development. Four mowing heights were evaluated (0.5, 1.5, 3 inch, and unmown), and their effect on doveweed spread measured by determining percent coverage of a 1.5 m x 1.5 m grid-square using the line intersect method. Plots were mown twice weekly and percent coverage calculated weekly. The effect of soil moisture was determined by growing doveweed in pots irrigated to 12.5, 25, 50, 75, or 100% field capacity every 3 d after gravimetrically determining soil water content. At maturity, plants were harvested and shoot weight determined.

Numerous pre- and post-emergence herbicides were evaluated for doveweed control efficacy. Greater than 80% control has been achieved with Specticle Flo applied at 9 fl oz/a and Tower applied at 32 oz/a for 10 and 6 weeks after treatment, respectively, when applied on May 1 in Augusta, GA. Approximately 6 weeks of >75% doveweed control in heavily infested Tifway bermudagrass has been achieved with sequential applications on three week intervals of Celsius applied at 3.7 oz/a, Tribute Total applied at 3.2 fl oz/a, Speedzone at 3 pt/ac, and Blindside applied at 10 oz/ac. Further results will be discussed at field day.

CHARACTERIZATION AND CONTROL OF *OPHIOSPHAERELLA SPP.* CAUSING SPRING DEAD SPOT OF BERMUDAGRASS IN SOUTH CAROLINA & ARGENTINA

Alejandro Canegallo , Bruce Martin (Clemson University Pee Dee REC, Florence SC), Bert McCarty , Paula Agudelo , Julia Kerrigan (Clemson University, Clemson SC), Lane Tredway (Syngenta Lawn and Garden), and Wonkeun Park (Clemson University Pee Dee REC, Florence SC)

Spring dead spot is the most devastating disease of Bermudagrass in North America, Australia and Argentina. Symptoms are round and sunken patches and rings, bleached to straw in color that develop when bermudagrass breaks dormancy during the spring.

This patch disease is caused by the ectotrophyc root infecting fungi *Ophiosphaerella korrae, O. herpotricha,* and *O. narmari*; isolated from symptomatic roots of susceptible hosts including common (*Cynodon dactylon*) or hybrid bermudagrass (*C. dactylon x C. transvaalensis*) and zoysia grass (*Zoysia* spp.) . Samples from symptomatic turf were taken, washed and diseased roots were selected and cultured in a specific media to grow *Ophiosphaerella* species. After fungal growth, hyphae resembling *Ophiosphaerella* species were transferred to new media to obtain pure cultures. Cultures were then transferred to potato dextrose broth media to obtain clean fungal hyphae for DNA extraction. Analysis of nucleotides from the nuclear ribosomal DNA (rDNA), which contains the three rDNA genes 28S, 5.8S and 18S and a non-coding or space regions ITS1 and ITS2 was performed on the samples using species specific primers for the various causal agents.

In South Carolina, 273 samples were taken from symptomatic turf out of 23 locations visited throughout the state. Of these, 221 cultures were obtained resembling *Ophiosphaerella spp*. and transferred to pure culture. 207 out of the 221 samples were positive for *Ophiosphaerella korrae.* In Argentina, 238 samples were taken from 21 locations from symptomatic common and hybrid bermudagrass turf on fairways and putting greens of 15 golf courses, 5 polo fields and one sod farm. Diseased roots were cultured and growth of 145 suspected cultures was transferred to new media. DNA was extracted and analyzed from 102 isolations, with 101 identified as *Ophiosphaerella herpotricha*. Sequencing of those amplifications will be done to determine relatedness between isolations.

Amplified fragment length polymorphism (AFLP) technique was also performed to determine species distribution patterns or potential correlations with cultivars and locations from samples from both Argentina and South Carolina.

A field experiment with three factors in a randomized complete block design with 4 replications was established at Pilara Golf Club, Pilar, BA (Argentina) in 2012. The purpose of the field trials were to evaluate the effects of nitrogen fertilizers, fungicide applications and cultural practices to develop best practices for management of SDS. 2014 will be the third year to complete the visual and digital image analysis to differentiate the area affected by the disease.

Mini-Ring: Pathogen identification and development of management practices to control and prevent the disease

Dant L.A., Martin S.B., McCarty L.B., and Kerns J.P

A turf disease now known as "mini-ring" (also called *Rhizoctonia* leaf and sheath spot) was first reported on bermudagrass putting greens in 1999. It has become more common in the southeast United States as golf courses convert from creeping bentgrass to ultradwarf bermudagrass putting surfaces. Mini-ring symptoms typically resemble "frog-eye" patches that measure 4-18 inches in diameter and generally appear mid- to late-July and may persist until bermudagrass dormancy. Infected turf may not recover in the fall; therefore, scars can be present through the winter into the following spring. Fungicidal control of mini-ring has been inconsistent and largely ineffective in recent research trials conducted in North Carolina and South Carolina. Initial isolations from diseased turf indicate that the causal agent may be *Rhizoctonia zeae* Voorhees, but this diagnosis has not been confirmed using molecular techniques. The objective of the current research is to: 1) Collect several geographically diverse isolates from symptomatic turf and identify the pathogen which causes mini-ring; 2) Genetically compare the causal agent of mini-ring to previously characterized *Rhizoctonia* spp. isolates; 3) Infect bermudagrass turf using mini-ring isolates to reproduce mini-ring symptoms; and 4) Determine optimal conditions for mini-ring infection including: environmental conditions, turf fertility, and agronomic practices that may promote the pathogen. The desired outcome of this research is to develop comprehensive management practices that control and prevent the pathogen which causes mini-ring.

UNDERSTANDING NEMATODE DAMAGE THRESHOLDS

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Turfgrass managers rely on nematode thresholds to make important decisions such as when to make costly nematicide applications. However, many people fail to understand how thresholds are determined and how they should be used to develop an overall management strategy for controlling plant-parasitic nematodes. An extensive literature review found no published research establishing thresholds for the sting nematode *Belonolaimus longicaudatus*. In South Carolina that threshold is only 17 nematodes per 100 cc of soil for bermudagrass. How are thresholds determined? Are they accurate? How should you evaluate your nematode assay report? This poster will answer these questions and more.

Get a free copy of *Nematode Guidelines for South Carolina* by scanning this image using a QR scanner on your smart phone.

Monitoring Electrical Conductivity of Tidally Influenced Surface Water for Irrigation Scheduling

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Yeamans Hall Club is located in Hanahan, South Carolina. Goose Creek (a tributary of the Cooper River) and it's tidally influenced marshes surround the Yeamans Hall Club on the North and East perimeter. The irrigation pond is primarily fed by a spring located in an adjacent pond (Cypress Pond), rain and associated stormwater runoff. However the irrigation pond also abuts the marsh. Salt water intrusion is minimized by a manmade dike, however in March 2012, it was determined that saltwater was still entering the pond causing the irrigation water to have salt concentrations greater than 600 ppm. Unfortunately, before it was determined that the water had become contaminated with salt, the turfgrass became stressed and in some areas, died due to using the water. Fortunately, once the water was identified as the problem, the club switched to using city water, until salt levels declined in the pond.

Yeamans Hall Club recognizes the importance of being good stewards of the environment and the importance of conserving potable water sources for essential uses. Thus in an effort to reduce their dependency on city water for irrigation, the club wanted to determine a way to monitor and manage the tidally influenced water from their main irrigation pond. On June 14th, 2013 Clemson scientists installed sensors in the main irrigation pond, and in the adjacent spring-fed pond to monitor electrical conductivity and water depth.

Over the past 1.5 months measurements have been recorded every 15 minutes. Data suggests that (a) during spring high tides (new and full moon) saltwater intrusion is greatest into the irrigation pond, otherwise, electrical conductivity is within a manageable range in the irrigation pond, (b) water in the Cypress Pond is not contaminated with salts, thus the spring which feeds the pond currently does not have saltwater intrusion, and subsequently (c) that the saltwater intrusion is only coming from the marsh. Over the next few months, data will continue to be collected and the team will determine an irrigation schedule customized for this source. The schedule will be based off of tidal charts and sensor data, and how to know timing and quantity of water to release from the Cypress Pond to minimize salinity in the irrigation pond.

Please see the poster for sample data and more information.

Development of Water Management and Drought Response Industry Standards for South Carolina Golf Courses

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The Carolina Golf Course Superintendents Association (CGCSA) and South Carolina Department of Health and Environmental Control (SCDHEC) agreed on the importance of South Carolina golf courses to develop every-day water conservation plans and drought response procedures.

Doug Lowe, Clemson University and CGCSA have worked together to develop two documents that are currently in review with the South Carolina Directors of the CGCSA. After approval, they will be sent to SCDHEC for further review. The first document entitled The Carolinas Golf Course Superintendents Association Water Conservation Plan and Drought Response Procedures, lays the foundation for all SC golf courses that are members of the CGCSA to follow regarding general water management strategies. The document includes an overview of water conservation strategies that are always implemented on a golf course, regardless of drought conditions. In addition, the document also outlines how golf courses will respond to different drought phases issued by local municipalities. Under this document, among other actions, member golf courses agree to reduce water for irrigation purposes by 15, 20 and 25% for moderate, severe, and extreme drought phases respectively, as defined by the SC Drought Response Committee.

The second document is a template for SC golf courses to use for when developing Drought Operations and Contingency Plans (OCPs). The OCPs are a more detailed version of the first document, requiring specific information about the golf course facility and water conservation practices. An OCP is required for all SC golf courses that are reporting water use to SCDHEC and or are applying for a change or new water withdrawal permit.

View a draft and learn more about the documents at stop # 2.

Water Quality Flow Chart for Evaluation of Irrigation Water pH, Alkalinity, and Salts.

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As demand and competition for high quality, potable water increases in South Carolina, proper irrigation management is becoming critical. Identifying all potential stressors and accurate interpretation of water quality reports is essential to identifying proper management strategies to optimize both soil and turfgrass health. Interpretation of irrigation water quality reports is complex, making interpretation and selection and implementation of appropriate management options difficult. This poster will (a) review potential stressors that must be considered when assessing irrigation quality, and (b) an easy to follow flow chart that has been developed for identifying common irrigation water quality issues will be introduced. Collectively, turfgrass managers will be able to make informed management decisions to increase turf and soil quality, and reduce potential contamination and minimize pressure on natural water sources.

Learn how to use the flow chart at stop 2.

Over-expression of *AsHSP17*, a creeping bentgrass (*Agrostis stolonifera*) small heat shock protein, increases abiotic stress sensitivity in transgenic *Arabidopsis thaliana*

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Abstract: Heat shock proteins (HSPs) are universal stress proteins that accumulate in response to heat and other abiotic stressors. Small heat shock proteins (sHSPs) are the most ubiquitous HSP subgroup with molecular weights ranging from 12 to 42 kDa. We have cloned a new sHSP gene, *AsHSP17* from creeping bentgrass (*Agrostis stolonifera*) and studied the role it plays in plant response to environmental stress. *AsHSP17* encodes a protein of 17 kDa. Its expression was strongly induced in both leaf and root tissues by heat treatment. *AsHSP17* was also induced slightly in root by salt and abscisic acid (ABA) treatment, but not by water withholding. No expression was found in leaf tissue under salt, drought and ABA treatment. These results indicate that *AsHSP17* accumulates in response to heat, salt and ABA but not in response to drought. Transgenic *Arabidopsis* plants overexpressing *AsHSP17* exhibited higher sensitivity to heat stress than wild-type controls. Overexpression of *AsHSP17* also led to decreased seed germination in transgenic plants under salt and ABA treatment. The results obtained so far suggest that AsHSP17 may be a negative regulator involved in plant response to adverse environmental stresses. This information would allow development of molecular strategies manipulating sHSP expression in transgenic plants, achieving improved plant resistance to various abiotic stresses in crop species.

Constitutive Expression of *Osa-miR528* Alters Plant Development and Enhances Plant Tolerance to Salinity Stress and Nitrogen Starvation in Transgenic Creeping Bentgrass

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ABSTRACT

One of the adaptive mechanisms that plants have evolved in stress response is mediated by microRNAs (miRNAs). Large-scale expression analyses reveal that a conserved monocot-specific miRNA, miR528 has the potential of mediating multiple stress responses. So far, however, the experiment support is lacking. To determine the role miR528 plays in plant response to abiotic stress, and the underlying molecular mechanisms, we analyzed its impacts on a perennial monocot crop species, creeping bentgrass (*Agrostisstolonifera* L.). Our stem-loop RT-PCR analysis demonstrates that the expression of miR528 was up-regulated under salt and drought stresses, but down-regulated under N deficiency in the wild type (WT) creeping bentgrass. Furthermore, we generated transgenic creeping bentgrass plants overexpressing a rice miR528 (*Osa-miR528*). Our data indicate that both plant development and stress response have been altered in transgenic plants. Morphologically, transgenic plants display shorter internodes, more tillers and upright growth than WT controls. Resistance to salt stress and N deficiency was enhanced in transgenics. Improved salt stress resistance was associated with increased water retention, cell membrane integrity, and chlorophyll content, while enhanced tolerance to N deficiency was associated with increased biomass, total nitrogen and chlorophyll content. Gene expression analysis identified four putative target genes, *AsASO*, *AsLAC11*, *AsCSD2*, and *AsLPR1*, which function in oxidation-reduction. Additionally, the expression level of *AsNir* encoding for nitrite reductase is increased in transgenic plants compared to WT controls, which might contribute to enhanced N use efficiency. The data obtained indicate the potential of manipulating *miR528* in improving plant abiotic stress resistance.

Evaluation of foliar N regime and reduced aeration on 'TifEagle' and 'Champion' ultradwarf bermudagrass in the transition zone

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Superintendents and golf course managers are constantly searching for ways to reduce costs without reducing turfgrass health or performance. Proper management of golf course greens includes regular fertilization and yearly aeration to maintain turfgrass health and playability. Turf managers could try to decrease cost by reducing the amount of inputs from fertilization or labor from reduced aeration regimes. To investigate the effects nitrogen (N) fertilization and reduced aeration on warm-season golf course greens in the transition zone, a two year study was initiated during summer of 2012 and continued through the fall of 2013. The study was a split-plot design investigating two cultivars ('Champion' and 'TifEagle' bermudagrass), two nitrogen fertility programs (196 and 392 kg N ha annually)and two hollow tine aeration regimes (1x and 2x per season). Urea nitrogen was applied foliarly on a 7-10 d interval with a CO_2 packback sprayer during the growing seasons. Parameters measured were turf quality, chlorophyll content, ball roll distance, thatch depth and organic matter. Turf quality responded significantly to all three main effects with TifEagle, 2x per year aeration, and the 392kg N rate having significantly higher TQ than their respective treatments. Ball roll distance was significantly decreased with the increased N rate. Thatch depth was affected by the main effect of Cultivar with TifEagle revealing reduced thatch compared to Champion. Organic matter measured by loss on ignition revealed Cultivar and Aeration Rate significantly affected the organic matter, with TifEagle and the 2x per year aeration rate having lower total organic matter. There was not a significant interaction between any of the main effects. The results suggest that with by reducing your N input or aeration rate your turfgrass health will suffer over time leading to increased organic matter and decreased turf quality. Ultradwarf bermudagrass putting greens in the transition zone should be hollow tine aerated $\geq$ 2x per year accompanied with a balanced fertility program between 4lb and 8lb of N per year to aid turfgrass health without reducing playability.

Poster Presentation.

Investigation of turfgrass leaf morphological and cuticular differences and their relationship to hydrophobicity of foliar applications

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Foliar applications of fertilizers and pesticides are common in turfgrass management. The quick response time, accuracy and ability to tank mix products make foliar applications cost effective and increase labor efficacy. Understanding the mechanisms involved in the uptake of the chemicals is pivotal to increasing uptake and reducing overall losses. The hydrophobicity of surfaces is commonly related to the surface roughness of the surface. A study was initiated to investigate the characteristics of the plant leaf that affect the hydrophobicity of the leaf and develop a model to determine which variables are most important to the repellency of foliar applications. Tall fescue and St. Augustine turfgrasses were studied first to develop methodologies and parameters that will be utilized for further species. Leaf morphology results showed tall fescue to have a rougher surface, because of the ridges that can be seen on the tall fescue morphology. But the cuticle morphology revealed that both species had wax platelets on their cuticle surface, and St. Augustine's cuticle had a higher crystalloid density and larger crystalloids compared to tall fescue creating a rougher micro-surface. These crystalloids are dependent upon the chemical constituents of the cuticle and the analyses of individual cuticles are in the process of being evaluated. The hydrophobicity, measured by the contact angle of a water droplet at the interface between the leaf and droplet, revealed St. Augustine to have significantly more hydrophobic leaf surface compared to tall fescue. This hydrophobicity is most likely caused by the cuticle morphology which is control by the cuticle composition. Even though tall fescue revealed a rougher leaf morphology, the ridges are large enough that the water droplet falls between them, reducing the contact angle and increasing the wettability of the leaf. Future work needs to be conducted investigating more parameters, such as stomatal density, as research has shown the stomatal pathway is major for foliar uptake. Also the relationship between hydrophobicity and foliar uptake needs to be confirmed, with tests using radio-labeled solutions and florescent microscopy.

Thanks for the funding from USGA and Carolinas Gold Course Superintendents Association (CGCSA)

Poster Presentation.

Winter frost traffic impacts on 'Crenshow' creeping bentgrass putting green in the transition zone

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Winter frosts often cause cancellations or delays of tee time resulting in lost revenue. In response to this winter golf course management issue, a field trial was conducted at Clemson University from January 2014 to March 2014 on a 'Crenshow' creeping bentgrass putting green to investigate the effects of winter frost traffic on bentgrass performance. Treatments consisted of no traffic (control), 3x rolling traffic, 6x rolling traffic or 9x rolling traffic (A modified roller stimulating a golfer or worker) at 08:00 am on mornings of heavy frost or temperatures below 32 F. Data collections included weekly readings of visual turfgrass quality (TQ), chlorophyll index (CI) and ball roll distance (BRD) throughout the study. The three levels of traffic decreased TQ and CI, but increased BRD. TQ and CI were decreased more badly by 6x and 9x traffic than 3x traffic. All the three levels of traffic increased BRD, but there was no difference within the three levels. This study indicates that a linear decreased relationship was identified from no traffic to the most severe traffic impact for TQ and CI.

Thanks for the funding from USGA Green Section.

Poster Presentation.

Nitrogen uptake of foliar-applied different Nitrogen sources on creeping bentgrass under greenhouse conditions

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Absorption of foliar-applied nitrogen is complicated since the absorbed forms including a cation as NH_4^+, an anion as NO_3^-, and organic forms as urea and amino acids. A project was conducted at Clemson University from January 2014 to May 2014 on creeping bentgrass to investigate the leaf N metabolism of different N sources at a molecular level-urease enzyme activity (UEA) and total amino acid (TAA) under greenhouse conditions. Six different N sources, including Urea, NH_4Cl, $NaNO_3$ and three commercially available N products UMAXX, UFLEXX, and HYDREXX, were foliar-applied at 0.2 lbs N/1000 ft^2 with a spray chamber. Timing of leaf tissue sampling was at 3, 6 and 9 weeks after foliar application and leaf tissue were used for testing UEA, TAA and total N content (TNC). Turf Quality (TQ) was recorded weekly throughout the study. N sources differently increased UEA at week 3 and week 6, but had no effect for TAA and TNC. UMAXX, FLEXX, HYDREXX and Urea had higher UEA than other N sources and control at week 3. At week 6, Urea had a little lower UEA than UMAXX and HYDREXX, but higher than other N sources and control. All N sources showed higher TQ than control in the first two weeks, but Urea, NH_4Cl and $NaNO_3$ had a gradually decreased TQ compared to UMAXX, UFLEXX, and HYDREXX, which oppositely showed a more consistent higher TQ throughout the study. This study indicates that a higher turf quality may benefit from a more consistent release of N and a higher level of N metabolism.

Thanks for the funding from Koch Agronomic Services, LLC.

Fertilizer Burn Potential and Color Response for 'TifWay' 419 Bermudagrass Fairway As Affected By N Sources with Carbon and Rates

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'TifWay' 419 bermudagrass is a popular warm season turfgrass for both golf courses and sports fields. Proper fertilization is essential to the grass's optimal health, but incorrect fertilizers and application rates can be detrimental to the turf. This study was performed using various fertilizers at two different nitrogen levels to determine the burn potential of the turf under these varying treatments. Fertilizers were applied under conditions that maximize burning potential. There was heavy dew and the fertilizer was NOT watered in after the application.

Burn ratings are presented for the selected fertilizers at the 3 pound nitrogen rate because of their higher tendency to burn. With the exception of Scott's Turf Builder and CAS 5%/STB at the 3 lbs. N/ 1000 ft2, the general trend is for the turf to show symptoms of burning before the signs gradually fade. Both Turf Builder and CAS 5%/STB at the 3 lbs. N/ 1000 ft2 rate had comparable burn levels at 14 days after treatment compared to the initial burn levels 1 day after treatment. Initially, the fertilizers that showed the highest burn potential were Scott's Turf Builder, ammonium sulfate, and CAS 5%/STB .

Thanks to Sulvaris, Canada for the funding.

Poster Presentation.

Clemson Turf Major Internship Program

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In the past two years (2013-2014), we have had a total of 16 turf interns in the turf related areas located in six states of SC, NC, and MA with 14 interns on golf courses, 2 with sports fields, and 1 in landscape management. The working experiences of our interns obtained from all aspects of turf management with a total estimated of more than 10,000 working hours input by these interns! The supervisors have spent hundreds of hours together with interns for providing advising and training.

We Clemson faculty members and interns would like to take this opportunity to thank all the intern sponsors for the great opportunities provided to our students and these internship experiences they obtained cannot be gained from regular classrooms and are invaluable for our students' current leaning and future careers. We thank you so much and hope for the continued support for the future internships and we also look for new internship sponsors as well to further broaden our internship experiences.

In the past 13 years, the turf major internship has become a required course for the turf majors at Clemson and we have had over 240 students finished their internships in close to 30 different states including some international internships. The connections through those internships have helped our students for their future employment and their career development. We want to thank many golf courses and sports fields who have hosted multiple Clemson turf majors for their internship programs and such great connection and support are so important and essential for our turfgrass education program at Clemson to be successful.

We thank Clemson Turf Major Internship Sponsors and look forward to sending more interns to your programs.

For more information, please contact Dr. Haibo Liu (haibol@clemson.edu).

Poster Presentation.