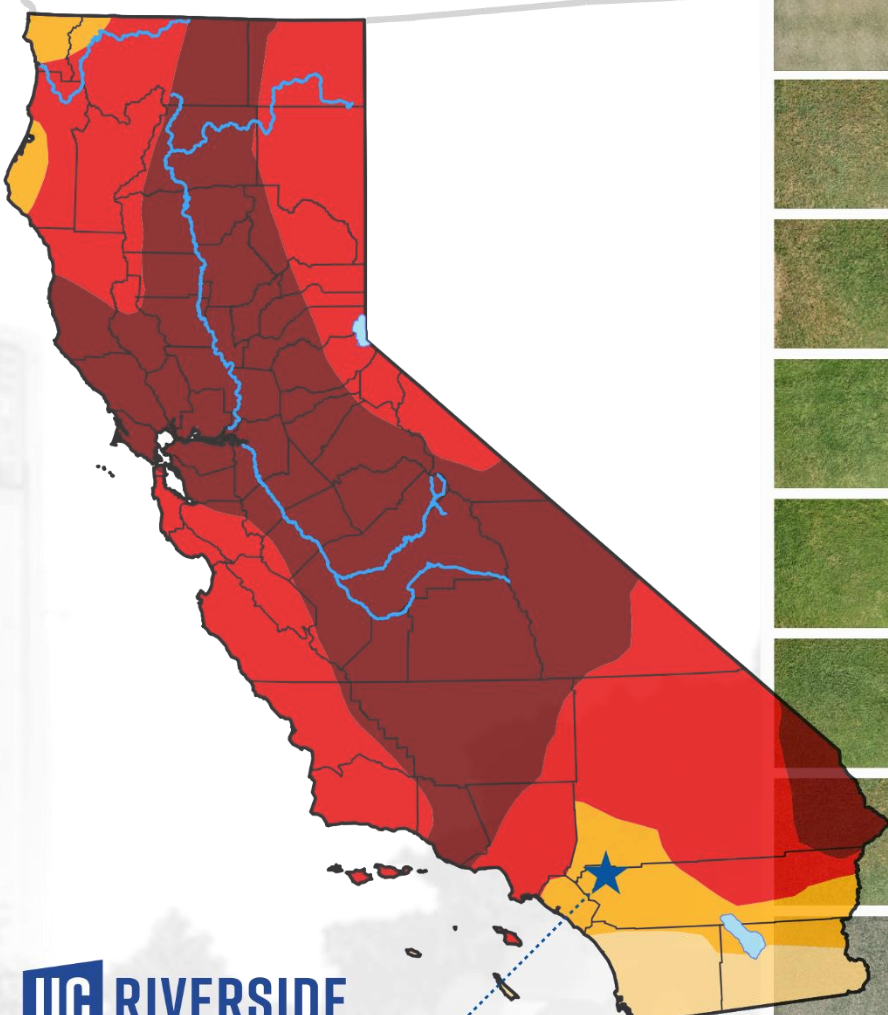
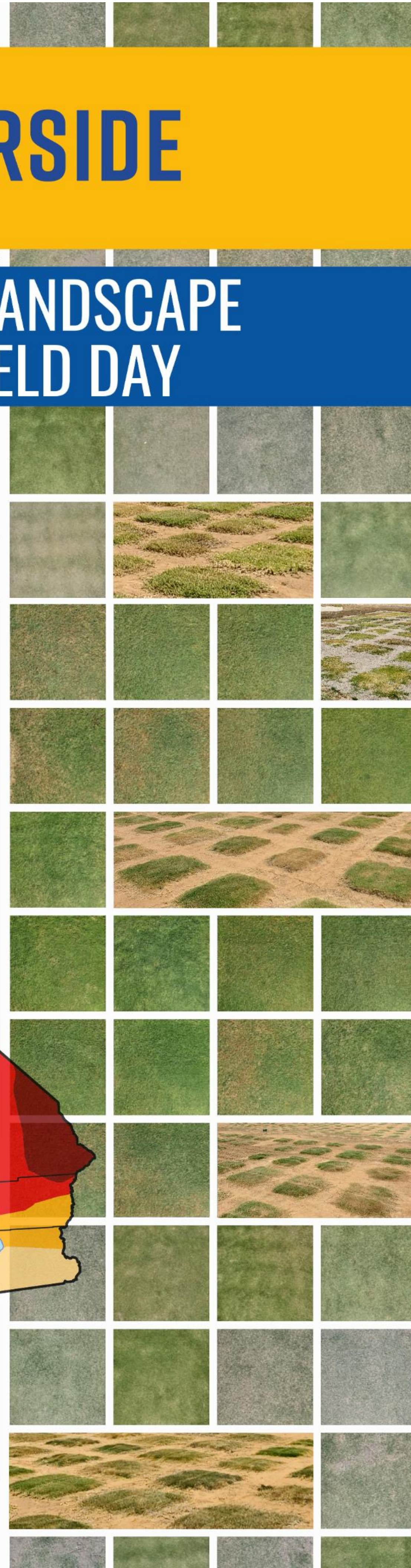
UC RIVERSIDE

TURFGRASS & LANDSCAPE RESEARCH FIELD DAY

September 16, 2021





UC RIVERSIDE
Turfgrass Science

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

CA TURFGRASS & LANDSCAPE FOUNDATION
"Keeping California Green and Growing"

College of Natural and Agricultural Sciences
UC Division of Agriculture and Natural Resources
Agricultural Experiment Station and Cooperative Extension

Department of Botany and Plant Sciences-072
Riverside, CA 92521-0124

Welcome to Field Day!

On behalf of the entire UCR Turfgrass and Landscape Team, welcome (back) to the 2021 UCR Turfgrass and Landscape Research Field Day. Not excluding last year's virtual tour, this marks the 14th consecutive year of this event under my watch. We missed seeing everyone in person last year and hope that both you and yours are healthy and vaccinated, if possible. We continue to strive to make Field Day one of the pinnacle events of our industry – a place where all come together annually to see old friends, share ideas, and learn about world-class research activities at UCR.

Today, you will see and hear about cutting edge new and longstanding research that addresses turfgrass selection, pest, water, and salinity management issues to help mitigate stresses on turf and landscape plants. Especially in light of the severity of the current drought, we are excited to show you our new hybrid bermudagrasses that are nearing release. In particular, UCR 17-8 bermudagrass is capable of maintaining green color and quality under irrigation as low as 30% of reference evapotranspiration (ETo). That's easily 50-70% less water required compared to tall fescue! Even more than that, we have identified products on display at Field Day that can help turf look good with comparable reductions in water use. For the tenth consecutive year, we welcome several of our industry partners under the Exhibitor's Tent. Please take the time to visit them and learn more about new products and services while enjoying complimentary food and beverages. Last but not least, while this handout serves to give you a brief synopsis of our current research activities for the research tours, you can read or print our full research reports in their entirety from our website, **turfgrass.ucr.edu**.

As you enjoy today's tours, please take a moment to thank those folks, mostly wearing bright yellow shirts with our Turfgrass Science logo, who assisted with preparation for this event. Special thanks go to my fellow Field Day planning committee members including Marta Pudzianowska, Peggy Mauk, Sue Lee, Steve Ries, Sherry Cooper, Julia Kalika, and Kellie McFarland. Production of this publication, signs, and online reports would not have been possible without assistance from Dr. Marta Pudzianowska. Staff and students from UCANR, Agricultural Operations and my lab have worked tirelessly to make this event possible and are deserved of your appreciation. Last but not least, very special thanks to all of our industry partners for their generous donations to our turf and landscape programs throughout the year, and especially for today's delicious food and beverages under the shade of tents!

Enjoy Field Day! And we hope to see you again next year on **Thursday, September 15, 2022**.

Sincerely,

James H. Baird, Ph.D.
Associate Specialist in Cooperative Extension and Turfgrass Science

2021 Turfgrass and Landscape Research Field Day Sponsors

(as of September 10, 2021)

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- Wilbur Ellis
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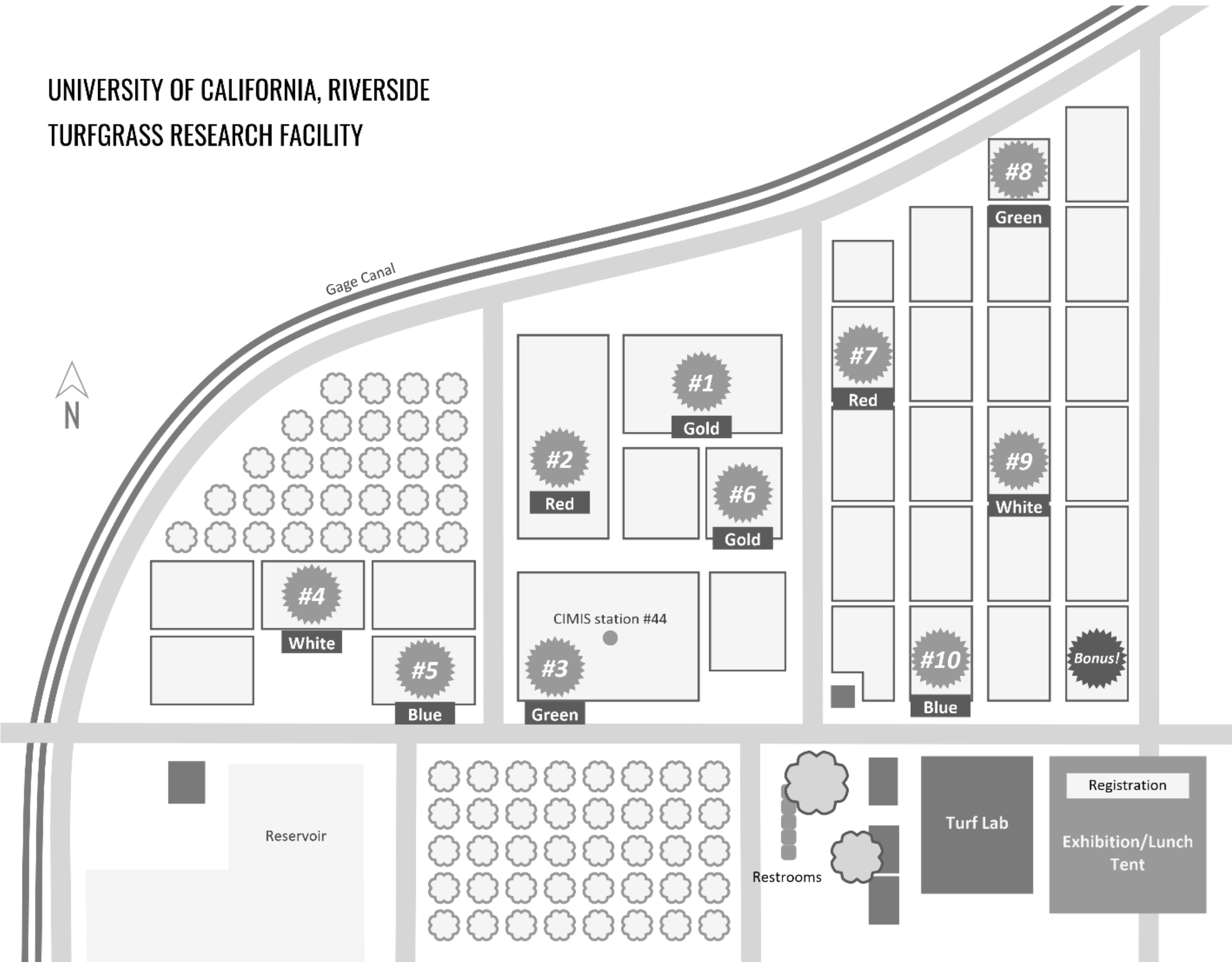

UNIVERSITY OF CALIFORNIA, RIVERSIDE
TURFGRASS RESEARCH FACILITY
N
Gage Canal
#1
Gold
#2
Red
#6
Gold
#7
Red
#8
Green
#9
White
#4
White
#5
Blue
CIMIS station #44
#3
Green
#10
Blue
Bonus!
Reservoir
Restrooms
Turf Lab
Registration
Exhibition/Lunch Tent

2021 Turfgrass and Landscape Research Field Day Agenda

8:00 AM	**Exhibitor Set-Up**
8:30-9.30 AM	**Registration and Trade Show Open**
	Bonus Stop (at your leisure) **Selective Control of Kikuyugrass and Seashore Paspalum in Bermudagrass** Jim Baird
9:30 AM	**Welcome and Introductions** Peggy Mauk and Jim Baird
9:40-11:00 AM	**Field Tour Rotation (20 minutes per Stop; choose 4 stops)**
Stop #1 *Gold tent*	**Warm-Season Turfgrass Breeding – Evaluation of Bermudagrass, Zoysiagrass, Seashore Paspalum, and St. Augustinegrass Lines Under Salinity Stress** Adam Lukaszewski, Marta Pudzianowska, and Christian Bowman
Stop #2 *Red tent*	**Evaluation of Products for Water Conservation on Bermudagrass Turf Using a Linear Gradient Irrigation System** Matteo Serena
Stop #3 *Green tent*	**Management of Pacific Shoot-Gall Disease in California Putting Greens** Ole Becker
Stop #4 *White tent*	**Evaluation of Fungicides for Control of Anthracnose and Dollar Spot Diseases; UCR TP6-3 Bermudagrass Overview** Jim Baird
Stop #5 *Blue tent*	**Postemergence Control of Crabgrass in Bermudagrass Turf** Pawel Orlinski
11:00-11:30 AM	**Break and Trade Show**
11:30-12:50 PM	**Field Tour Rotation (20 minutes per Stop; choose 4 Stops)**
Stop #6 *Gold Tent*	**Evaluation of Fungicides for Control of Rapid Blight and Summer Patch Diseases** Jim Baird
Stop #7 *Red Tent*	**USGA/NTEP Warm-Season Water Use Trial** Bernd Leinauer and Elena Sevostianova
Stop #8 *Green Tent*	**Curative Effects of Soil Surfactants for Localized Dry Spots on Putting Greens** Matteo Serena
Stop #9 *White Tent*	**NTEP Bermudagrass Water Use and Zoysiagrass Trials; UCR 17-8 Bermudagrass Overview** Adam Lukaszewski, Marta Pudzianowska, and Christian Bowman
Stop #10 *Blue Tent*	**Preemergence and Postemergence Control of Spotted Spurge and Common Purslane** Pawel Orlinski
12:50-2:00 PM	**Barbeque Lunch and Trade Show**
2:50 PM	**Adjourn**

Stop #1: Warm-Season Turfgrass Breeding - Evaluation of Bermudagrass, Zoysiagrass, Seashore Paspalum, and St. Augustinegrass Lines Under Salinity Stress

Marta Pudzianowska, Christian Bowman, Luiz H. Monticelli, Adam J. Lukaszewski, and Jim Baird
Department of Botany & Plant Sciences
University of California, Riverside

Background and objectives:

Repeated testing in Riverside, CA has demonstrated that even the most drought tolerant cool-season grasses cannot compete with warm-season species in water use efficiency. California has been experiencing drought for several years, affecting water availability and price. Extending the use of warm-season grasses, already better adapted to arid climates, and their further improvement for the drought stress resistance, can help tackle this issue. The warm-season turfgrass breeding program at University of California, Riverside (UCR) was re-established in 2012, by planting a bermudagrass collection and first crosses among collection accessions to develop improved hybrids. In 2016 a collection of kikuyugrass was established and 3 years later the first hybrids were planted. The main goal of the program is to develop new, improved genotypes of these two species. At the same time, extensive testing of bermudagrass, zoysiagrass, seashore paspalum and St. Augustinegrass is also underway, in cooperation with other breeding programs in the United States. In bermudagrass and kikuyugrass, the emphasis is on drought resistance (hence reduced irrigation) and winter color retention. Winter dormancy hampers the replacement of cool-season with warm-season grasses so selection is also aimed at the reduction of the winter dormancy period. New cultivars with improved winter color retention would likely increase acceptance of warm-season grasses. In addition, with more frequent water shortages, switching to non-potable water resources of lower quality will be necessary. Thus, screening of warm-season grasses for tolerance to saline water becomes an important part of breeding for arid regions.

Project milestones since Field Day 2020:

- Continued one-on-one crosses of bermudagrass accessions generating hybrids with highest quality and winter color retention.
- Continued testing of bermudagrass hybrids in trials established in previous years in Riverside, Coachella Valley, Northern California and Nevada.
- Established a new study including UCR bermudagrass hybrids and commercial checks for roughs and residential sites use.
- Continued evaluation of kikuyugrass hybrids.
- Established a new shade study including UCR bermudagrass and kikuyugrass hybrids in Riverside.
- Initiated evaluation of experimental lines of bermudagrass, zoysiagrass, seashore paspalum and St. Augustinegrass within the USDA-NIFA Specialty Crop Research Initiative (SCRI) for overall performance, and drought and salinity tolerance.

New UCR bermudagrasses – UCR 17-8 and UCR TP6-3 – large scale testing:

Two large plots of UCR hybrids, UCR 17-8 and UCR TP6-3, were established in May 2021, for large-scale management tests. The two were selected from more than 400 hybrids and other entries after a long evaluation and selection process, including non-replicated and replicated trials in Riverside, Coachella Valley and Northern California. Recently they were included in a trial at the Shadow Creek Golf Course in Las Vegas, NV (planted in 2019) and in the SCRI project evaluating warm-season turfgrasses with focus on residential areas (planted in 2020). UCR 17-8 and UCR TP6-3 were included at six locations across the US with evaluation for the overall quality and performance under light drought stress; at UCR also as local checks for performance under severe drought and salinity stress. UCR 17-8 is also included in the 2018 USGA-NTEP deficit irrigation trial (see report "USGA/NTEP Warm-Season Water Use Trial", page 42).

Table 1 presents results of a fairway trial at the Napa Golf Course, Napa, CA, with four UCR hybrids, including UCR 17-8 and UCR TP6-3, and seven commercial cultivars ('Bandera', 'Celebration', 'Latitude 36', 'Santa Ana', 'Tahoma 31', 'Tifway II' and 'TifTuf'). Plots were established on two fairways in May 2019; 'Tahoma 31' was added in October 2019. Large plots were planted with sod in the middle of the fairways to evaluate performance under regular golf course maintenance regimes and traffic. Evaluation of the turfgrass quality (1-9; 9=best), color (1-9; 9=darkest green), seedhead production (1-9; 1=lowest), uniformity (1-9; 9=highest) and the Normalized Difference Vegetation Index (NDVI; 0-1) started in winter 2019/2020. Over the course of two years the highest quality scores were for UCR 17-8, 'Latitude 36', UCR TP6-3 and Santa Ana, while 'Celebration' had the lowest quality. UCR 17-8, UCR TP6-3, 'Santa Ana', 'TifTuf' and UCR BF2 had good winter color retention; 'TifTuf' and 'Santa Ana' were producing seedheads more intensively than the other three entries. The lowest seedhead production was in 'Latitude 36', UCR BF2 and UCR 17-8. Entries also varied in uniformity, with UCR 17-8 and 'Latitude 36' showing the highest scores, and 'Tahoma 31' and 'Celebration' the lowest.

Evaluation of bermudagrass, zoysiagrass, seashore paspalum, and St. Augustinegrass lines under salinity stress, and other collaborative projects:

Evaluation of warm-season turfgrasses under salinity stress is a part of the Specialty Crop Research Initiative (SCRI) funded by the Unites States Department of Agriculture. The study includes 35 lines and four cultivars of bermudagrass, 43 lines and three cultivars of zoysiagrass, 13 lines and two cultivars of seashore paspalum and 26 lines and three cultivars of St. Augustinegrass, developed at North Carolina State University (NCSU), Oklahoma State University (OSU), Texas A&M AgriLife (TAMUS), the University of Georgia (UGA), the University of Florida (UF) and University of California, Riverside. Our study was planted at UCR, Riverside, CA in June and July 2020. Irrigation with saline water of electroconductivity EC=4.4 dSm^{-1} started on July 6th, 2021. This salinity level is considered high but realistic. No additional stress was applied. Variation in response to salinity stress expressed as changes in turfgrass quality (1-9; 9=best) and leaf firing (1-9; 9=highest) was observed among and within species. Under salinity stress seashore paspalum entries showed a higher turfgrass quality and lower leaf firing than other species (Figure 1). Bermudagrass and zoysiagrass performed slightly below seashore paspalum, but the presence of outliers retaining high quality suggests enough genetic variation to improve these two species through breeding efforts. The most severe leaf firing and the lowest turfgrass quality under saline conditions were in St. Augustinegrass, with quality dropping below acceptable levels. Figures 2 to 5 show fluctuations of quality of commercial cultivars and top performing experimental entries of all four species. In bermudagrass (Figure 2), zoysiagrass (Figure 3) and seashore paspalum (Figure 4) a reduction of quality in late July was observed, which may be related to stress adaptation or to reaction to increasing air temperature, combined with introduction of saline water. The quality of the seashore paspalum entries tended to increase in most cases after the initial drop in July. The quality of zoysiagrass entries remained stable, while that of bermudagrass kept fluctuating. A different pattern was observed in St. Augustinegrass (Figure 5), with quality slightly dropping in late July, followed by a more severe quality drop in early August, when temperatures reached over 100°F.

Testing warm-season turfgrasses at UCR within the SCRI project also encompasses evaluation of experimental lines of bermudagrass, zoysiagrass, seashore paspalum and St. Augustinegrass at earlier selection stages, for the overall performance and to some extent also for drought tolerance (Single Space Plant Nursery, SSPN), and evaluation of advanced lines for performance under severe drought. These trials are conducted at all participating locations, giving insight into the performance of individual entries in various regions and climate zones of the US. Twenty experimental bermudagrass lines developed at UCR are included in SSPN trials.

The UCR breeding program also collaborates with Texas A&M in evaluation of their zoysiagrass lines in Northern California, at Meadow Club, Fairfax, CA and Napa Golf Course, Napa, CA. This project is funded by United States Golf Association.

Progress in breeding of bermudagrass and kikuyugrass at UCR:

Bermudagrass:

While new hybrids of bermudagrass are generated every year, evaluation of nurseries established in 2018, 2019 and 2020 continues. Hybrids from 2018 and 2019 nurseries were selected for both golf course fairways and roughs/residential areas use. Two studies including these latest selections were planted at UCR in 2021:

- Rough/residential areas trial with 24 UCR hybrids and six cultivars (‘Bandera’, ‘Bullseye’, ‘Celebration’, ‘Midiron’, ‘Santa Ana’ and ‘Tifway II’). This study will evaluate the performance under 2.0 in mowing height.
- Shade trial including 35 UCR hybrids from 2018-2019 nurseries, with UCR 17-8, UCR TP6-3 and five commercial checks (‘Celebration’, ‘Latitude 36’, ‘Santa Ana’, ‘Tifway’ and ‘TifTuf’).

Other studies initiated in previous years and currently under evaluation in UCR, Riverside, CA and other locations include:

- A drought study to evaluate response to prolonged drought stress with 71 UCR hybrids and five commercial cultivars (‘Bandera’, ‘Celebration’, ‘Santa Ana’, ‘TifTuf’, ‘Tifway II’) at UCR established in 2019. Entries are subjected to two consecutive dry-down periods followed by recovery periods. Several UCR entries outperformed commercial checks in both years, based on their average green (living tissue) coverage as determined by digital image analysis. Two accessions in particular, UCRC180557 and UCRC180229, have remained among the top 5 performers since last year, retaining an average of 85% green coverage throughout the first dry-down cycle in 2021.

- An evaluation study of 12 UCR hybrids and 3 commercial cultivars (‘Bandera’, ‘Midiron’ and ‘Tifway II’) suitable for roughs/lawns at the West Coast Turf sod farm in Coachella Valley, CA and at Preserve at St. Lucia, Carmel-by-the-sea, CA initiated in 2019.
- A study at the Shadow Creek Golf Course, Las Vegas, NV was initiated in July 2020. It includes 21 UCR hybrids selected for superior quality and winter color retention and four commercial cultivars (‘Latitude 36’, ‘Santa Ana’, ’Tahoma 31’ and ‘TifTuf’).

Kikuyugrass:

Production of new kikuyugrass hybrids continues, through crosses among the best performing collection entries and by self-pollination of the best hybrids, to perpetuate and enhance desirable traits. The germplasm collection planted in 2016 and a nursery of 280 hybrids planted in 2019 are evaluated for reduced vigor, finer texture, lower seedhead production and color. Based on their performance in nurseries, 17 hybrids were selected and together with ‘Whittet’ planted in a shade trial at UCR in August 2021.

Evaluation of the kikuyugrass collection entries for response to prolonged drought continues. This study was established in 2019 and of comprises of 38 accessions with ‘Whittet’ selections and ‘AZ-1’ as commercial checks. Accessions are being evaluated over two consecutive dry-down periods, followed by recovery periods. Generally, the drought tolerance of kikuyugrass is lower than that of bermudagrass, but some variation among entries does exist. The best performing entries can be used in further breeding efforts to improve the drought tolerance of this species.

Continuous evaluation of bermudagrasses and kikuyugrasses allowed to select number of entries of promising quality, and further trials will be initiated in various locations to continue the selection toward lines with better quality, improved winter color retention and tolerance to drought as well as other stresses.

Acknowledgements:

Thanks to the CTLF, USGA, MWD, WMWD, USDA NIFA, West Coast Turf, Meadow Club, Napa GC, The Preserve at Santa Lucia and Shadow Creek GC for their support of this research.

Table 1. Turfgrass quality (1-9; 9=best), color (1-9; 9=darkest green), seedhead production (1-9; 9=highest), NDVI (0-1) and uniformity (1-9; 9=highest) of 4 UCR hybrids and 7 bermudagrass cultivars at Napa Golf Course, Napa, CA, 2019-2021.

Name	VQ	VC	Seedhead production	NDVI	Uniformity
UCR 10-9	5.7 de	6.5 ab	3.1 ab	0.59 ab	6.8 abc
UCR 17-8	7.0 a	7.7 a	2.6 a	0.66 ab	7.8 a
UCR BF2	6.0 bcd	7.4 ab	2.5 a	0.64 ab	5.5 cde
UCR TP6-3	6.5 abc	7.5 a	3.9 ab	0.67 a	6.7 abcd
Bandera	6.1 bcd	7.0 ab	3.2 ab	0.62 ab	6.5 abcde
Celebration	4.2 f	5.2 c	4.6 ab	0.54 b	5.4 de
Latitude 36	6.8 ab	7.1 ab	2.5 a	0.63 ab	7.4 ab
Santa Ana	6.5 abcd	7.5 a	5.6 b	0.67 a	7.1 ab
Tahoma 31	5.1 e	6.1 bc	3.1 ab	0.57 ab	5.4 e
TifTuf	6.1 bcd	7.3 ab	5.3 ab	0.65 ab	6.4 bcde
Tifway II	5.8 cde	6.6 ab	5.3 ab	0.61 ab	6.1 bcde

Means followed by the same letter in a column are not significantly different (P=0.05).

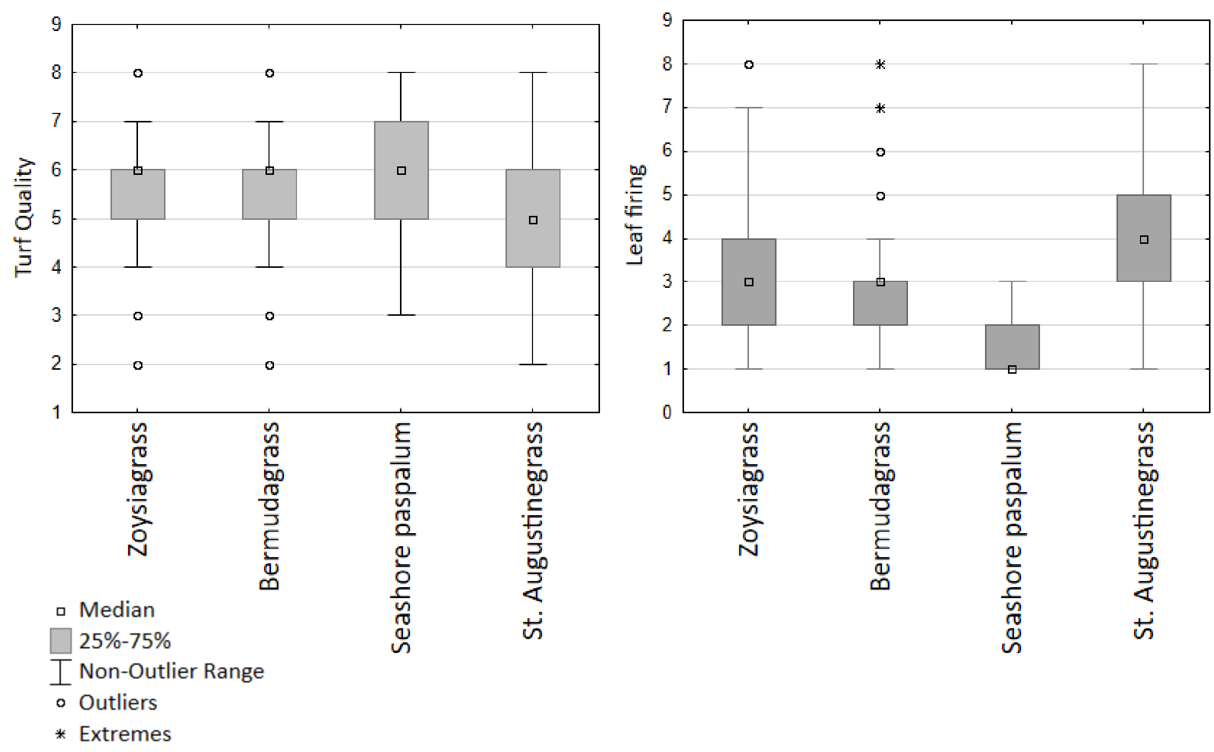

Figure 1. Average turfgrass quality (1-9; 9=best) and leaf firing (1-9; 9=highest) of bermudagrass, zoysiagrass, seashore paspalum and St. Augustinegrass under irrigation with water of electroconductivity 4.4 dSm^{-1} at UCR, Riverside, CA, 2021.

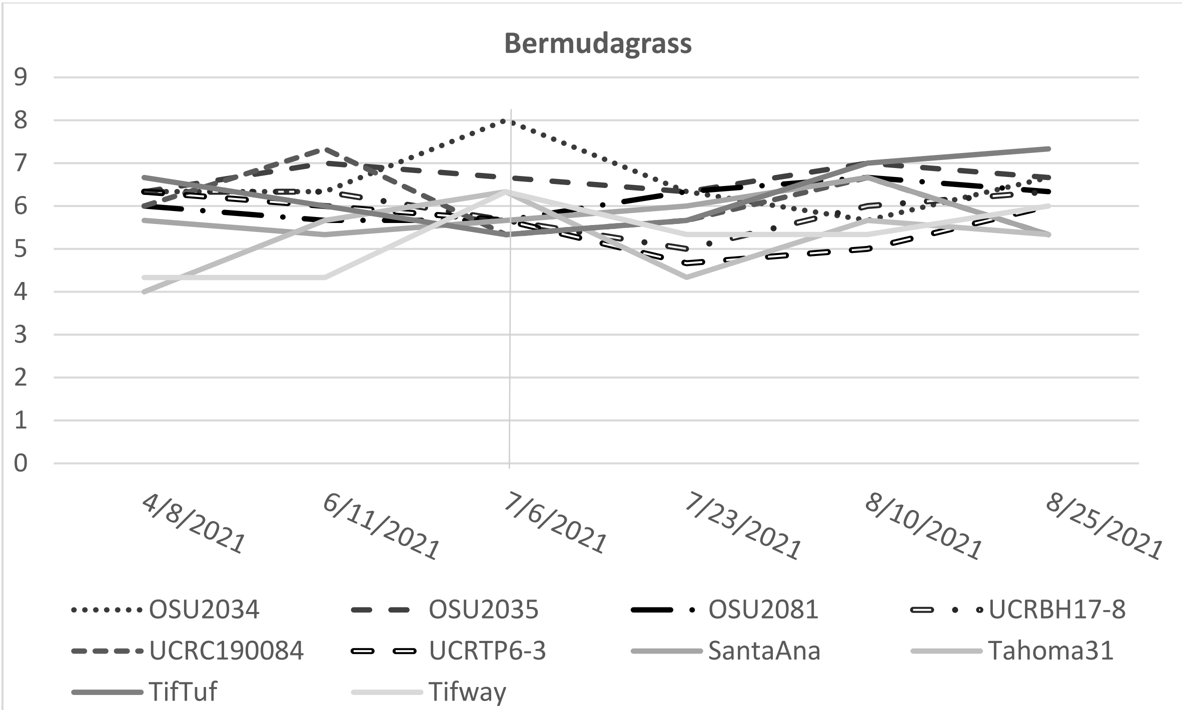

Figure 2. Changes in turfgrass quality (1-9; 9=best) of the best performing bermudagrass entries and commercial checks under irrigation with water of electroconductivity 4.4 dSm^{-1} at UCR, Riverside, CA, 2021.

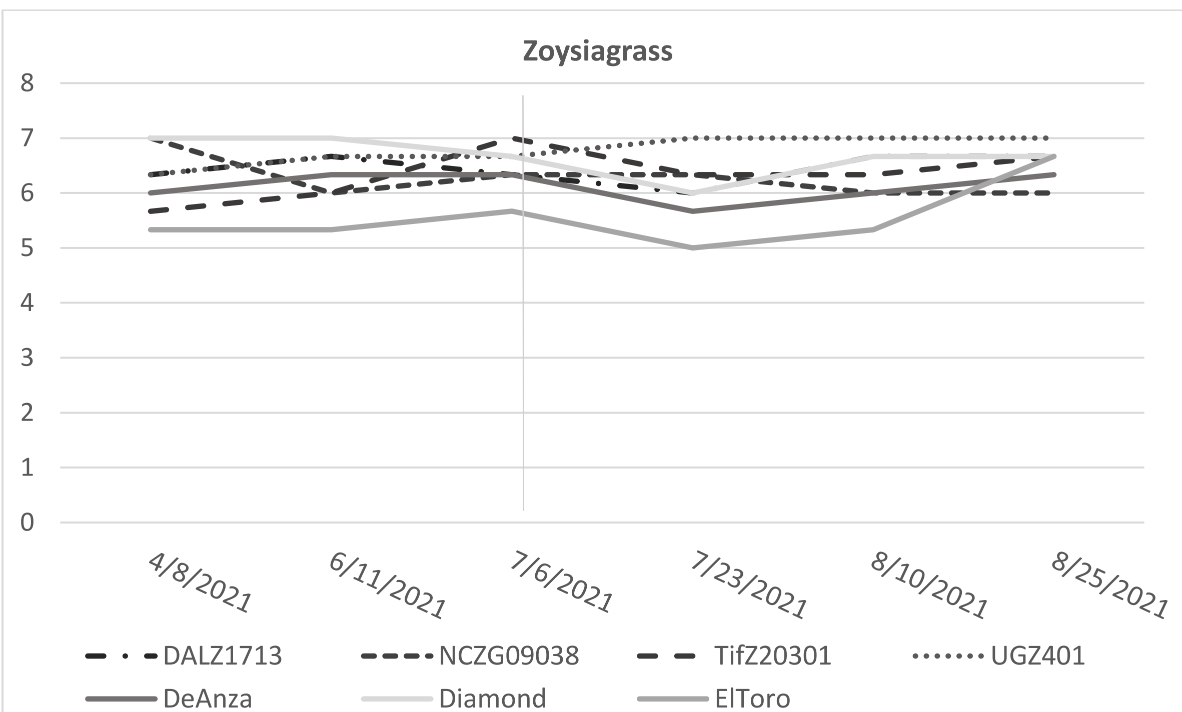

Figure 3. Changes in turfgrass quality (1-9; 9=best) of the best performing zoysiagrass entries and commercial checks under irrigation with water of electroconductivity 4.4 dSm^{-1} at UCR, Riverside, CA, 2021.

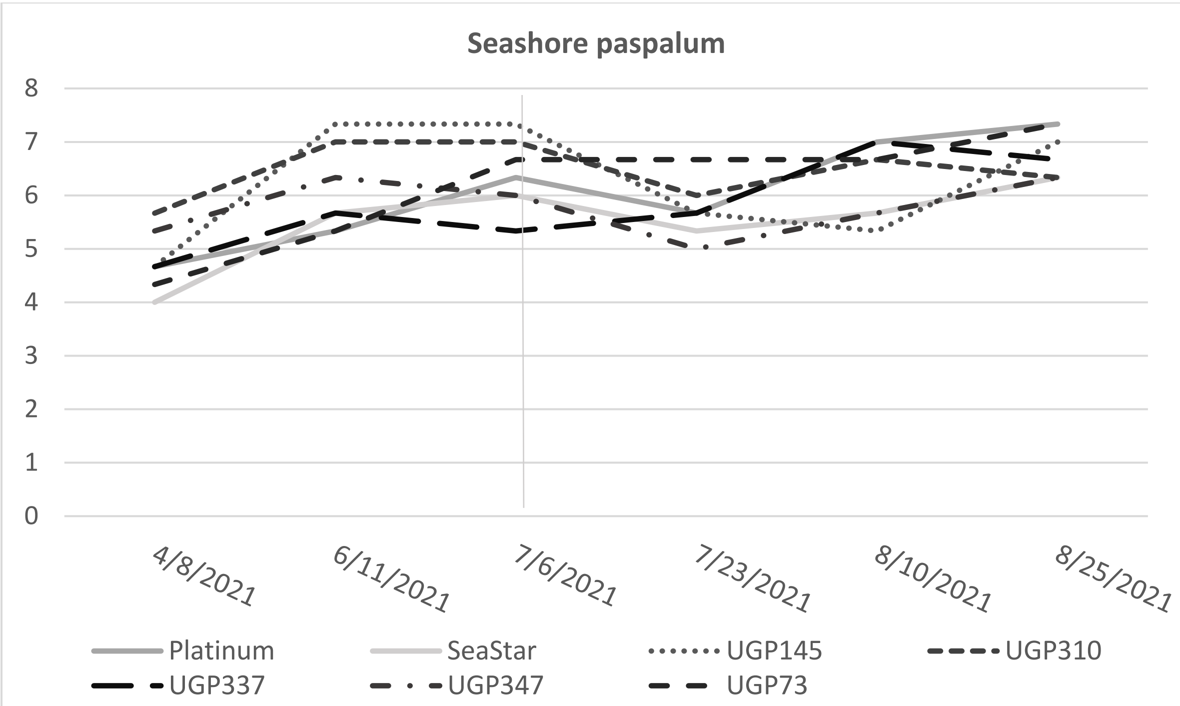

Figure 4. Changes in turfgrass quality (1-9; 9=best) of the best performing seashore paspalum entries and commercial checks under irrigation with water of electroconductivity 4.4 dSm^{-1} at UCR, Riverside, CA, 2021.

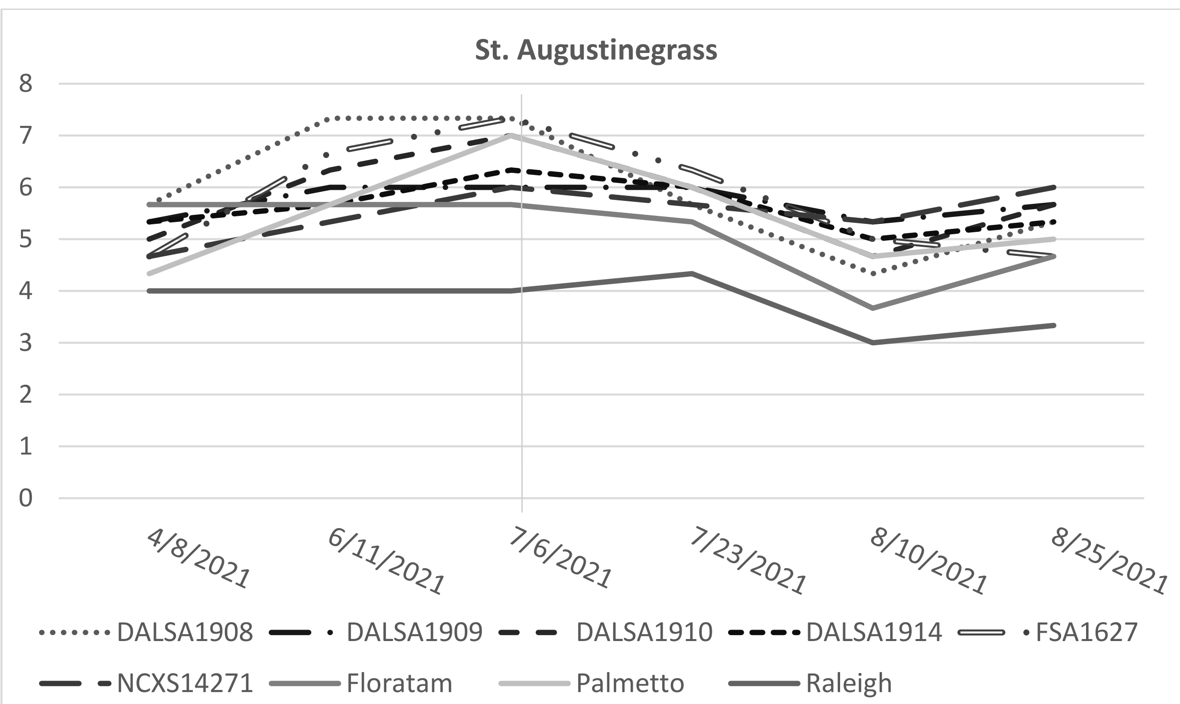

Figure 5. Changes in turfgrass quality (1-9; 9=best) of the best performing St. Augustinegrass entries and commercial checks under irrigation with water of electroconductivity 4.4 dSm^{-1} at UCR, Riverside, CA, 2021

Stop #2: Evaluation of Products for Water Conservation on Bermudagrass Turf Using a Linear Gradient Irrigation System

Matteo Serena, and Jim Baird
Department of Botany and Plant Sciences
University of California, Riverside

Objectives:

As drought persists throughout the western U.S., golf courses and other turf facilities have been asked to reduce irrigation. After several years of investigating multiple strategies to maintain higher fairway quality, this study lay side by side what are considered some of the best tools available to turf managers. Recent studies have demonstrated that the use of plant growth regulators (PGRs), soil surfactants and their combination, can improve turfgrass quality under drought conditions. In particular, Primo Maxx (trinexapac-ethyl) has consistently shown superior quality among other PGRs available in the market. Soil surfactants have demonstrated increased soil moisture uniformity, and therefore turfgrass quality under drought or deficit irrigation. Other products, such as fungicides, fertilizers, and mineral oils have been experimentally used in other scenarios, and proved to increase turfgrass quality under abiotic stress conditions. In this study, we evaluated 11 different products to establish the best option for water conservation.

Materials and Methods:

The linear gradient irrigation system (LGIS) study area consisted of hybrid bermudagrass 'Tifway 419' mowed at 0.5 inches. When the experiment is in progress, only the center irrigation line provides water to experimental plots. The placement of the center-line sprinklers are 1/3 of normal spacing to allow for a simulated gradient of irrigation, from well-watered near the center to close to zero irrigation at distant end of the plots. Treatments were applied on 4-ft x 48-ft plots, with each treatment replicated 4 times (two on each side of the field). All treatments were applied on 14-d intervals, starting on June 17, 2021. List of treatments and rates is provided in Table 1, and plot plan is presented in Figure 1. Each plot was sub-divided into 6 zones of 8-ft length, representing 6 different replacements of reference evapotranspiration (ET_o), (100%-80-60-50-40-25%). Figure 2 shows the difference in moisture content across the ET_o% levels. Data collection consisted of weekly turfgrass quality (1-9; 9=best), digital image analysis to measure cover (% green turf color) and dark green color index (DGCI) (0-0.666), Normalized Difference Vegetation Index (NDVI) (0-1) and moisture convent (%VWC). Based on visual quality ratings on August 31, linear regression was used to determine the amount of water (replacement of ET_o) required for each treatment to maintain turf at an acceptable level of 6.

Results:

According to our analysis, when using Civitas or Daconil Action + Appear II, approximately 50% less water is necessary to maintain acceptable turfgrass quality compared to untreated turf. Furthermore, all other treatments could result in at least 10-20+% water savings. When considering the inherent water savings of using warm- vs. cool-season turfgrasses, which is 20-30%, use of products like these can save appreciable amounts of water and are warranted in the Southwest. Significant differences were observed among treatments, and for the interaction of treatment by ET_o. However, for the purpose of this report, only the main effect of treatment is presented in Table 2, and each value represents the average of six ET_o levels, 4 replications and 3 rating dates in August 2021.

Thus far, the two products containing pigment, Civitas and Daconil Action + Appear II, resulted in higher turfgrass quality and cover when compared to the other treatments. The nanocarbon technology resulted in lower NDVI; however this is not connected to a reduction in turfgrass quality or DGCI compared to the other products. Moisture content appears to be uniform across the study, indicating that the benefits of the products are increasing turfgrass health, and not dependent on moisture content. These are only preliminary results from one month of evaluation. We expect results to be different by the end of the growing season.

Table 1. Treatments applied in the linear gradient irrigation study, Riverside, CA. 2021.

Trt No.	Name	Manufacturer	Rate (oz/1000 ft^2)
1	Non-treated control		
2	Primo Maxx	Syngenta	0.25
3	Civitas	Intelligro	8.5
4	Appear II + Daconil Action	Syngenta	6 + 3.5
5	Nanocarbon	Vulpes Corp.	32
6	Revolution	Aquatrols	3
7	TriCure AD	Mitchell Products	3
8	WA-001	JRX Biotechnology	3
9	Hydro 90 + Symphony	Harrell's	1.5 + 1.5
10	Passage	Numerator Technologies	3
11	Forte+ Brilliance	Simplot	0.185 + 1.5
12	Aquimax Turf Lateral	Exacto	2

N ↑

1 2 3 4 5 6 6 5 4 3 2 1

	West	Plot	Trt	Trt	Plot	East
4 ft	Replication 3	25	Trt 9	Trt 1	1	Replication 1
4 ft		26	Trt 11	Trt 2	2	
4 ft		27	Trt 7	Trt 3	3	
4 ft		28	Trt 12	Trt 4	4	
4 ft		29	Trt 10	Trt 5	5	
4 ft		30	Trt 3	Trt 6	6	
4 ft		31	Trt 5	Trt 7	7	
4 ft		32	Trt 6	Trt 8	8	
4 ft		33	Trt 4	Trt 9	9	
4 ft		34	Trt 2	Trt 10	10	
4 ft		35	Trt 8	Trt 11	11	
4 ft		36	Trt 1	Trt 12	12	
4 ft	Replication 4	37	Trt 8	Trt 12	13	Replication 2
4 ft		38	Trt 9	Trt 5	14	
4 ft		39	Trt 1	Trt 1	15	
4 ft		40	Trt 10	Trt 10	16	
4 ft		41	Trt 5	Trt 9	17	
4 ft		42	Trt 2	Trt 4	18	
4 ft		43	Trt 11	Trt 2	19	
4 ft		44	Trt 12	Trt 8	20	
4 ft		45	Trt 6	Trt 11	21	
4 ft		46	Trt 7	Trt 6	22	
4 ft		47	Trt 3	Trt 3	23	
4 ft		48	Trt 4	Trt 7	24	

1 2 3 4 5 6 6 5 4 3 2 1

8ft 8ft 8ft 8ft 8ft 8ft 8ft 8ft 8ft 8ft 8ft 8ft

Figure 1. Plot plan for the 2021 linear gradient irrigation system

Table 2**.** Replacement of reference evapotranspiration (ET_o) necessary to maintain minimally acceptable turfgrass quality on August 31. Turfgrass quality (1-9; 9=best), green turf cover (%), dark green color index (DGCI, 0-0.66), normalized difference vegetation index (NDVI, 0-1), and moisture (VWC, %) averaged over six ET_o levels, 4 replications and 3 rating dates in August using **a** linear gradient irrigation system**.** Riverside, CA. 2021.

Treatment	**ET_o**	**Turf Quality**	**Cover**	**DGCI**	**NDVI**	**Moisture**
Non-treated control	0.69 A*	6.4 CD	84 BCD	0.37 BC	0.59 BC	18.3 ABC
Primo Maxx	0.53 BC	6.3 CD	87 BC	0.38 B	0.61 A	19.2 ABC
Civitas	0.34 D	7.3 A	94 A	0.42 A	0.59 AB	16.8 D
Appear II + Daconil Action	0.33 D	7.0 AB	90 AB	0.42 A	0.61 A	19.7 A
Nanocarbon	0.46 C	6.6 BC	80 DE	0.38 B	0.56 E	18.7 ABC
Revolution	0.55 BC	6.1 DE	80 DE	0.36 CDE	0.58 BCD	19.1 ABC
TriCure AD	0.57 BC	6.1 DE	81 DE	0.36 CDE	0.57 DE	17.9 CD
WA-001	0.57 BC	5.7 E	75 E	0.34 E	0.58 CD	18.6 ABC
Hydro 90 + Symphony	0.57 B	6.0 DE	81 DE	0.35 DE	0.57 DE	19.2 ABC
Forte + Brilliance	0.56 BC	6.2 CD	80 DE	0.37 BCD	0.58 BCD	19.6 AB
Passage	0.54 BC	6.3 CD	83 CD	0.37 BCD	0.58 BCD	18.2 BC
Aquimax Turf Lateral	0.53 BC	6.0 DE	80 DE	0.36 CDE	0.57 CDE	18.2 BC

*Means followed by the same letter in a column are not statistically different ($P < 0.05$)

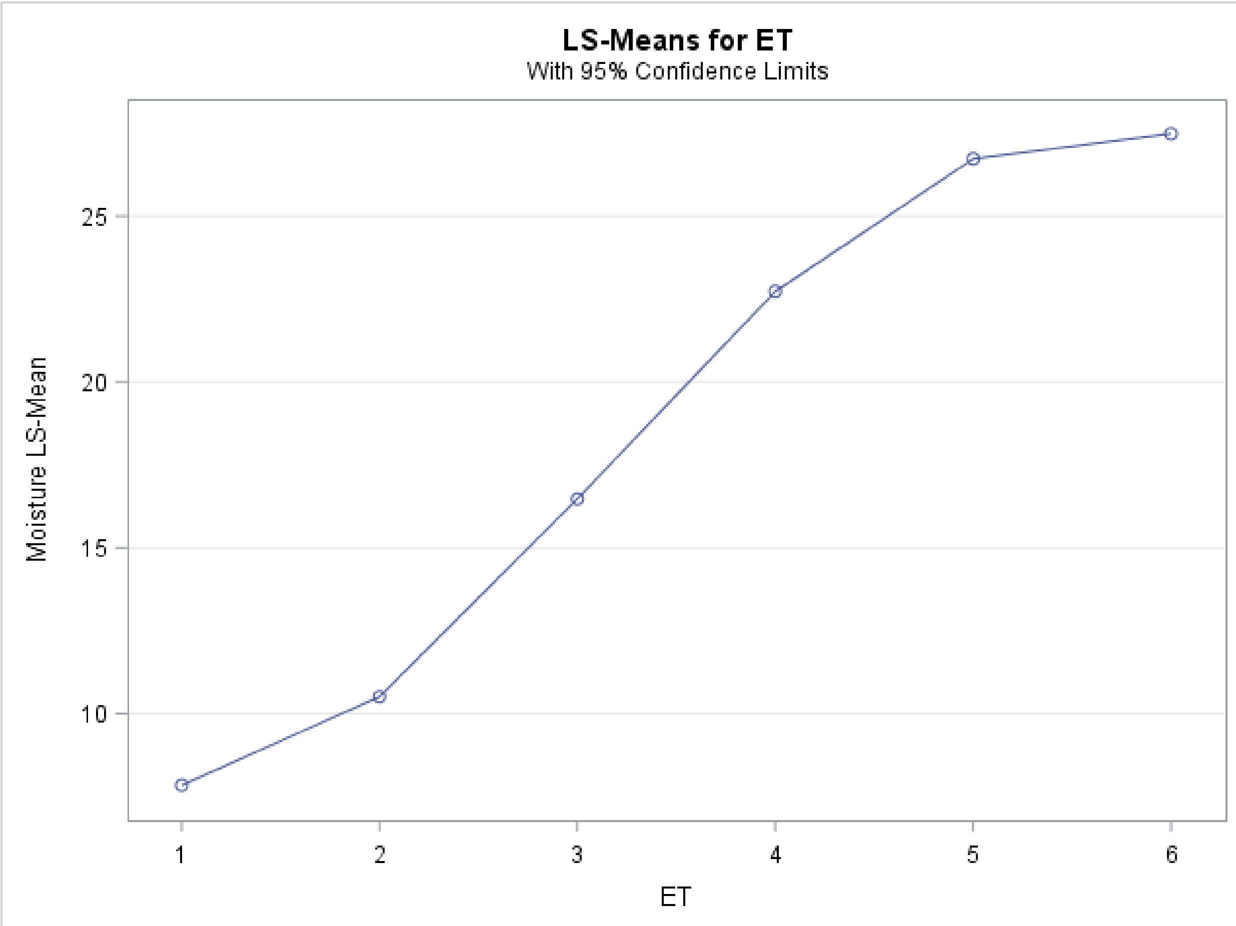

Figure 2. Average moisture content across different ET levels in the linear gradient irrigation study in Riverside, CA. 2021

Stop #3: Management of Pacific Shoot-Gall Disease in California Putting Greens

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Introduction:

More than four decades ago, in 1978, University of California farm advisor Larry Costello discovered curious disease symptoms on golf course putting greens with annual bluegrass (*Poa annua*). Patches of the grass were chlorotic and stunted, causing an uneven, bumpy playing surface. On closer inspection, many of the grass shoots featured a gall on their base. The causal organisms, *Anguina pacificae*, are plant-parasitic nematodes found almost exclusively in *P. annua* putting greens along a thin strip of the northern coast of California.

The Pacific shoot-gall nematode juveniles require cool and moist conditions to move in a thin water film on the plant's surface to the crown. With increasing distance from the coast and a drop in humidity, the nematodes' journey becomes quickly more treacherous. If the shoot surface dries, the nematodes perish. But if the nematodes reach the top of the crown, they penetrate the grass tissue and induce a cavity that expands and creates the characteristic shoot gall. Protected in the cavity, the nematodes feed on the plant tissues and molt into third and fourth-stage juveniles. The last molt results in adults. After mating, the female may lay more than 1000 eggs. In mature galls, many eggs, juveniles, and a few adults can be found. When the galls eventually decompose after a couple of months, infectious juveniles leave and search out new crowns.

In the past, Nemacur (fenamiphos) helped to mitigate Pacific shoot-gall disease outbreaks. When its registration was withdrawn in 2008, some golf course superintendents used Neemix 4.5, a 4.5% azadirachtin-containing insecticide, as a replacement. The label suggests its utility to suppress nematodes. The product showed no efficacy against *A. pacificae*, spiral, and ring nematodes in our previous trials.

Objectives:

The purpose of this study was to evaluate the efficacy of two novel nematicidal products to mitigate the Pacific shoot-gall disease in various California golf courses. The nematicides Divanem and Indemnify were applied several times during the season, and the soil-dwelling population of *A. pacificae* and newly developed disease symptoms were enumerated, while the turf health was visually monitored.

Materials and Methods:

The trials were conducted for several years on *P. annua* putting greens with a history of Pacific shoot-gall disease. Most research was performed at the three coastal California golf courses Pasatiempo, Santa Cruz, Laguna Seca, Monterey, and Del Monte, Monterey. The starting time of the study's initiation was based on Pacific shoot-gall disease history and weather conditions.

The experimental design at each location was a randomized complete block with four replications with plots measured 4 by 6 ft. Abamectin was applied as Divanem (Syngenta, Greensboro, NC) at 0.28 fl oz/1000 ft^2 of product with the addition of 0.25% (v/v) Induce nonionic surfactant (Helena Agri-Enterprises LLC; Collierville, TN). Fluopyram was used as Indemnify (Bayer CropScience U.S., St. Louis, MO) at 0.39 fl oz/1000 ft^2. The nematicides were applied using a CO_2 backpack sprayer. Divanem treatments were immediately followed with at least 0.1-inch irrigation water. Fluopyram was applied in the morning and irrigated in the evening according to the Indemnify label recommendations.

At low Pacific shoot-gall disease occurrence (<10%), turfgrass ratings were based on overall plot vigor or quality on a scale of 1–9 (1 = dead; 6 = minimally acceptable quality; 9 = no disease, optimum color, density, texture, and uniformity). At high disease pressure, Pacific shoot-gall disease ratings were taken (0–100%). For nematode soil population analysis, five samples per plot were taken using an Oakfield soil probe on the day preceding the initial nematicide applications and one month after the final application. The samples were pooled, and 100 cm^3 were processed by a sieving/sugar flotation and centrifugation method at the Department of Nematology, University of California, Riverside. Among plant-parasitic nematodes, only *A. pacificae*, spiral (*Helicotylenchus* spp.), and ring (*Criconemoides* spp.) nematodes were found in significant numbers and counted with the use of dissecting and compound microscopes.

All data were analyzed separately for each golf course using analysis of variance. For any given parameter, when appropriate, multiple comparisons of means were separated using Fisher's protected least significant difference test at $P = 0.05$.

Results:

Our earlier research was confirmed that one or two applications of Indemnify were sufficient for the recovery and season-long protection against the Pacific shoot-gall disease. In direct comparison, four applications of Divanem were equally effective as fluopyram. Both products were not very soil mobile and consequently did not influence the monitored nematode soil populations of *A. pacificae*, spiral, and ring nematodes. The appearance of the turfgrass treated with these plant protection compounds was remarkably improved at all test locations. By disrupting the disease cycle and protecting against the formation of new shoot galls, the recovery of the turfgrass became noticeable when new shoots of *P. annua* filled in for the slowly decomposing diseased ones. Consequently, it took several weeks after the nematicide applications before the formerly diseased patches improved.

Acknowledgments

We thank participating golf course personnel, Syngenta Crop Protection, Bayer CropScience, Golf Course Superintendents Association of Northern California, and California Turfgrass and Landscape Foundation for their support.

Stop #4a: Evaluation of Fungicides for Control of Anthracnose Disease on Annual Bluegrass Putting Greens

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Objectives:

This study was conducted to evaluate 32 different fungicide treatments to control foliar and basal rot anthracnose (*Colletotrichum cereale*) disease preventatively on an annual bluegrass (*Poa annua*) putting green.

Materials and Methods:

The study was initiated on May 31, 2021 on mature annual bluegrass (*Poa annua*) 'Peterson's Creeping' turf on a Hanford fine sandy loam amended with sand. The green was established in 2007 from seed and the plot area was originally inoculated with the pathogen, which has become ubiquitous since then. Turf was mowed 5 days/wk at 0.125 inches and received no fertilizer during the study period. Initially, irrigation was provided to prevent water stress until fungicide treatments were applied for the third time on June 27. Thereafter, the irrigation system was turned off and the green was hand watered once or twice daily to promote water stress and incite disease outbreak.

Fungicide treatments were applied every 14 days beginning on May 31 (before disease symptoms were present) and ending on September 6 for a total of 8 applications. Later in the experiment, certain treatments were applied on 21-d intervals. Treatments were applied using a CO_2-powered backpack sprayer equipped with TeeJet 8003VS nozzles calibrated to deliver 2 gallons/1000 ft^2. Experimental design was a complete randomized block with 6 replications. Plot size was 4×6 ft.

Plots were evaluated every two weeks visually for turf quality (1-9; 9=best) and anthracnose disease cover (0-100%) once disease activity was present. Data were analyzed using Analysis of Variance with Fisher's Protected Least Significant Difference (LSD) test (P =0.05).

Results:

Acervuli of *Colletotrichum cereale* were first noted in only one of the untreated plots on July 9. Disease ratings were first taken on July 22 with no statistical differences among treatments (data not shown) until the August 16 rating date (Table 1). Reliance on hand watering as the sole method of irrigation promoted localized dry spots (LDS) on the green, which is where anthracnose disease was mostly observed. Nevertheless, we did not see rampant spread of the disease in 2021 like has been observed in previous years. Although the green was maintained overall drier than in previous years, which is usually a key ingredient for disease outbreak, more often than not it appeared that efficacy of treatments was related to the occurrence of LDS in plots followed by anthracnose invasion. On the other hand, certain but not all plots of some fungicide treatments appeared immune to LDS, which resulted in the best turf quality and lowest disease cover.

In general, most all of the fungicide treatments were effective against anthracnose disease in this year's trial with the exception of Pinpoint and Xzemplar fungicides. In defense of both products, neither is known for having strong efficacy against anthracnose and both treatments were not submitted by their parent companies.

No turf injury from fungicide treatments was observed throughout the study until the end of August. Treatments 10, 11, and 12 containing Appear II (phosphite + pigment) started showing symptoms of chlorosis and etiolation, which weakened the turf to the point of invasion from anthracnose. Prior to these observations, the aforementioned treatments displayed the darkest green and best quality turf among all treatments. At this time, our best guess is that the turf was damaged due to application of a phosphite product in hot weather. The same or similar treatments have been included in previous anthracnose trials at UCR with exceptional disease control and turf quality, and no turf injury. Unfortunately due to challenges with labor resources in 2021, treatments were applied much later in the mornings or sometimes in afternoons when temperatures exceeded 90°F.

Ratings will continue until October 4 (4 wks after 8^{th} application).

Acknowledgments

Thanks to the CTLF, BASF, Bayer, Corteva, FMC, Intelligro, Nufarm, and Syngenta for supporting this research and/or for providing products.

Table 1. Effects of fungicide treatments on turf quality (1-9, 9 = best) and anthracnose disease cover (0-100%) on annual bluegrass turf. 2021. Riverside, CA.

Trt	Product	Company	Rate (oz/1,000 ft^2)	Interval	Quality 8/16/21	Quality 9/1/21	Cover 8/16/21	Cover 9/1/21
1	Control	--	--	--	6.0 de	5.8 de	12 a	10 ab
2	Maxtima	BASF	0.6	ACEG				
2	Insignia	BASF	0.7	BDFH				
2	Encartis	BASF	4.0	BDFH				
2	Civitas	Intelligro	12	CEG				
2	Affirm	Nufarm	1.0	CEG	6.8 abc	6.8 ab	4 def	4 ef
3	Navicon Intrinsic	BASF	0.85	ACEG				
3	Lexicon Intrinsic	BASF	0.47	BDFH				
3	Signature Xtra	Bayer	5.3	BDFH				
3	Secure	BASF	0.5	CF				
3	Primo Maxx	Syngenta	0.1	ABCDEFGH	6.5 bcd	6.7 abc	3 ef	5 c-f
4	Kalida	FMC	0.4	ABCDEFGH	7.0 ab	6.7 abc	4 def	5 c-f
5	UCR001	--	--	--	6.5 bcd	5.8 de	8 abc	8 bc
6	UCR002	--	--	--	7.0 ab	6.5 a-d	3 ef	5 c-f
7	UCR002	--	--	--				
7	UCR001	--	--	--	7.2 a	6.0 cde	2 f	7 b-f
8	UCR002	--	--	--				
8	UCR003	--	--	--	7.0 ab	6.2 b-e	3 ef	4 def
9	Ascernity	Syngenta	1.0	ABCDEFGH	6.8 abc	6.2 b-e	5 c-f	7 b-f
10	Daconil Action	Syngenta	3.5	ABCDEFGH				
10	Appear II	Syngenta	6.0	ABCDEFGH				
10	Primo Maxx	Syngenta	0.1	ABCDEFGH	6.7 abc	5.7 e	4 def	8 bc
11	Briskway	Syngenta	0.9	ADG				
11	Appear II	Syngenta	6.0	ADG				
11	Primo Maxx	Syngenta	0.1	ADG				
11	Daconil Action	Syngenta	3.5	BEH				
11	Secure Action	Syngenta	0.5	BEH				
11	Primo Maxx	Syngenta	0.1	BEH				
11	Ascernity	Syngenta	1.0	CF				
11	Appear II	Syngenta	6.0	CF				
11	Primo Maxx	Syngenta	0.1	CF	6.8 abc	6.3 a-e	3 ef	5 c-f
12	Ascernity	Syngenta	1.0	ABCDEFGH				
12	Appear II	Syngenta	6.0	ABCDEFGH				
12	Primo Maxx	Syngenta	0.1	ABCDEFGH	6.8 abc	6.0 cde	2 f	8 bcd
13	UCR004	--	--	--	6.8 abc	6.3 a-e	3 ef	6 c-f
14	UCR005	--	--	--	7.0 ab	6.5 abcd	3 ef	6 c-f
15	UCR005	--	--	--	6.7 abc	6.3 a-e	5 cdef	6 c-f
16	UCR006	--	--	--	6.3 cde	6.0 cde	6 bcde	8 b-e
17	UCR007	--	--	--	6.8 abc	6.7 abc	4 ef	4 ef
18	Daconil Action	Syngenta	3.5	ABCDEFGH	6.5 bcd	6.5 a-d	4 def	6 c-f
19	UCR008	--	--	--	7.0 ab	6.2 b-e	4 ef	7 b-f
20	Pinpoint	Nufarm	0.31	ABCDEFGH	5.8 e	5.8 de	10 ab	8 bcd
21	Fame	FMC	0.36	ABCDEFGH	6.5 bcd	6.2 b-e	5 cdef	6 c-f
22	UCR008	--	--	--				
22	Pinpoint	Nufarm	0.31	ABCDEFGH	6.5 bcd	6.2 b-e	4 def	7 b-f
23	UCR008	--	--	--				
23	Fame	FMC	0.36	ABCDEFGH	6.7 abc	6.3 a-e	4 def	7 b-f
24	Xzemplar	BASF	0.16	ABCDEFGH	6.3 cde	6.2 b-e	8 bcd	12 a
25	Lexicon	BASF	0.47	ABCDEFGH	7.0 ab	5.8 de	3 ef	8 b-e
26	UCR009	--	--	--	6.7 abc	6.3 a-e	5 cdef	8 b-e
27	UCR009	--	--	--	7.0 ab	6.0 cde	3 ef	6 c-f
28	UCR009	--	--	--	6.8 abc	6.0 cde	4 def	8 bc
29	UCR009	--	--	--	6.7 abc	6.3 a-e	4 def	8 bc
30	UCR009	--	--	--	6.7 abc	7.0 a	4 def	4 f
31	Maxtima	BASF	0.4	CDEFGH	7.0 ab	6.3 a-e	4 def	6 c-f
32	Maxtima	BASF	0.4	C (4@21 days)	6.5 bcd	6.5 a-d	5 c-f	6 c-f

Means followed by the same letter in a column are not significantly different (P=0.05).

Application Intervals: A=5/31/21; B=6/14/21; C=6/27/21; D=7/13/21; E=7/25/21; F=8/6/21; G=8/19/21; H=9/6/21.

2021 Anthracnose Fungicide Trial Plot Plan

UC Riverside

NW

7	18	X	5	16	11	6	1	3	X	X	22	8	19
28	24	2	12	30	1	12	19	16	20	1	9	15	5
17	21	23	11	23	17	29	13	9	11	26	24	3	11
10	31	14	29	17	24	7	32	12	22	23	7	26	7
27	20	8	21	13	31	25	25	26	25	11	20	14	22
4	30	31	8	20	5	22	2	7	14	4	28	29	13
13	1	26	10	32	26	16	8	28	10	13	5	1	18
29	9	4	6	14	14	32	15	10	X	21	29	6	24
22	15	19	22	7	9	3	23	18	32	27	18	23	16
12	25	15	27	4	2	18	21	24	16	6	19	2	31
32	16	9	1	13	21	8	14	5	3	17	25	28	10
3	19	28	25	19	30	20	30	31	30	2	17	9	20
5	11	18	3	27	15	28	6	4	8	12	21	30	27
6	26	24	2	23	10	29	27	17	15	31	32	12	4

Demonstration: Curative Effects of Individual Fungicides on Anthracnose Disease

Trt	Product	Company	Rate (oz/1,000 ft^2)	Interval
1	Control	--	--	AB
2	Maxtima	BASF	0.6	AB
3	Insignia	BASF	0.7	AB
4	Encartis	BASF	4.0	AB
5	Navicon	BASF	0.85	AB
6	Lexicon	BASF	0.47	AB
7	Xzemplar	BASF	0.26	AB
8	Affirm	Nufarm	1.0	AB
9	Kalida	FMC	0.4	AB
10	Ascernity	Syngenta	1.0	AB
11	Daconil Action	Syngenta	5.4	AB
12	Briskway	Syngenta	1.2	AB
13	Appear II	Syngenta	8.0	AB
14	Secure Action	Syngenta	0.5	AB
15	UCR001	--	--	AB
16	Fame	FMC	0.36	AB
17	Signature Xtra	Bayer	6.0	AB
18	UCR002	--	--	AB

Application Intervals: A=8/19/21; 9/2/21.

Plot Plan (2ft x 16ft plots; 3 reps)

NW

18	**12**
14	**10**
1	**1**
2	**13**
11	**12**
1	**6**
15	**17**
7	**3**
5	**16**
2	**4**
3	**9**
16	**1**
11	**18**
4	**17**
5	**16**
6	**15**
7	**8**
8	**14**
18	**13**
10	**12**
2	**5**
7	**11**
13	**4**
3	**17**
9	**14**
10	**9**
15	**1**
6	**8**

Demonstration: Effects of Fungicides and Plant Health Products on Anthracnose Disease and Drought Stress

Trt	Product	Company	Rate (oz/1,000 ft^2)	Trt	Product	Company	Rate (oz/1,000 ft^2)	Interval
I	Control	--	--	1	Control	--	--	AB
II	Ascernity	Syngenta	1.0	2	Primo Maxx	Syngenta	0.125	AB
III	Daconil Action	Syngenta	5.4	3	Appear II	Syngenta	8.0	AB
IV	Navicon	BASF	0.85	4	Signature Xtra	Bayer	4.0	AB
V	Maxtima	BASF	0.6	5	Civitas	Intelligro	17	AB
VI	Mirage Stressgard	Bayer	2.0	6	Affirm	Nufarm	1.0	AB
VII	UCR001	--	--	7	Fore	Corteva	8.0	AB

Application Intervals: A=8/21/21; 9/2/21.

Plot Plan (4 ft x 4 ft plots)

NW

VII 3	**IV 3**	**II 3**	**VI 3**	**III 3**	**I 3**	**V 3**
VII 1	**IV 1**	**II 1**	**VI 1**	**III 1**	**I 1**	**V 1**
VII 7	**IV 7**	**II 7**	**VI 7**	**III 7**	**I 7**	**V 7**
VII 2	**IV 2**	**II 2**	**VI 2**	**III 2**	**I 2**	**V 2**
VII 6	**IV 6**	**II 6**	**VI 6**	**III 6**	**I 6**	**V 6**
VII 4	**IV 4**	**II 4**	**VI 4**	**III 4**	**I 4**	**V 4**
VII 5	**IV 5**	**II 5**	**VI 5**	**III 5**	**I 5**	**V 5**
VII 1	**IV 1**	**II 1**	**VI 1**	**III 1**	**I 1**	**V 1**
VII 3	**IV 3**	**II 3**	**VI 3**	**III 3**	**I 3**	**V 3**
VII 6	**IV 6**	**II 6**	**VI 6**	**III 6**	**I 6**	**V 6**
VII 4	**IV 4**	**II 4**	**VI 4**	**III 4**	**I 4**	**V 4**
VII 7	**IV 7**	**II 7**	**VI 7**	**III 7**	**I 7**	**V 7**
VII 5	**IV 5**	**II 5**	**VI 5**	**III 5**	**I 5**	**V 5**
VII 2	**IV 2**	**II 2**	**VI 2**	**III 2**	**I 2**	**V 2**

Stop #4b: Evaluation of Fungicides for Control of Dollar Spot Disease on Creeping Bentgrass Putting Greens

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Objectives:

This study was conducted to evaluate 20 different fungicide treatments to control dollar spot *Clarireedia jacksonii* (formerly *Sclerotinia homoeocarpa*) disease on a creeping bentgrass (*Agrostis stolonifera*) putting green.

Materials and Methods:

The study was initiated on August 19, 2021 on a mature creeping bentgrass (*Agrostis stolinfera*) putting green with a sand-based root zone. Turf was mowed 5 days/wk at 0.125 inches and received no fertilizer during 2021 to help incite disease. The green was irrigated nightly to prevent water stress and to maximize leaf wetness for disease progression.

Fungicide treatments were applied every 14 days beginning on August 19. Some dollar spot disease was present at the beginning of the study and fungicide treatments were randomly assigned to plots within replications based on initial disease cover. Treatments were applied using a CO_2-powered backpack sprayer equipped with TeeJet 8003VS nozzles calibrated to deliver 2 gallons/1000 ft^2. Experimental design was a complete randomized block with 5 replications. Plot size was 4×6 ft with 2-ft alleys.

Plots were evaluated every two weeks visually for dollar spot disease severity (0-5, 5=100% cover). Data were analyzed using Analysis of Variance with Fisher's Protected Least Significant Difference (LSD) test (P =0.05).

Results:

Dollar spot disease that was present at the beginning of the study has subsided due to weather and fungicide treatments; however, no significant differences have been observed among treatments thus far (Table 1). The study will continue thru November 2021.

Acknowledgments

Thanks to the CTLF, BASF, Bayer, Corteva, FMC, Nufarm, and Syngenta for supporting this research and/or for providing products.

Table 1. Effects of fungicide treatments on dollar spot disease severity (0-5, 5 = 100% cover) on creeping bentgrass turf. 2021. Riverside, CA.

Trt	Product	Company	Rate (oz/1,000 ft^2)	Interval	Severity 8/19/21	Severity 8/27/21	Severity 9/1/21
1	Control	--	--	--	2.4	1.2	0.8
2	Encartis	BASF	4.0	A			
2	Maxtima	BASF	0.4	C			
2	Xzemplar	BASF	0.21	E			
2	Secure	Syngenta	0.5	G			
2	Navicon	BASF	0.1	I	1.2	0.0	0.0
3	Secure Action	Syngenta	0.5	ACEGI	1.8	0.2	0.0
4	Posterity	Syngenta	0.16	ACEGI	1.0	0.4	0.2
5	Secure Action	Syngenta	0.5	ACEGI			
5	Posterity	Syngenta	0.16	ACEGI	1.6	0.4	0.0
6	UCR001	--	--	--	1.2	0.0	0.2
7	UCR001	--	--	--	2.0	0.4	0.2
8	UCR001	--	--	--	1.0	0.0	0.0
9	UCR001	--	--	--	1.4	0.2	0.0
10	UCR001	--	--	--	1.0	0.4	0.8
11	Maxtima	Bayer	0.4	ACEGI	1.2	0.4	0.0
12	Maxtima	Bayer	0.4	ADGJ	1.8	0.6	0.4
13	UCR002	--	--	--	1.4	0.2	0.2
14	Pinpoint	Nufarm	0.31	ACEGI	1.2	0.0	0.0
15	Fame	FMC	0.36	ACEGI	1.2	0.2	0.2
16	UCR002	--	--	--			
16	Pinpoint	Nufarm	0.31	ACEGI	1.4	0.2	0.2
17	UCR002	--	--	--			
17	Fame	FMC	0.36	ACEGI	1.2	0.2	0.0
18	Xzemplar	BASF	0.16	ACEGI	1.4	0.0	0.2
19	Lexicon	BASF	0.47	ACEGI	1.0	0.2	0.0
20	Emerald	BASF	0.13	ACEGI	1.8	0.4	0.0

Means followed by the same letter in a column are not significantly different (P=0.05).

Application Intervals: A=8/19/21; C=9/2/21; D=9/10/21; E=9/17/21; G=10/1/21; I=10/15/21; J=10/22/21

2021 Dollar Spot Fungicide Trial Plot Plan

UC Riverside

NW

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

Stop #5: Postemergence Control of Crabgrass in Bermudagrass Turf

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Objectives:

Two studies were conducted to evaluate and compare the efficacy of various herbicides for smooth crabgrass (*Digitaria ischaemum*) control (in early tillering or mature stage) in hybrid bermudagrass (*Cynodon* spp.) maintained as a golf course fairway or athletic field.

Materials and methods:

The study was conducted on mature hybrid bermudagrass (*Cynodon* spp.) 'GN-1' turf on a Hanford fine sandy loam. Turf was mowed 2 days/wk at 0.5 inches and fertilized with a total of 1.5 lbs N in 2021 season separated into 3 fertilization events (0.5 lb N each). Treatments were applied using a CO_2-powered backpack sprayer equipped with TeeJet 8002VS nozzles calibrated to deliver 1 gallon/1000 ft^2. Irrigation to the plots was withheld for at least 24h following treatment application. Experimental design for both studies was a complete randomized block with 4 replications. Plot size was 4×6 ft with 1.5-ft alleys for "East" study (early tillering stage) and 3x3 ft with 1-ft alleys for "West" study (mature crabgrass). The East study was initiated on June 30, 2021 to target crabgrass at 1-3 tiller or 5 tiller stage. Treatments for this study are presented in Table 1. A low rate of Barricade (0.2 lbs ai/A) was applied in early February to the area where East study was conducted to reduce crabgrass pressure. The West study was initiated on August 19, 2021 to target mature crabgrass and treatments for this study are presented in Table 4. In both studies plots were evaluated for visual quality (1-9, 9 = best), crabgrass cover (%), crabgrass injury (%), turfgrass injury (%), Normalized Difference Vegetation Index (NDVI) using a GreenSeeker instrument and Dark Green Color Index (DGCI) as well as percent green cover using Digital Image Analysis (DIA). The differences in weed cover were assessed using non-parametric Kruskal-Wallis test with Mann-Whitney U-test for pairwise comparisons and using Analysis of Variance with Tukey's HSD post-hoc test for all other parameters at $P = 0.05$.

Results:

For a long time quinclorac was a standard application for control of crabgrass but overuse of this herbicide resulted in appearance of crabgrass populations resistant to this active ingredient. Such populations were also detected at this study location. Results for smooth crabgrass cover in the East study are presented in Table 2. Although crabgrass cover following two quinclorac treatments was never significantly different from the control, the numbers were lower. This was caused by successful eradication of susceptible plants, hence reducing number of plants present. Unfortunately, the majority of plants was not injured and soon increased in size, rapidly taking over the plots. Manuscript treatments (1,2,4 and 5), regardless of timing of application, were successful in controlling smooth crabgrass, reducing cover of this weed to 3-6% by September 1, 2021. However, despite being visible to the eye, reduction was not statistically significant and most likely due to variability among plots. The only treatment that was significantly different from control was treatment 10, which was able to control crabgrass with only one application but at the same time caused almost 2-month-long injury to bermudagrass. All other treatments with exception of treatments 8 and 9 caused only short-lasting injury to bermudagrass and this injury was below the acceptable value of 30% (Table 3).

By the time of publication of this report crabgrass cover was not reduced in West study, where mature crabgrass was targeted (data not shown). Turfgrass injury, crabgrass injury and percent green cover data for this study are presented in Table 5. The most effective treatments, causing 60-100% injury to crabgrass, were treatments 3, 7, 9 from single active ingredient treatments and all tank-mixed treatments (15-20). The most injurious at this point was treatment 9 (Pylex) causing >90% injury to bermudagrass. Addition of triclopyr reduced injury to bermudagrass but did not significantly reduce crabgrass injury. Out of the best performing treatments, treatments 17 and 20 caused the least turf injury (<10%). It is too early to determine the best performing products as some herbicides work slower and their efficacy can't be determined as soon as 2 weeks following initial application.

Acknowledgments:

Thanks to BASF, Bayer, Corteva, FMC, Syngenta and the California Turfgrass & Landscape Foundation (CTLF) for providing products and supporting this research.

Table 1. Herbicide treatments tested in “East” postemergence smooth crabgrass (*Digitaria ischaemum* (Schreb.) Schreb. ex Muhl.) control trial. Riverside, CA. 2021.

Treatment No	Product	Rate	Timing	Active Ingredient	Crabgrass Stage
1	Manuscript + Adigor + Barricade*	42 oz/A + 0.5% v/v + 16 oz/A	AC	Pinoxaden + Prodiamine	1-3 tillers
2	Manuscript + Adigor	42 oz/A + 0.5% v/v	AC	Pinoxaden	1-3 tillers
3	Drive XLR8 + MSO	64 oz/A + 0.5% v/v	AC	Quinclorac	1-3 tillers
4	Manuscript + Adigor + Barricade*	42 oz/A + 0.5% v/v + 16 oz/A	BD	Pinoxaden + Prodiamine	5 tillers
5	Manuscript + Adigor	42 oz/A + 0.5% v/v	BD	Pinoxaden	5 tillers
6	Drive XLR8 + MSO	64 oz/A + 0.5% v/v	BD	Quinclorac	5 tillers
7	Untreated Control				
8	Barricade	16 oz/A	A	Prodiamine	1-3 tillers
9	Barricade	16 oz/A	B	Prodiamine	5 tillers
10	Manuscript + Adigor + Barricade + Fusilade II	42 oz/A + 0.5% v/v + 16 oz/A + 16 oz/A	A	Pinoxaden + Prodiamine + Fluazifop-P-butyl	1-3 tillers

* - Barricade was only applied/tank mixed once

Application timing: A - 6/30/2021 B - 7/15/2021 C - 7/21/2021 D - 8/5/2021

Table 2. Effect of treatments on smooth crabgrass (*Digitaria ischaemum* (Schreb.) Schreb. ex Muhl.) cover (%) in “East” study. Riverside, CA. 2021.

Treatment	6/29/2021	7/2/2021	7/6/2021	7/14/2021	7/19/2021	7/23/2021	8/5/2021	8/23/2021	9/1/2021
Trt 01	7	10	7	6	8	8 ab	3 bc	5 ab	6 abc
Trt 02	7	10	6	3	5	4 ab	3 bc	5 ab	5 abc
Trt 03	8	7	9	12	14	16 ab	18 ab	21 ab	26 abc
Trt 04	7	9	14	12	12	6 ab	4 bc	4 b	5 bc
Trt 05	8	9	14	16	9	10 ab	6 abc	5 ab	3 bc
Trt 06	6	8	10	12	16	20 a	18 ab	28 a	24 a
Trt 07	7	9	13	13	18	20 ab	24 ab	40 ab	36 ab
Trt 08	10	14	16	15	17	21 ab	24 abc	27 ab	24 abc
Trt 09	8	10	13	16	22	20 ab	25 a	31 a	34 a
Trt 10	10	13	11	6	2	2 b	1 c	2 b	2 c
p-value	0.995	0.983	0.586	0.339	0.152	0.052	0.018	0.023	0.018

Means followed by the same letter in a column are not significantly different (P = 0.05).

Table 3. Effect of treatments in “East” study on turfgrass injury (%). Riverside, CA. 2021.

Treatment	6/29/2021	7/2/2021	7/6/2021	7/14/2021	7/19/2021	7/23/2021	8/5/2021	8/23/2021	9/1/2021
Trt 01	0	3 b	11 b	0 b	0 c	4 cd	0 b	0	0
Trt 02	0	1 bc	12 b	0 b	0 c	3 cd	1 b	0	0
Trt 03	0	2 bc	15 b	0 b	0 c	0 d	0 b	0	0
Trt 04	0	0 c	0 c	0 b	14 b	8 bc	4 b	0	0
Trt 05	0	0 c	0 c	0 b	11 b	7 bcd	0 b	0	0
Trt 06	0	0 c	0 c	0 b	12 b	13 b	0 b	0	0
Trt 07	0	0 bc	1 c	0 b	0 c	0 d	0 b	0	0
Trt 08	0	0 c	0 c	0 b	1 c	0 d	0 b	0	0
Trt 09	0	0 c	0 c	0 b	1 c	0 d	0 b	0	0
Trt 10	0	6 a	59 a	94 a	90 a	73 a	25 a	0	0
p-value		0.000	0.000	0.000	0.000	0.000	0.000		

Means followed by the same letter in a column are not significantly different (P = 0.05).

Table 4. Herbicide treatments tested in “West” postemergence smooth crabgrass (*Digitaria ischaemum* (Schreb.) Schreb. ex Muhl.) control trial. Riverside, CA. 2021.

Treatment No	Product	Rate	Timing	Active Ingredient
1	Untreated Control			
2	Manuscript + Adigor	40 oz/A + 0.5% v/v	AB	Pinoxaden
3	Tenacity + NIS	5 oz/A + 0.25% v/v	AC	Mesotrione
4	Sencor	5 oz/A	AC	Metribuzin
5	Dimension + NIS	32 oz/A + 0.25% v/v	AC	Dithiopyr
6	Tribute total + NIS	3.2 oz/A + 0.25% v/v	AC	Thiencarbazone-methyl + Foramsulfuron + Halosulfuron-methyl
7	Acclaim Extra + NIS	1 pt/A + 0.25% v/v	AC	Fenoxaprop-p-ethyl
8	Solitare WSL	5 oz/M	AC	Sulfentrazone + Quinclorac
9	Pylex + MSO	0.75 oz/A + 0.5% v/v	AC	Topramezone
10	Turflon Ester Ultra	16 oz/A	AC	Triclopyr
11	Barricade	16 oz/A	A	Prodiamine
12	Celsius + NIS	3.7 oz/A + 0.25% v/v	AC	Thiencarbazone-methyl + Iodosulfuron-methyl-sodium + Dicamba
13	UCR 001			
14	UCR 002			
15	Pylex + Turflon Ester Ultra + MSO	0.75 oz/A + 0.5% v/v	AC	Topramezone + Triclopyr
16	Tenacity + Sencor + NIS	5 oz/A + 5 oz/A + 0.25% v/v	AC	Mesotrione + Metribuzin
17	Dimension + RoundUp PowerMax + NIS	32 oz/A + 8 oz/A + 0.25% v/v	AC	Dithiopyr + Glyphosate
18	Dimension + Tenacity + NIS	32 oz/A + 5 oz/A + 0.25% v/v	AC	Dithiopyr + Mesotrione
19	Dimension + Sencor + NIS	32 oz/A + 5 oz/A + 0.25% v/v	AC	Dithiopyr + Metribuzin
20	Manuscript + Barricade* + Adigor	40 oz/A + 16 oz/A + 0.5% v/v	AB	Pinoxaden + Prodiamine

* - Barricade was only applied in timing A

Application timing: A - 8/19/2021 B - 9/4/2021 C - 9/18/2021

Table 5. Effect of treatments in "West" study on turfgrass injury (%), crabgrass injury (%) and percent green cover (%). Riverside, CA. 2021.

Treatment	Turfgrass Injury		Crabgrass Injury			Percent Cover		
	8/26/2021	9/1/2021	8/23/2021	8/26/2021	9/1/2021	8/23/2021	8/26/2021	9/1/2021
Trt 01	0 de	0 e	0 c	0 h	0 f	92 ab	90 a	89 a
Trt 02	4 cde	0 e	1 c	20 efgh	56 bcde	90 ab	78 abcd	68 abc
Trt 03	29 bc	7 cde	12 bc	65 abc	90 ab	92 ab	73 abcd	46 de
Trt 04	11 cde	0 e	8 bc	28 defgh	20 def	88 ab	72 abcd	77 a
Trt 05	5 cde	3 de	7 bc	9 h	16 ef	92 ab	86 abc	75 ab
Trt 06	6 cde	3 de	4 c	19 gh	21 cdef	93 ab	90 a	85 a
Trt 07	25 bcd	49 b	26 bc	56 bcd	62 abc	86 ab	65 bcd	41 de
Trt 08	12 cde	6 de	71 a	32 cdefgh	19 def	60 c	62 cd	78 a
Trt 09	52 a	92 a	15 bc	68 ab	95 ab	95 a	72 abcd	14 f
Trt 10	7 cde	39 bc	0 c	1 h	31 cdef	91 ab	82 abcd	68 abc
Trt 11	0 e	0 e	0 c	0 h	11 f	93 ab	89 ab	81 a
Trt 12	4 cde	2 de	3 c	19 gh	14 ef	92 ab	85 abc	82 a
Trt 13	7 cde	1 e	6 bc	20 fgh	18 ef	91 ab	86 abc	81 a
Trt 14	8 cde	0 e	2 c	20 fgh	15 ef	91 ab	86 abc	81 a
Trt 15	32 abc	68 ab	4 c	49 bcdefg	89 ab	90 ab	75 abcd	28 ef
Trt 16	38 ab	34 bcd	29 bc	94 a	100 a	86 ab	23 e	14 f
Trt 17	9 cde	8 cde	40 ab	66 abc	76 ab	82 b	62 cd	49 cde
Trt 18	27 bc	15 cde	7 bc	55 bcde	80 ab	93 ab	79 abcd	40 de
Trt 19	12 cde	14 cde	14 bc	54 bcdef	62 abc	88 ab	60 d	54 bcd
Trt 20	4 cde	2 de	5 c	28 defgh	60 abcd	91 ab	82 abcd	69 abc
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Means followed by the same letter in a column are not significantly different (P = 0.05).

Plot Plan for “East” Crabgrass Control Study

101 Trt 01	102 Trt 02	103 Trt 03	104 Trt 04	105 Trt 05
201 Trt 09	202 Trt 10	203 Trt 08	204 Trt 07	205 Trt 06
301 Trt 07	302 Trt 02	303 Trt 08	304 Trt 04	305 Trt 03
401 Trt 05	402 Trt 09	403 Trt 01	404 Trt 10	405 Trt 06
501 Trt 01	502 Trt 08	503 Trt 05	504 Trt 07	505 Trt 09
601 Trt 06	602 Trt 03	603 Trt 10	604 Trt 02	605 Trt 04
701 Trt 05	702 Trt 02	703 Trt 06	704 Trt 04	705 Trt 01
801 Trt 10	802 Trt 03	803 Trt 07	804 Trt 08	805 Trt 09

Plot Plan for “West” Crabgrass Control Study

101 Trt 01	102 Trt 02	103 Trt 03	104 Trt 04	105	106	107 Trt 05
201 Trt 12	202 Trt 11	203 Trt 10	204 Trt 09	205 Trt 08	206 Trt 07	207 Trt 06
301 Trt 13	302 Trt 14	303 Trt 15	304 Trt 16	305 Trt 17	306	307 Trt 18
401 Trt 09	402 Trt 06	403 Trt 12	404 Trt 18	405 Trt 03	406 Trt 20	407 Trt 19
501 Trt 02	502 Trt 13	503 Trt 20	504 Trt 15	505 Trt 07	506 Trt 18	507 Trt 05
601 Trt 12	602 Trt 05	603 Trt 08	604 Trt 01	605 Trt 17	606 Trt 14	607 Trt 10
701	702 Trt 03	703 Trt 20	704 Trt 02	705 Trt 11	706 Trt 16	707 Trt 04
801 Trt 19	802 Trt 13	803 Trt 11	804 Trt 08	805 Trt 05	806 Trt 14	807 Trt 04
901	902 Trt 07	903 Trt 04	904 Trt 14	905 Trt 19	906 Trt 09	907 Trt 17
1001	1002 Trt 20	1003 Trt 07	1004 Trt 12	1005 Trt 02	1006 Trt 15	1007 Trt 11
1101	1102 Trt 16	1103 Trt 01	1104 Trt 10	1105 Trt 18	1106 Trt 06	1107 Trt 03
1201	1202 Trt 01	1203 Trt 16	1204 Trt 06	1205 Trt 08	1206 Trt 13	1207 Trt 10
1301	1302	1303 Trt 17	1304	1305	1306	1307
1401	1402 Trt 19	1403 Trt 09	1404 Trt 15	1405	1406	1407

Stop #6a: Evaluation of Fungicides for Control of Rapid Blight Disease on Annual Bluegrass Putting Greens

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Objectives:

This study was conducted to evaluate 12 different fungicide treatments to control rapid blight disease caused by *Labyrinthula terrestris* on an annual bluegrass (*Poa annua*) putting green.

Materials and Methods:

The study was conducted on a 5,400-ft^2 research putting green that was constructed according to USGA recommendations in 2019. A 12-inch sand and peat rootzone mix was derived to simulate a mature putting green with a minimum allowable infiltration rate. Gravel and drainage were installed below the rootzone layer. The green was established with *Poa annua* var. *reptans* 'Two Putt' seed in the spring 2019 and thin or bare areas of turf following the 2019 and 2020 studies were seeded again in spring 2021. In addition, the green became contaminated with bentgrass and various warm-season turfgrasses, which had to be physically removed, replaced with sand, and seeded with annual bluegrass. The combination of hot weather, turf re-establishment, and weed encroachment left the green with sparse areas of annual bluegrass prior to initiation of the study. Turf was mowed at 0.125 inches 5 times/wk, lightly topdressed with sand biweekly, and received Primo Maxx at 0.125 oz/M biweekly. Granular fertilizer (Best Micro Green 15-5-8 + 5% Fe; J.R. Simplot) was applied monthly at 0.5 lb N/M following solid tine aeration. Furthermore, Grigg Brothers (Brandt) products were sprayed weekly according to protocols from the 2020 salinity trial. To control diseases other than rapid blight, fungicides including Briskway, Banner Maxx II, Subdue Maxx, Medallion SC, Heritage WG, and Maxtima were applied alone or in various combinations every month throughout the study period. Scimitar insecticide was applied twice throughout the study period to control ants.

A total of 12 treatments including an untreated control were evaluated in this study. The list of products and timing of application is presented in Table 1. Treatments were initiated on August 1, 2021. Starting from August 3, plots were irrigated with saline water (electrical conductivity = EC = 4.4 dS/m) at 100-120% ET_o. Saline water was made by mixing salts in potable water within two 5000-gal storage tanks containing submersible pumps for mixing and agitation. Saline water ion composition was based on Colorado River water (personal communication, D.L. Suarez, USDA-ARS Salinity Laboratory) and contained elevated concentrations of salts including Na^+, Cl^-, and SO_4^{2-} but nominal HCO_3^- and CO_3^{2-}. Saline water used to irrigate plots was classified as very high in salinity. Total salinity of the water was chosen to simulate an extreme, but realistic irrigation salinity for turf in California (personal communication, M. Huck). Turf was also syringed daily by hand using potable water to ensure uniform water distribution on the plots and help neutralize effects of salinity stress.

Fungicide treatments were applied every 14 days beginning on August 1 and ending on September 10 for a total of 4 applications. Treatments were applied using a CO_2-powered backpack sprayer equipped with TeeJet 8003VS nozzles calibrated to deliver 2 gallons/1000 ft^2. Experimental design was a randomized block with 10 replications. Plot size was 4×6 ft with 2-ft alleys. Plots were evaluated every two weeks visually for turf quality (1-9; 9=best) and disease cover (0-100%). Data were analyzed using Analysis of Variance with Fisher's Protected Least Significant Difference (LSD) test.

Results:

Although there was a great deal of turf stress and loss at the beginning of the study, which was not caused by rapid blight disease, positive performance of certain fungicide treatments thus far, including Insignia, Navicon, Daconil Action + Appear II, and Velista + Appear II, point toward the presence of rapid blight disease in the study area. Disease samples from the untreated control and top-performing treatments were submitted to the University of Florida Rapid Turfgrass Diagnostic Clinic and results were pending by publication of this report. Ratings will continue until October 8 (4 wks after 4th application).

Acknowledgments

Thanks to the CTLF, BASF, Bayer, Corteva, FMC, and Syngenta for supporting this research and/or for providing products.

Table 1. Effects of fungicide treatments on turf quality (1-9, 9 = best) and disease cover (0-100%) on annual bluegrass turf. 2021. Riverside, CA.

Trt	Product	Company	Rate (oz/1,000 ft²)	Interval	Quality 8/27/21	Quality 9/1/21	Cover 8/27/21	Cover 9/1/21
1	Control	--	--	--	3.9 a-d	4.1 bcd	47 a-d	45 abc
2	Fame	FMC	0.36	ABCD	4.0 a-d	3.9 cd	48 abc	43 a-d
3	Rayora	FMC	1.4	ABCD	3.8 a-d	3.8 cd	44 a-d	46 abc
4	Insignia	BASF	0.4	ABCD	4.5 a	4.5 a-d	36 bcd	32 cd
5	Navicon	BASF	0.7	ABCD	4.3 abc	4.9 ab	34 cd	33 bcd
6	Fore	Corteva	8.0	ABCD	4.1 a-d	4.2 bcd	42 a-d	40 a-d
7	Signature Xtra	Bayer	4.0	ABCD	3.5 cd	3.7 d	50 ab	50 a
8	Fore	BASF	8.0	ABCD				
8	Signature Xtra	Bayer	4.0	ABCD	3.4 d	3.9 cd	48 abc	48 ab
9	Daconil Action	Syngenta	3.5	ABCD				
9	Appear II	Syngenta	6.0	ABCD	4.4 ab	4.7 abc	34 cd	28 d
10	Velista	Syngenta	0.5	ABCD				
10	Appear II	Syngenta	6.0	ABCD	4.6 a	5.3 a	32 d	33 bcd
11	Secure Action	Syngenta	0.5	ABCD				
11	Appear II	Syngenta	6.0	ABCD	3.6 bcd	3.9 cd	48 abc	43 a-d
12	Ascernity	Syngenta	1.0	ABCD				
12	Appear II	Syngenta	6.0	ABCD	3.6 bcd	4.2 bcd	52 a	47 abc
					P = 0.04	P = 0.019	P = 0.096	P = 0.087

Means followed by the same letter in a column are not significantly different.

Application Intervals: A=8/1/21; B=8/15/21; C=8/27/21; D=9/10/21.

2021 Rapid Blight Fungicide Trial Plot Plan

UC Riverside

NW	I	II	III	IV	V	VI
1	1	11	6	10	5	4
2	2	8	3	7	1	9
3	3	7	5	12	10	2
4	4	9	2	11	2	6
5	5	10	9	6	3	4
6	6	6	4	11	10	5
7	7	11	8	8	1	3
8	8	7	10	2	6	7
9	9	9	1	4	9	12
10	10	7	5	10	1	5
11	11	12	3	2	4	11
12	12	4	5	2	8	9
13	6	12	1	11	3	12
14	1	2	12	8	7	4
15	12	5	7	2	3	8
16	3	4	10	1	8	2
17	7	8	1	7	12	9
18	6	10	11	3	10	11
19	12	9	6	9	4	5
20	11	3	8	6	5	1

Stop #6b: Evaluation of Fungicides for Control of Summer Patch Disease on Kentucky Bluegrass

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Objectives:

This study was conducted to evaluate 19 different fungicide treatments to summer patch (*Magnaporthe poae*) disease preventatively on Kentucky bluegrass turf.

Materials and Methods:

The study was initiated on June 6, 2021 on mature Kentucky bluegrass (*Poa pratensis*) turf on a Hanford fine sandy loam. The plot was established in 2020 using a cultivar with confirmed susceptibility to summer patch disease. Turf was mowed 3 days/wk at 1.75 inches and received multiple applications of fertilizer during the study period using ammonium nitrate to elevate pH and favor shoot growth over root growth. In addition, irrigation was provided deeply and infrequently to provide both waterlogged and water stress conditions to favor disease activity.

Fungicide treatments were applied every 21 or 28 days beginning on June 6 (before disease symptoms were present) and ending on August 20 for a total of 3 or 4 applications. Treatments were applied using a CO_2-powered backpack sprayer equipped with TeeJet 8003VS nozzles calibrated to deliver 2 gallons/1000 ft^2 and watered in immediately after application. Experimental design was a randomized block with 5 replications. Plot size was 4×6 ft.

Plots were evaluated every two weeks visually for turf quality (1-9; 9=best) and summer patch disease severity (0-5, 5=100% cover) once disease activity was present. Data were analyzed using Analysis of Variance with Fisher's Protected Least Significant Difference (LSD) test (P=0.05).

Results:

Summer patch disease in affected plots was confirmed by submitting samples to the University of Florida Rapid Turfgrass Diagnostic Center. Symptoms were most evident beginning on August 20 (Table 1). Of the treatments evaluated, Mirage Stressgard, Maxtima, and Briskway provided the best control of this disease.

Acknowledgments

Thanks to the CTLF, BASF, Bayer, Corteva, FMC, and Syngenta for supporting this research and/or for providing products.

Table 1. Effects of fungicide treatments on summer patch disease severity (0-5, 5 = 100% cover) on Kentucky bluegrass turf. 2021. Riverside, CA.

Trt	Product	Company	Rate (oz/1,000 ft^2)	Interval	Severity 8/20/21	Severity 8/27/21	Severity 9/1/21
1	Control	--	--	--	1.2 a-d	1.8 a-d	2.0 abc
2	Ascernity	Syngenta	1.0	ADGK	0.6 bcd	1.0 b-e	1.2 b-e
3	Briskway	Syngenta	0.9	ADGK	0.2 cd	0.4 de	0.2 de
4	UCR001	--	--	--	1.2 a-d	1.8 a-d	2.2 abc
5	UCR001	--	--	--	1.4 a-c	2.4 ab	2.6 ab
6	UCR001	--	--	--	0.2 cd	0.8 cde	1.0 cde
7	UCR002	--	--	--			
7	Compass	Bayer	0.25	ACE	1.0 a-d	1.8 a-d	2.2 abc
8	UCR002	--	--	--			
8	Compass	Bayer	0.25	ACE	1.8 ab	1.8 a-d	2.4 abc
9	UCR002	--	--	--			
9	Compass	Bayer	0.25	ACE	2.2 a	2.6 a	2.6 ab
10	Armada	Bayer	1.5	ACEK	1.2 a-d	1.0 b-e	1.2 b-e
11	UCR002	--	--	--			
11	Compass	Bayer	0.25	AEI	1.2 a-d	1.4 a-e	1.6 a-d
12	UCR002	--	--	--			
12	Compass	Bayer	0.25	AEI	1.0 a-d	1.2 a-e	1.4 a-e
13	UCR002	--	--	--			
13	Compass	Bayer	0.25	AEI	1.6 ab	1.8 a-d	2.2 abc
14	Armada	Bayer	1.5	AEIK	1.2 a-d	1.2 a-e	1.4 a-e
15	Rayora	FMC	1.4	ADGK	1.0 a-d	1.4 a-e	1.6 a-d
16	Maxtima	BASF	0.8	ADGK	0.0 d	0.2 e	0.2 de
17	Mirage Stressgard	Bayer	2.0	ADGK	0.0 d	0.0 e	0.0 e
18	Fore	Corteva	6.0	ADGK	1.8 ab	2.4 ab	2.8 a
19	Pillar G	BASF	48	AEI	1.6 ab	2.2 abc	2.6 ab

Means followed by the same letter in a column are not significantly different (P=0.05).

Application Intervals: A=6/6/21; C=6/20/21; D=6/27/21; E=7/4/21; G=7/13/21; I=8/3/21; K= 8/20/21.

2021 Summer Patch Fungicide Trial Plot Plan

UC Riverside

NW	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	X	18	17	16	15	1	2	14	13	12	11	10	9	3
2	8	19	1	2	7	3	4	6	5	5	6	7	4	8
3	14	11	16	9	10	10	16	8	3	11	15	6	18	2
4	13	X	6	12	7	19	18	8	5	1	2	13	4	11
5	14	12	3	1	14	15	16	17	2	3	18	4	17	5
6	X	11	10	9	8	9	5	7	9	4	1	17	10	6
7	19	12	13	19	12	13	14	15	19	7	16	17	15	18

Stop #7: USGA/NTEP Warm-Season Water Use Trial

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Department of Botany and Plant Sciences
University of California, Riverside
Presented By Bernd Leinauer and Elena Sevostianova, New Mexico State University

Objectives:

The National Turfgrass Evaluation Program (NTEP) is one of the most well-known turfgrass variety research and testing programs in the United States, Canada, and many other countries. The NTEP organization has been dedicated to evaluating new turfgrass genotypes and provides valuable data to end-users. Water conservation is increasingly important when selecting turfgrasses, especially in the southwestern United States. Deficit irrigation is a common practice for water conservation in areas where limited water is available. Warm-season turfgrasses are generally more drought-resistant than cool-season grasses. A total of 20 entries, including three species of warm-season grasses [bermudagrass (*Cynodon spp.*), buffalograss (*Buchloe dactyloides* L.), and zoysiagrass (*Zoysia spp.*)], were evaluated under deficit irrigation conditions (Table 1). The objective of this study was to determine the amount of water needed to sustain acceptable turfgrass quality and to identify cultivars best adapted to drought conditions.

Materials and Methods:

The study area was established on June 22, 2018 with 14 bermudagrass, 4 zoysiagrass, and 2 buffalograss entries (Table 1, Figure 1). Turf was maintained under fairway conditions and mowed three times/wk at 0.5 inches. Plots received 0.5 lb N/1000 ft^2/month for a total of 4.5 lbs N/yr. The entries were maintained under non-limiting irrigation conditions before and after the deficit irrigation treatment period, which takes place from June 1 to October 15, 2019, 2020, and 2021. During that period, replicated plots were irrigated by hand watering 3 times/wk at three reference evapotranspiration (ET_o) replacements: 60%, 45%, and 30% ET_o. Visual turfgrass quality (1-9 scale, optimum color, density, texture, and uniformity) and percentage green cover (using digital image analysis through turf analyzer software) are recorded weekly during the deficit irrigation conditions. Statistical analysis of 2021 data, showed a significant variety, ET_o replacement and sampling date effect. The interaction variety*sampling date was also shown to be significant. Values presented in Table 2 represent an average of 12 sampling dates (from June 1 to August 24, 2021) and 3 replications.

Results

During the summers of 2019 and 2020, the tested entries showed a wide range of cover and quality among three ET_o levels. Similar results were observed in 2021 (Table 2).

At 60% ET_o, which would be considered mild deficit irrigation for warm-season turfgrasses, FB 1628 bermudagrass had the highest visual quality of 8.3 followed by FAES 1306 zoysiagrass; however, Meyer zoysiagrass exhibited a quality rating of 4.9. Other bermudagrasses showing good turfgrass quality at 60% included UCR 17-8.

For southern California, 45% ET_o is considered stressful deficit irrigation and thus representing significantly lower water use. Under such stressful conditions, TifTuf and OKC 1211 bermudagrasses are showing the highest turfgrass quality, but not statistically different from several other entries, including UCR 17-8.

At 30% ET_o, which is the most extreme deficit irrigation, TifTuf and UCR 17-8 bermudagrasses, were the only entries to exhibit turfgrass quality above 5.0.

As expected, turf cover declined with reducing irrigation levels (60 ET_o > 45 ET_o > 30% ET_o) with the largest variation in coverage among the 30% ET_o irrigation treatment.

In summary, among the tested entries in this study, bermudagrass was the most drought-resistant species compared to zoysiagrass and buffalograss. Some bermudagrasses, including UCR 17-8 and TifTuf, maintained acceptable quality even when irrigated as low as 30% ET_o replacement. UCR 17-8 was selected for its superior drought resistance and also for winter color when most warm-season grasses enter dormancy. From the beginning of this study, UCR 17-8 has demonstrated darker green color during the winter months than all other entries (data not shown).

Using newly developed turfgrasses in southern California, such as UCR 17-8 and TifTuf, proper cultivar selection could result in significant water savings of more than 50% compared to cool-season turfgrasses such as tall fescue.

This is the final year of the trial, and the deficit irrigation will continue until October 15, 2021. The same study is conducted in 5 other locations across the USA using similar irrigation regimes. Data from Riverside and other locations are available at www.ntep.org.

Acknowledgments

We appreciate the financial support of the National Turfgrass Evaluation Program (NTEP) and the United States Golf Association (USGA).

Table 1. Entry list for the 2018 National Warm-Season Water Use and Drought Resistance Test.

Entry Number	Species	Cultivar	Establishment method
1	Bermuda	Tifway	Vegetative
2	Bermuda	Dog Tuff	Vegetative
3	Bermuda	ASC 118	Seeded
4	Bermuda	ASC 119	Seeded
5	Bermuda	OKC 1221	Vegetative
6	Bermuda	Premier Pro	Vegetative
7	Bermuda	Tahoma 31	Vegetative
8	Bermuda	TifTuf ™	Vegetative
9	Bermuda	JSC 2009-6-s	Seeded
10	Bermuda	Monaco	Seeded
11	Zoysia	Meyer	Vegetative
12	Zoysia	Stellar	Vegetative
13	Zoysia	FAES 1306	Vegetative
14	Zoysia	FAES 1307	Vegetative
15	Bermuda	FB 1628	Vegetative
16	Buffalo	Prestige	Vegetative
17	Buffalo	Cody	Seeded
18	Bermuda	UCR 17-8	Vegetative
19	Bermuda	UCR BF1	Vegetative
20	Bermuda	UCR BF2	Vegetative

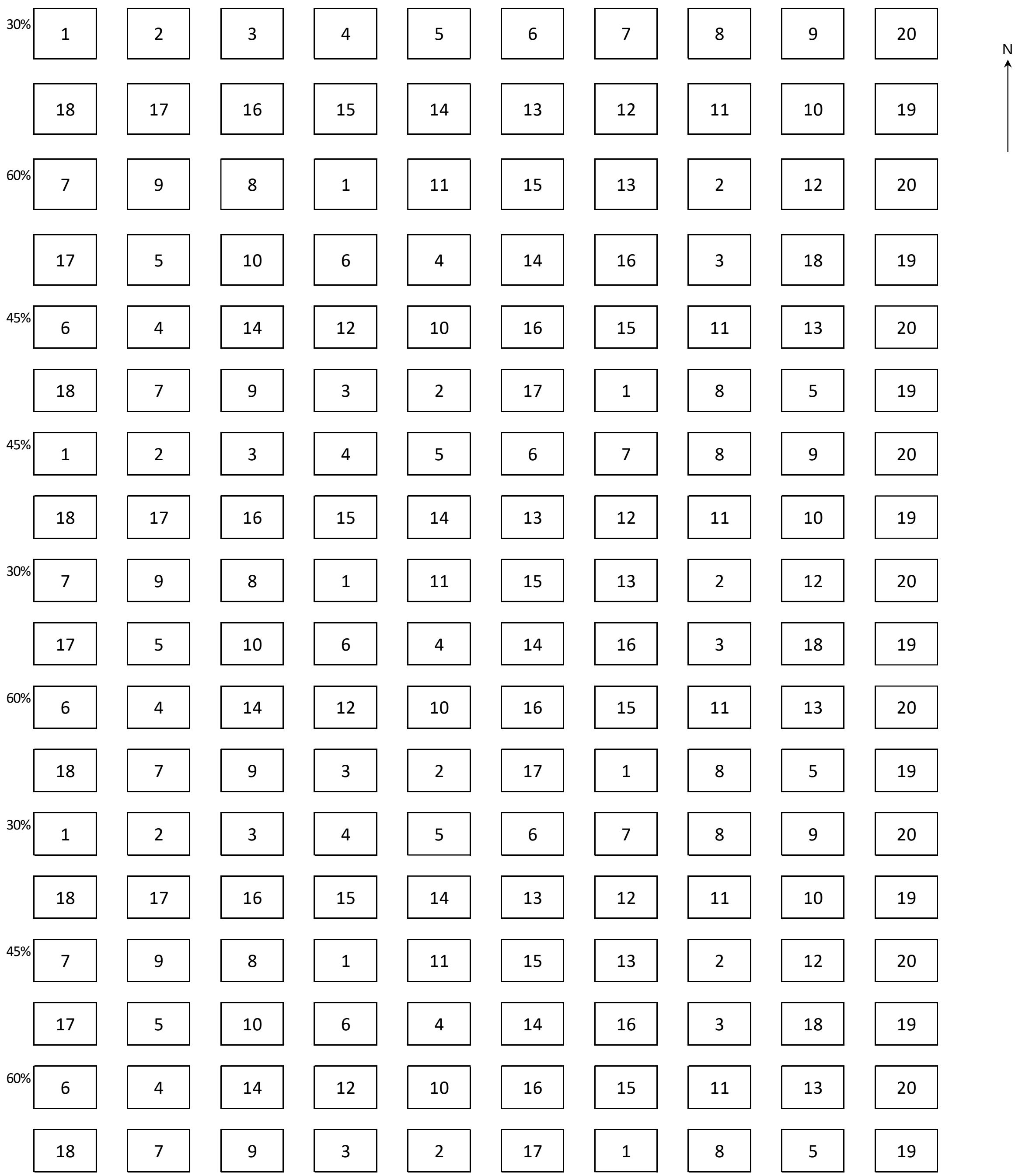

Figure 1. Plot plan for the 2018-2021 USGA/NTEP warm season drought trial. Riverside, CA.

Table 2. Turf quality and percent green turf cover of warm-season turfgrasses under deficit ET_o levels in summer 2021.

Cultivar	Turfgrass Quality (1-9)			Green turf cover (%)		
	30% ET_o	45% ET_o	60% ET_o	30% ET_o	45% ET_o	60% ET_o
ASC 118	3.3 ABC*	4.1 AB	4.8 C	62.6 C	69.7 C	78.1 BC
ASC 119	2.8 BC	3.5 B	4.8 C	45.3 E	59.9 C	82.0 BC
Cody	3.4 ABC	4.1 AB	4.9 C	64.4 C	69.1 C	70.4 C
Dog Tuff	5.0 ABC	5.4 AB	6.3 ABC	80.2 AB	83.5 AB	90.9 AB
FAES 1306	3.9 ABC	6.2 AB	7.8 AB	66.0 BC	84.4 AB	96.2 A
FAES 1307	3.1 ABC	4.3 AB	6.5 ABC	62.2 C	73.8 BC	89.3 B
FB 1628	4.4 ABC	5.5 AB	8.3 A	68.5 BC	85.9 AB	97.5 A
JSC 2009-6-s	3.7 ABC	5.1 AB	5.8 ABC	64.9 C	80.2 B	87.4 B
Meyer	2.4 C	3.8 AB	4.9 C	42.5 E	60.0 C	76.9 BC
Monaco	4.5 ABC	5.4 AB	6.1 ABC	76.2 AB	88.5 AB	92.9 AB
OKC 1221	4.3 ABC	6.7 A	6.4 ABC	68.6 BC	92.6 A	90.1 AB
Premier Pro	3.4 ABC	5.6 AB	6.5 ABC	55.6 D	84.8 AB	91.7 AB
Prestige	4.1 ABC	4.6 AB	5.6 ABC	76.1 AB	75.5 BC	89.8 B
Stellar	4.3 ABC	5.8 AB	7.4 ABC	72.0 B	84.5 AB	96.3 A
Tahoma 31	4.6 ABC	5.6 AB	7.1 ABC	70.4 B	79.3 B	93.3 AB
TifTuf ™	5.7 A	6.5 A	7.2 ABC	84.2 A	90.5 A	95.0 AB
Tifway	4.6 ABC	5.5 AB	6.8 ABC	73.6 B	81.2 B	91.3 AB
UCR 17-8	5.4 AB	6.4 AB	7.5 ABC	81.5 AB	93.3 A	95.8 A
UCR BF1	2.2 C	4.6 AB	5.7 ABC	40.0 E	78.0 B	86.2 B
UCR BF2	2.6 BC	4.9 AB	5.2 BC	52.9 D	79.7 B	82.8 BC

*Means followed by the same letter in a column are not statistically different ($P < 0.05$)

Stop #8: Curative Effects of Soil Surfactants for Localized Dry Spot (LDS) on Putting Greens

Matteo Serena, Luiz Monticelli, and Jim Baird
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University of California, Riverside

Objectives:

Soil surfactants have been used successfully on golf courses to prevent the onset of localized dry spot (LDS) on putting greens. Generally, these products are applied on a regular basis to prevent the development of hydrophobic conditions. However, there are limited data on curative applications made when hydrophobic conditions are already visible. The objective of this study was to evaluate the performance of several soil surfactant chemistries applied curatively to promote recovery and maintain turfgrass quality on sandy soils that are already severely hydrophobic. In this study, we tested 12 different products against an untreated control to establish the best option for curative and preventative treatments of LDS.

Materials and Methods:

An established sand-based creeping bentgrass 'Pure Distinction' putting green with a history of LDS was used to test 12 soil surfactants applied at 4-wk intervals. The green was mowed 5 days/wk at 0.125 inches and received bi-weekly sand topdressing. All treatments were applied on a 28-d interval starting on June 24, 2021. List of treatments and rates are provided in Table 1, plot plan for the study is presented in Figure 1. Each treatment was replicated 6 times and applied on a 4-ft by 4-ft plot with 1-ft border, with 0.1 inches of water applied immediately after application. Data collection consisted of weekly turfgrass quality (1-9; 9=best); digital image analysis to measure cover (% green turf color) and dark green color index (DGCI) (0-0.666); and Normalized Difference Vegetation Index (NDVI) (0-1). For each plot, 10 readings for moisture content (%VWC) at 3 depth (0.5, 1.5, and 3 inches) were collected using a Field Scout 350 (Spectrum technologies). The standard deviation among 10 readings was used as an estimate of moisture uniformity in the soil.

Results:

During the first two months of the study, some treatments have shown improvement in turfgrass quality (Fig. 2). Revolution, ReWet, TriCure AD, and Hydro-90 have produced the highest turfgrass quality at the time of publication. All treatments except UCR-Exp4 increased NDVI values, which is a good indicator of turfgrass health (Fig. 3). In general, most of the treatments were able to maintain good moisture distribution in the soil profile down to 3 inches when compared to the (Table 2). The study will continue in the fall until appreciable rainfall occurs.

Acknowledgments

We appreciate the financial support of Simplot Partners, Mitchell Products, Harrell's and Numerator Technologies.

Table 1. Treatment list and rates for the 2021 localized dry spot, Riverside, CA.

No.	Name	Manufacturer	Rate (oz/1000 ft^2)
1	Non-treated control		
2	Revolution	Aquatrols	6
3	UCR-Exp1	Simplot	
4	UCR-Exp2	Simplot	
5	Rely III	Simplot	6
6	ReWet	Simplot	8
7	TriCure AD	Mitchell Products	3
8	UCR-Exp3	Mitchell Products	
9	UCR-Exp4	Mitchell Products	
10	SP 2300	Harrell's	5
11	Hydro-90	Harrell's	5
12	Symphony	Harrell's	5
13	UCR-Exp4	Numerator Technologies	

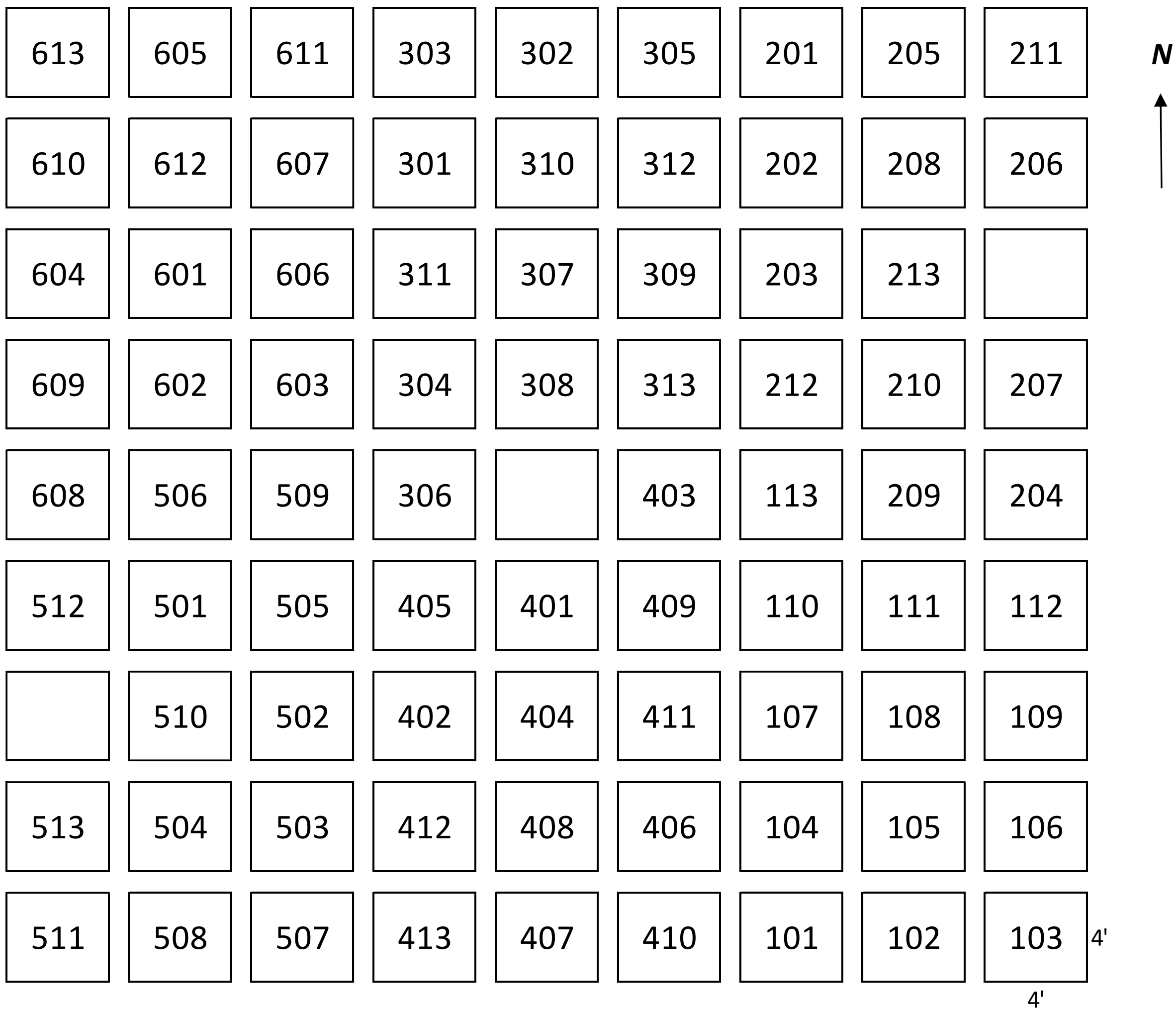

Figure 1. Plot plan for the 2021 localized dry spot study. Riverside, CA.

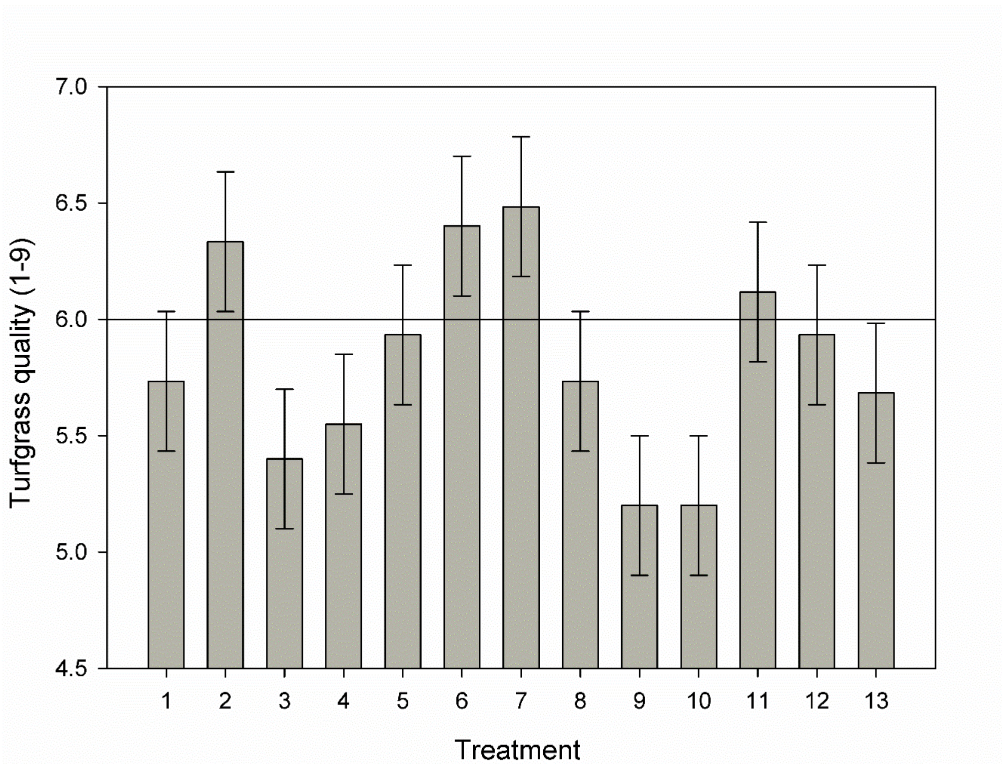

Figure 2. Average turfgrass quality for the LDS study from June 24 to August 26, 2021.

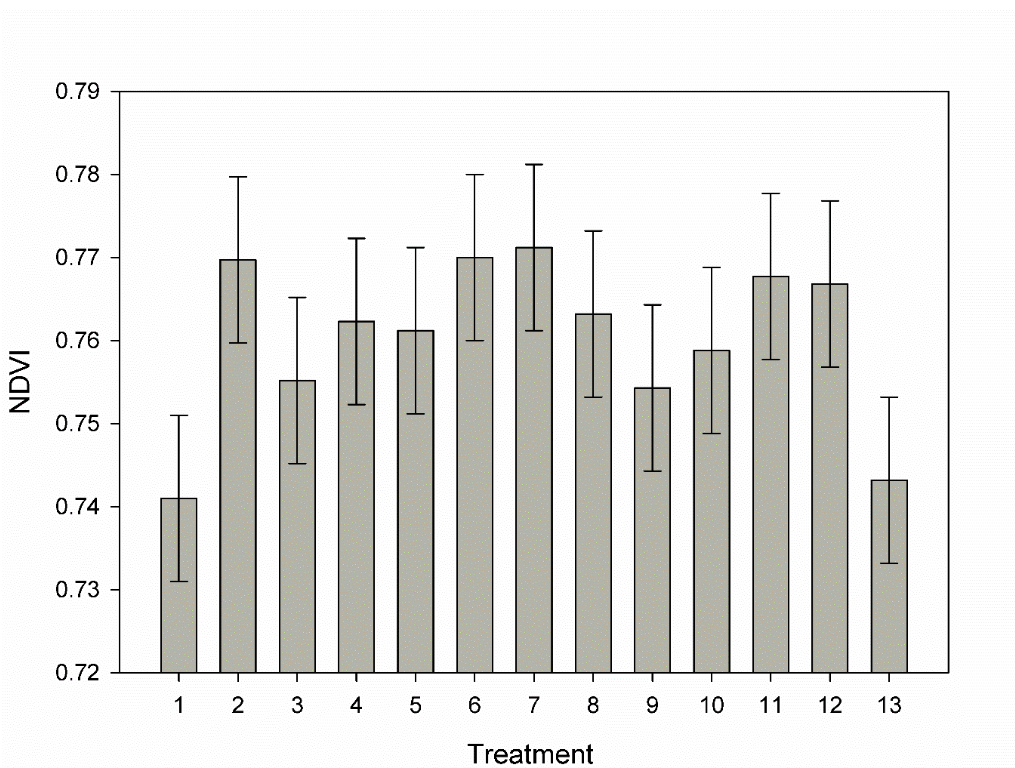

Figure 3. Average Normalized Difference Vegetation Index (NDVI) for the LDS study from June 24 to August 26, 2021.

Table 2. Average volumetric moisture content (VWC %) and moisture uniformity (standard deviation of 10 readings). Values represents an average of 10 sampling dates from June 24 to August 26, 2021) and 6 replications. *Lower uniformity values represent better moisture uniformity.

Treatment	0.5 inches		1.5 inches		3 inches	
	VWC (%)	Uniformity*	VWC (%)	Uniformity	VWC (%)	Uniformity
1	7.4 ab[y]	2.0 ab	25.2 ab	3.7 ab	23.1 ab	4.7 ab
2	7.1 ab	1.7 ab	24.9 ab	3.6 ab	22.9 ab	4.5 ab
3	7.9 ab	2.1 ab	25.6 ab	4.2 a	22.6 ab	5.1 a
4	7.2 ab	1.7 ab	22.9 ab	3.2 ab	19.4 b	4.1 ab
5	7.0 ab	1.5 b	26.4 ab	3.1 ab	25.0 a	4.4 ab
6	8.0 ab	1.7 ab	25.4 ab	2.9 b	22.4 ab	3.6 b
7	7.5 ab	1.6 ab	26.2 ab	3.4 ab	23.9 ab	4.6 ab
8	7.3 ab	1.7 ab	24.8 ab	3.1 ab	21.1 ab	3.8 ab
9	7.0 ab	1.7 ab	22.8 b	3.1 ab	19.0 b	3.8 ab
10	6.8 b	1.8 ab	23.6 ab	3.8 ab	21.0 ab	4.5 ab
11	8.8 a	1.7 ab	28.9 a	3.4 ab	26.0 a	4.4 ab
12	7.5 ab	1.7 ab	25.4 ab	3.2 ab	22.1 ab	4.4 ab
13	8.5 a	2.3 a	27.0 ab	4.1 a	24.0 ab	5.2 a

[y] Means followed by the same letter in a column are not statistically different ($P < 0.05$).

Stop #9: NTEP Bermudagrass Water Use and Zoysiagrass Trials

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University of California, Riverside

Objectives:

The National Turfgrass Evaluation Program (NTEP) facilitates evaluation of turfgrass species in various areas of the United States and Canada, providing valuable information for individuals, companies, researchers, and other entities in thirty countries. The program provides a broad picture of cultivars' adaptation but also helps to determine if they are well adapted to local environment. The importance of water saving in California cannot be overestimated and one of the solutions is to expand use of warm-season turfgrass species on golf courses, athletic fields and home lawns. Bermudagrass and zoysiagrass trials are conducted at UCR to evaluate performance of those warm-season species in Southern California, but the approach for each of the studies is different. The objective of bermudagrass trial is to evaluate performance under deficit irrigation, but also winter color retention and spring greenup for fairway/tee use. The objective of zoysiagrass trial is to evaluate suitability for athletic fields and home lawns, also with focus on winter color retention and spring greenup, but without inducing additional stresses.

Materials and Methods:

The bermudagrass study was established on 06/27/2019 (vegetative entries) and 07/03/2019 (seeded entries) and is mowed in 5/8 in. The zoysiagrass study was established on 06/20/2019 with mowing height 2 in. List of entries in both trials is provided in Table 1. In both trials establishment rate (% ground cover), turfgrass quality (1-9; 9=best), spring greenup (1-9; 1=dormant), leaf texture (1-9; 9=finest), genetic color (1-9; 9=darkest green), fall/winter color retention (1-9; 1=dormant; starting second full year of the trial) are being evaluated. In addition, seedhead production (1-9; 1=no seedheads) is being evaluated and, in bermudagrass trial, performance under deficit irrigation (% green cover). Deficit irrigation was applied between 08/03/2020 and 10/31/2020 at 40% evapotranspiration (ET_{os}) replacement, and starting on 07/07/2021 at 35% ET_{os}. During this period turfgrass quality and percent green retention are being evaluated. Deficit irrigation study will be repeated every summer.

Results:

Significant differences were observed among all entries of both species for most of evaluated traits.

In terms of overall turfgrass quality bermudagrass entries MSB-1017, 'TifTuf', OKC 1876 and 2 local checks UCR TP6-3 and UCR 17-8 showed good performance over two seasons of ratings (Table 2). These entries were characterized by rather fine leaf texture. The best fall/winter color retention and spring greenup showed FB 1902. OKC 1876, UCR 17-8 and UCR TP6-3 also retained color well in the winter and greened up quickly in the spring. Among seeded entries JSC 2013-5S, JSC 2013-10S and ‘Monaco’ showed the highest overall quality. Good fall/winter color retention showed PST-R6MM, DLF-460/3048 and ‘Monaco’, while the fastest greenup JSC 2013-5S, JSC 2013-8S and JSC 2031-10S. Seedhead production of seeded entries was on average higher than vegetative, however some of vegetative bermudagrasses were producing more seedheads than the most heavily flowering seeded entries. The lowest seedhead production among vegetative entries showed MSB-1075, MSB-1050 and FB 1628, and among seeded entries OKS 2015-1 and ‘Riviera’. Green cover under deficit irrigation on 08/25/2021 varied, with MSB-1050 and MSB-1075 retaining cover 95% or above. Other entries with high green cover were UCR 17-8, FB 19003 and ‘TifTuf’. These entries were performing well under deficit irrigation also in 2020. Among seeded entries OKS 2015-1 and JSC 2013-10S retained the highest green cover as of 08/25/2020.

Zoysiagrass showed high variation in leaf texture, with DALZ 1802 and DALZ 1807 being the finest, and FZ 1407 and DAZL 1603 the coarsest entries (Table 3). DALZ 1802 showed the highest overall quality, good fall/winter color retention and early spring greenup. DALZ 1408, FZ 1727, ‘Zeon’, UGA GZ 17-4 and FAES 1335 were other well performing entries. DALZ 1802 and DALZ 1408 were characterized by fine, while the other three entries by medium leaf texture. Good both fall/winter color retention and early greenup showed also DALZ 1806. DALZ 1807, FAES 1335 and FZ 1368 were another well retaining color zoysiagrass entries, while FZ 1727 and ’Emerald’ were characterized by fast spring greenup. Some differences in seedhead production could be observed, however they were not significant. This may result from flowering intensity fluctuations over the season. UGA GZ 17-4, FZ 1727, DALZ 1409 and FZ 1728 had slightly lower seedhead production than other entries. DALZ 1701, DALZ 1806 and FAES 1319 were the darkest green entries when evaluated for genetic color, while ‘Zeon’ was the brightest.

Acknowledgments:

Thanks to the National Turfgrass Evaluation Program (NTEP) for support of this research.

Table 1. Entry list for the 2019 National Bermudagrass Test and 2019 National Zoysiagrass Test. Riverside, CA.

Bermudagrass			Zoysiagrass		
No.	Name	Type	No.	Name	Type
1	Tifway	Vegetative	1	Meyer	Vegetative
2	TifTuf	Vegetative	2	Emerald	Vegetative
3	OKC1666	Vegetative	3	Zeon	Vegetative
4	OKC1406	Vegetative	4	FZ 1410	Vegetative
5	Latitude 36	Vegetative	5	FZ 1368	Vegetative
6	OKC1876	Vegetative	6	FZ 1367	Vegetative
7	OKC1873	Vegetative	7	FZ 1440	Vegetative
8	OKC1682	Vegetative	8	FZ 1422	Vegetative
9	MSB-1048	Vegetative	9	FZ 1727	Vegetative
10	MSB-1075	Vegetative	10	FZ 1436	Vegetative
11	MSB-1026	Vegetative	11	15-TZ-11715	Vegetative
12	MSB-1050	Vegetative	12	16-TZ-12783	Vegetative
13	MSB-1017	Vegetative	13	16-TZ-13463	Vegetative
14	MSB-1042	Vegetative	14	UGA GZ 17-4	Vegetative
15	JSC 77V	Vegetative	15	Empire	Vegetative
16	JSC 80V	Vegetative	16	DALZ 1713	Vegetative
17	Tahoma 31	Vegetative	17	DALZ 1714	Vegetative
18	Astro	Vegetative	18	DALZ 1802	Vegetative
19	FB 1628	Vegetative	19	DALZ 1806	Vegetative
20	FB 1630	Vegetative	20	DALZ 1807	Vegetative
21	FB 1902	Vegetative	21	DALZ 1808	Vegetative
22	FB 1903	Vegetative	22	DALZ 1311	Vegetative
23	PST-R6TM	Seeded	23	DALZ 1408	Vegetative
24	PST-R6MM	Seeded	24	DALZ 1409	Vegetative
25	DLF-460/3048	Seeded	25	DALZ 1601	Vegetative
26	OKS2015-1	Seeded	26	DALZ 1603	Vegetative
27	OKS2015-3	Seeded	27	DALZ 1613	Vegetative
28	OKS2015-7	Seeded	28	DALZ 1614	Vegetative
29	JSC 2013-5S	Seeded	29	DALZ 1701	Vegetative
30	JSC 2013-7S	Seeded	30	DALZ 1707	Vegetative
31	JSC 2013-8S	Seeded	31	FAES 1319	Vegetative
32	JSC 2013-10S	Seeded	32	FAES 1335	Vegetative
33	JSC 2013-12S	Seeded	33	FZ 1327	Vegetative
34	Riviera	Seeded	34	FZ 1407	Vegetative
35	Monaco	Seeded	35	FZ 1721	Vegetative
36	UCR 17-8	Vegetative	36	FZ 1722	Vegetative
37	UCR TP6-3	Vegetative	37	FZ 1723	Vegetative
38	UCR BF2	Vegetative	38	FZ 1728	Vegetative
39	UCR 10-9	Vegetative	39	FZ 1732	Vegetative
			40	De Anza	Vegetative

Table 2. Turfgrass quality (1-9; 9=best), fall/winter color retention (1-9; 9=best), spring greenup (1-9; 1=dormant), leaf texture (1-9; 9=finest), genetic color (1-9; 9=darkest green), seedhead production (1-9; 1=no seedheads) and green cover (%) under deficit irrigation on 08/25/2021 of bermudagrass entries. Riverside, CA.

Name	Turf quality	Fall/winter color	Spring greenup	Leaf texture	Genetic color	Seedhead production	Green cover % (08/25/2021)
Tifway	5.3 c-j	6.1 b-g	7.0 a-g	6.5 b-e	6.7 c-i	3.2 c-h	39.8 g
TifTuf	6.7 a	7.2 a-c	7.8 a-f	6.7 a-d	6.0 f-j	4.5 a-h	92.0 a-d
OKC1666	5.1 fj	4.0 i-m	5.8 c-g	6.8 a-c	5.8 g-j	2.5 d-h	68.2 a-g
OKC1406	4.7 i-n	3.5 lm	6.1 a-g	6.7 a-d	6.2 e-j	6.7 a-c	64.3 a-g
Latitude 36	5.0 g-k	5.5 d-i	6.6 a-g	6.8 a-c	6.2 e-j	4.8 a-h	49.2 e-g
OKC1876	6.3 ab	7.7 ab	8.0 a-c	7.0 ab	7.2 a-h	5.2 a-g	72.1 a-g
OKC1873	6.0 a-d	7.2 a-c	7.3 a-g	6.7 a-d	6.0 f-j	7.2 ab	67.4 a-g
OKC1682	5.7 b-g	5.5 d-i	6.8 a-g	6.8 a-c	7.7 a-g	5.3 a-f	72.4 a-g
MSB-1048	5.0 g-k	3.5 k-m	5.3 g	7.0 ab	7.8 a-f	3.5 b-h	88.3 a-e
MSB-1075	5.1 g-j	6.0 b-g	7.2 a-g	6.2 b-f	9.0 a	1.0 h	95.0 ab
MSB-1026	5.2 f-j	4.9 f-m	7.4 a-g	6.2 b-f	8.8 ab	2.7 d-h	90.7 a-e
MSB-1050	5.8 b-f	5.9 c-h	6.9 a-g	8.0 a	9.0 a	1.5 f-h	98.9 a
MSB-1017	6.4 ab	6.8 a-d	7.5 a-g	6.8 a-c	7.8 a-f	1.8 f-h	88.0 a-e
MSB-1042	6.0 a-c	6.2 a-g	7.0 a-g	7.0 ab	6.5 d-i	3.3 b-h	73.9 a-g
JSC 77V	4.1 m-q	3.4 l-m	6.0 b-g	6.3 b-f	5.0 ij	5.8 a-e	41.3 fg
JSC 80V	4.9 h-l	3.7 j-m	5.6 e-g	6.5 b-e	5.0 ij	3.2 c-h	71.2 a-g
Tahoma 31	5.4 c-i	3.5 lm	6.4 a-g	6.7 a-d	8.2 a-d	3.2 c-h	86.0 a-e
Astro	4.7 i-n	5.2 d-k	6.1 a-g	5.8 b-h	4.3 j	4.5 a-h	56.7 a-g
FB 1628	6.0 a-e	6.8 a-d	7.9 a-d	6.5 b-e	8.5 a-c	1.3 gh	74.4 ag
FB 1630	5.3 d-j	7.3 a-c	7.2 a-g	5.5 c-i	7.3 a-h	6.7 a-c	49.7 d-g
FB 1902	5.5 c-h	7.8 a	8.0 a-c	5.5 c-i	6.3 d-i	5.3 a-f	75.1 a-g
FB 1903	5.2 f-j	6.6 a-e	5.8 c-g	6.0 b-g	8.0 a-e	7.7 a	93.1 a-c
PST-R6TM	4.2 l-q	5.2 d-k	6.3 a-g	4.7 g-j	5.5 h-j	4.5 a-h	61.7 a-g
PST-R6MM	4.0 n-q	5.5 d-i	6.2 a-g	4.5 h-j	5.5 h-j	4.7 a-h	52.6 b-g
DLF-460/3048	3.9 o-q	5.3 d-j	6.4 a-g	4.7 g-j	6.0 f-j	4.2 a-h	68.3 a-g
OKS2015-1	3.5 q	3.3 m	5.4 g	4.0 j	6.5 d-i	3.2 c-h	81.8 a-g
OKS2015-3	3.7 pq	3.3 m	5.7 d-g	4.7 g-j	6.5 d-i	4.7 a-h	40.2 g
OKS2015-7	3.6 pq	3.3 m	5.5 fg	4.3 ij	6.3 d-i	4.7 a-h	58.9 a-g
JSC 2013-5S	5.2 f-j	4.6 g-m	7.1 a-g	5.0 f-j	7.5 a-g	6.0 a-e	76.2 a-g
JSC 2013-7S	4.3 k-p	4.1 i-m	6.1 a-g	4.5 h-j	7.8 a-f	6.8 a-c	63.6 a-g
JSC 2013-8S	4.6 j-o	4.7 g-m	7.0 a-g	4.5 h-j	6.7 c-i	6.2 a-d	52.1 c-g
JSC 2013-10S	5.2 e-j	5.1 e-l	7.0 a-g	4.7 g-j	7.5 a-g	5.8 a-e	80.0 a-g
JSC 2013-12S	4.8 h-m	4.3 h-m	6.4 a-g	5.0 f-j	7.0 b-h	5.3 a-f	76.6 a-g
Riviera	3.8 pq	3.8 i-m	5.8 c-g	4.3 ij	6.3 d-i	3.5 b-h	76.2 a-g
Monaco	5.2 f-j	5.3 d-j	6.9 a-g	5.2 e-j	7.3 a-h	4.5 a-h	59.2 a-g
UCR 17-8	6.3 ab	7.4 a-c	8.3 a	7.0 ab	7.5 a-g	1.7 f-h	94.1 a-c
UCR TP6-3	6.3 ab	7.4 a-c	8.2 ab	7.0 ab	7.3 a-h	2.7 d-h	82.9 a-f
UCR BF2	6.0 a-c	6.9 a-d	7.8 a-e	6.2 b-f	6.8 c-i	3.3 b-h	68.1 a-g
UCR 10-9	6.0 a-e	6.5 a-f	7.4 a-g	5.3 d-j	7.2 a-h	2.2 e-h	91.3 a-e

Means followed by the same letter in a column are not significantly different (P=0.05).

Table 3. Turfgrass quality (1-9; 9=best), fall/winter color retention (1-9; 9=best), spring greenup (1-9; 1=dormant), leaf texture (1-9; 9=finest), genetic color (1-9; 9=darkest green) and seedhead production (1-9; 1=no seedheads) of zoysiagrass entries. Riverside, CA.

Name	Turf quality		Fall/winter color		Spring greenup		Leaf texture		Genetic color		Seedhead production
Meyer	3.7	q	2.1	k	4.0	i	5.0	i-l	7.0	a-c	5.3
Emerald	6.1	c-j	4.5	f-k	7.3	a-d	6.3	c-i	6.5	a-c	5.3
Zeon	6.3	a-e	5.4	b-j	6.5	a-h	6.7	c-g	5.0	c	5.2
FZ 1410	5.4	j-p	4.5	e-k	6.0	b-i	3.5	m-o	6.5	a-c	6.9
FZ 1368	6.0	c-k	7.0	a-d	6.2	a-h	6.8	c-f	6.5	a-c	6.8
FZ 1367	6.3	a-e	6.3	a-i	6.8	a-h	7.3	a-d	5.8	a-c	5.2
FZ 1440	6.2	b-h	5.8	a-i	6.3	a-h	7.3	a-d	7.2	a-c	5.7
FZ 1422	5.2	m-p	3.3	jk	5.3	e-i	5.3	g-k	6.2	a-c	6.3
FZ 1727	6.5	a-c	6.9	a-e	8.1	a	6.8	c-f	6.7	a-c	4.7
FZ 1436	6.2	c-i	6.5	a-g	6.4	a-h	7.0	b-f	6.3	a-c	5.9
15-TZ-11715	5.0	p	4.8	c-j	5.2	f-i	5.7	f-k	6.0	a-c	6.4
16-TZ-12783	5.7	e-o	5.0	b-j	5.1	g-i	5.2	h-l	7.3	ab	5.7
16-TZ-13463	5.5	i-p	4.8	c-j	4.9	hi	6.2	c-j	7.3	ab	5.4
UGA GZ 17-4	6.5	a-d	6.9	a-e	7.1	a-g	7.5	a-c	5.5	bc	4.5
Empire	5.2	m-p	4.5	f-k	5.3	d-i	3.3	no	6.7	a-c	6.9
DALZ 1713	6.0	c-l	6.3	a-i	5.9	c-i	5.8	e-k	5.7	bc	6.3
DALZ 1714	6.0	c-l	5.7	a-j	5.8	c-i	5.2	h-l	6.0	a-c	5.9
DALZ 1802	7.0	a	8.1	a	8.0	ab	8.3	ab	7.5	ab	6.6
DALZ 1806	6.3	a-g	7.1	a-c	7.5	a-c	7.0	b-f	7.3	ab	5.1
DALZ 1807	6.3	a-f	7.3	ab	7.3	a-e	8.7	a	6.5	a-c	5.3
DALZ 1808	5.6	g-p	4.3	g-k	6.0	b-i	4.8	j-m	6.3	a-c	5.8
DALZ 1311	5.5	h-p	4.6	d-j	5.1	g-i	3.5	m-o	7.3	ab	7.1
DALZ 1408	6.5	a-d	6.4	a-h	6.7	a-h	7.0	b-f	7.0	a-c	5.8
DALZ 1409	6.3	a-e	6.8	a-f	7.1	a-g	7.5	a-c	6.3	a-c	4.9
DALZ 1601	5.3	l-p	4.7	c-j	5.6	c-i	3.5	m-o	7.2	a-c	7.3
DALZ 1603	5.6	f-p	4.9	b-j	6.3	a-h	3.0	o	7.0	a-c	6.9
DALZ 1613	6.0	c-k	5.9	a-i	6.2	a-h	6.0	d-k	6.0	a-c	6.2
DALZ 1614	6.2	c-i	6.1	a-i	7.1	a-g	6.0	d-k	6.3	a-c	6.4
DALZ 1701	5.8	d-o	4.4	f-k	6.3	a-h	5.0	i-l	8.0	a	5.9
DALZ 1707	5.4	k-p	3.9	i-k	5.5	c-i	5.2	h-l	6.7	a-c	5.7
FAES 1319	5.8	c-m	5.8	a-i	7.2	a-f	4.7	k-n	7.5	ab	6.7
FAES 1335	6.9	ab	7.0	a-d	7.2	a-f	6.0	d-k	5.8	a-c	5.1
FZ 1327	5.1	n-p	4.1	g-k	5.0	hi	3.8	l-o	7.0	a-c	7.2
FZ 1407	5.0	p	4.0	h-k	4.9	hi	3.2	o	7.2	a-c	7.1
FZ 1721	5.8	c-n	6.3	a-i	6.9	a-h	7.2	b-e	6.8	a-c	5.3
FZ 1722	6.1	c-j	6.5	a-g	6.5	a-h	6.8	c-f	6.2	a-c	6.9
FZ 1723	6.1	c-j	5.8	a-i	6.7	a-h	6.5	c-h	5.3	bc	5.9
FZ 1728	6.2	b-h	5.9	a-i	6.7	a-h	7.5	a-c	6.3	a-c	4.9
FZ 1732	6.2	c-j	6.5	a-g	6.7	a-h	6.7	c-g	6.2	a-c	5.8
De Anza	5.1	op	5.4	b-j	5.6	c-i	5.7	f-k	5.8	a-c	6.1

Means followed by the same letter in a column are not significantly different (P=0.05).

2019 National Bermudagrass Test
Plot plan

N

101 38	114 17	201 7	214 14	301 16	314 12	401 32	501 31	601 29
102 16	115 10	202 21	215 2	302 21	315 17	402 35	502 26	602 31
103 1	116 20	203 6	216 11	303 14	316 20	403 30	503 28	603 24
104 14	117 18	204 12	217 15	304 36	317 10	404 27	504 34	604 33
105 11	118 8	205 37	218 8	305 38	318 2	405 34	505 32	605 26
106 37	119 12	206 5	219 36	306 5	319 37	406 24	506 35	606 34
107 22	120 3	207 1	220 22	307 22	320 1	407 33	507 25	607 28
108 7	121 5	208 16	221 9	308 9	321 8	408 29	508 24	608 27
109 39	122 21	209 18	222 10	309 39	322 7	409 25	509 33	609 30
110 15	123 9	210 38	223 3	310 13	323 18	410 31	510 23	610 35
111 2	124 19	211 20	224 13	311 3	324 15	411 28	511 30	611 25
112 13	125 6	212 4	225 17	312 19	325 4	412 23	512 29	612 23
113 36	126 4	213 19	226 39	313 11	326 6	413 26	513 27	613 32
Vegetative						Seeded		

2019 National Zoysiagrass Test
Plot plan

N

101	102	103	201	202	203	301	302	303
39	36	10	12	6	27		10	7
104	105	106	204	205	206	304	305	306
37	5	20	37	40	29	3	4	17
107	108	109	207	208	209	307	308	309
28	22	38	32	14	4	37	13	29
110	111	112	210	211	212	310	311	312
	18	2	23	28	3	15	21	30
113	114	115	213	214	215	313	314	315
27	31	33	25		31	35	22	26
116	117	118	216	217	218	316	317	318
7	24	32	13	11	21	14	39	38
119	120	121	219	220	221	319	320	321
15	12	3	16	8	33	32	27	34
122	123	124	222	223	224	322	323	324
29	26	35	35	39	19		18	2
125	126	127	225	226	227	325	326	327
4	1	6	38	26	20	9	31	28
128	129	130	228	229	230	328	329	330
40	23		1		34	11	25	12
131	132	133	231	232	233	331	332	333
19	21	9	9	15	18	6	5	36
134	135	136	234	235	236	334	335	336
30	16	14	10	36	7	8	16	1
137	138	139	237	238	239	337	338	339
25	8	11	5	17	22	33	24	23
140	141	142	240	241	242	340	341	342
17	34	13	2	24	30	40	20	19

Stop #10: Preemergence and Postemergence Control of Spotted Spurge and Common Purslane

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Objectives:

This study was conducted to evaluate and compare the ability of various herbicides for preemergence and postemergence control of spotted spurge (*Euphorbia maculata* L.) and common purslane (*Portulaca oleracea* L.).

Materials and methods:

The study was conducted on Hanford fine sandy loam with no turfgrass. The preemergence study was initiated on June 22, 2021 with 15 herbicide treatments tested against an untreated control (Table 1). Treatments 2-8 were applied manually using hand-shakers to ensure uniform distribution within each plot area, and treatments 9-16 were applied using a CO_2-powered backpack sprayer equipped with TeeJet 8002VS nozzles calibrated to deliver 1 gallon/1000 ft^2. Immediately following application, plots were irrigated to provide moisture required for their activation. The postemergence study was initiated on August 19, 2021 with 18 herbicide treatments tested against an untreated control (Table 3). All treatments in the postemergence study were applied with CO_2-powered backpack sprayer calibrated in the same way as described above. Experimental design for both studies was a complete randomized block with 3 replications. Plot size was 4x4 ft with 1-ft alley for preemergence study and 3x3 ft with 1 ft alleys for postemergence study. Irrigation on the plots in postemergence study was withheld for at least 24h following treatment application. In both studies plots were evaluated for spotted spurge cover (%), common purslane cover (%) and Normalized Difference Vegetation Index (NDVI) using a GreenSeeker instrument, and spotted spurge injury (%) and common purslane injury (%) for the postemergence study. Data were subjected to analysis of variance and when necessary, multiple comparison of means was performed using Tukey's HSD test at $P = 0.05$.

Results:

Results of preemergence study are presented in Table 2. Although numerically the differences among treatments and untreated control are quite high, none of the effects were statistically significant. Among best performing treatments by September 1, 2021 in regard to spotted spurge control were: Barricade 4FL (trt 9), Specticle FLO (trt 10) and Pendulum (trt 16) from sprayed herbicides and FreeHand 1.75G (trt 8), Crew (trt 3) and Specticle G (trt 6) from granular formulations. From granular formulations, a single application of the higher rate seemed to control spurge germination better then sequential applications with lower rates. There was a lower pressure of common purslane in study area but similar best performing herbicides were observed in case of this species with two additional treatments that seemed to work well: Ronstar FLO (trt 11) and Kerb (trt 15). NDVI is an indicator of live green vegetation, meaning higher values will be associated with higher green cover of the plot and/or healthier vegetation. Lowest values for this parameter were obtained for treatments 8, 9 and 7 followed by treatment 3 marking those treatments as best performers in this study.

Spotted spurge cover was high at the time of initiation of postemergence herbicide treatments but did not decline significantly within first 2 weeks of the study (Table 4). Quite high drop considering short period of time was only observed for Sure Power (trt 8), 4-Speed XT (trt 7), Blindside (trt 11) and Monument + Diablo (trt 5). The same treatments with the exception of treatment 5 and with addition of treatments 6 and 16 also caused more than 80% injury to existing spurge. Common purslane cover was relatively small and this plant was not present on all plots at the initiation of the trial. Because of that it was not possible to measure purslane injury in sufficient number of plots to conduct statistical analysis of this trait. Similar trends were observed as for spotted spurge cover and injury although injury to common purslane was generally higher. Similar to the preemergence study low NDVI values indicated low cover of or unhealthy vegetation and in this case marked treatments 11 (Blindside) and 8 (Sure Power) as best performers so far.

Acknowledgments:

Thanks to BASF, Bayer, Corteva, FMC, Nufarm, PBI Gordon, Syngenta and the California Turfgrass & Landscape Foundation (CTLF) for providing products and supporting this research.

Table 1. Herbicide treatments tested in preemergence spotted spurge and common purslane control trial. Riverside, CA. 2021.

Trt No	Treatment	Rate	Timing	Active ingredient(s)
1	Untreated Control			
2	Crew Specialty Herbicide	150 lbs/A	A	dithiopyr, isoxaben
3	Crew Specialty Herbicide	200 lbs/A	A	dithiopyr, isoxaben
4	Crew Specialty Herbicide	150 lbs/A	AB	dithiopyr, isoxaben
5	Specticle G	150 lbs/A	A	indaziflam
6	Specticle G	200 lbs/A	A	indaziflam
7	Specticle G	150 lbs/A	AB	indaziflam
8	FreeHand 1.75 G	200 lbs/A	A	dimethenamid-P, pendimethalin
9	Barricade 4FL	32 oz/A	A	prodiamine
10	Specticle FLO	9 oz/A	A	indaziflam
11	Ronstar FLO	122 oz/A	A	oxadiazon
12	Gallery	23 oz/A	A	isoxaben
13	Dimension	2 pt/A	A	dithiopyr
14	Pennant Magnum	2.1 pt/A	A	S-Metolachlor
15	Kerb	2.5 pt/A	A	pronamide
16	Pendulum	3.1 pt/A	A	pendimethalin

Application timing: A - 6/22/2021 B - 8/3/2021

Table 2. Effect of preemergence herbicide treatments on spotted spurge cover (%), common purslane cover (%) and NDVI. Riverside, CA. 2021.

Treatment	Spotted spurge cover (%)			Common purslane cover (%)			NDVI		
	7/9/2021	8/5/2021	9/1/2021	7/9/2021	8/5/2021	9/1/2021	7/9/2021	8/5/2021	9/1/2021
Trt 01	9	37	55	0	3	8	0.143	0.34	0.59
Trt 02	2	13	37	0	0	2	0.12	0.193	0.46
Trt 03	3	6	14	1	4	7	0.113	0.217	0.313
Trt 04	2	16	22	1	8	13	0.12	0.35	0.44
Trt 05	5	20	35	1	4	4	0.14	0.327	0.5
Trt 06	3	9	16	0	1	1	0.13	0.213	0.37
Trt 07	4	19	24	1	3	3	0.133	0.233	0.293
Trt 08	0	0	12	0	0	0	0.123	0.133	0.257
Trt 09	1	1	7	0	1	0	0.113	0.157	0.287
Trt 10	3	9	11	1	9	18	0.117	0.213	0.38
Trt 11	3	17	42	1	4	4	0.13	0.183	0.407
Trt 12	4	22	40	2	9	19	0.113	0.33	0.55
Trt 13	1	6	18	2	16	29	0.12	0.26	0.447
Trt 14	2	21	30	1	5	11	0.123	0.293	0.427
Trt 15	2	11	45	0	2	3	0.12	0.183	0.483
Trt 16	1	3	13	0	2	9	0.127	0.137	0.41
p-value	0.493	0.652	0.358	0.742	0.695	0.780	0.452	0.697	0.200

Table 3. Herbicide treatments tested in postemergence spotted spurge and common purslane control trial. Riverside, CA. 2021.

Trt No	Treatment	Rate	Timing	Active ingredient(s)
1	Untreated Control			
2	GameOn Specialty Herbicide	3.5 pt/A	A	2,4-D Choline + Fluroxypyr mepty + halauxifen-methyl
3	GameOn Specialty Herbicide	4 pt/A	A	2,4-D Choline + Fluroxypyr mepty + halauxifen-methyl
4	Relzar Specialty Herbicide + Agri DEX	0.72 oz/A + 0.25% v/v	A	Halauxifen-methyl, Florasulam
5	Monument + Diablo + NIS	10 g/A + 1 pt/A + 0.25% v/v	AB	Trifloxysulfuron-sodium + Dicamba
6	Tenacity + Turflon Ester Ultra+ NIS	5 oz/A + 32 oz/A + 0.25% v/v	AB	Mesotrione + Triclopyr
7	4-Speed XT	4 pt/A	AB	2,4-D, Triclopyr, Dicamba, Pyraflufen-ethyl
8	Sure Power	3.5 pt/A	AB	2,4-D, Triclopyr, Fluroxypyr, Flumioxazin
9	Tribute Total	3.2 oz/A	AB	Thiencarbazone-methyl + Foramsulfuron + Halosulfuron-methyl
10	Solitare WSL	5 oz/M	AB	Sulfentrazone + Quinclorac
11	Blindside	6.5 oz/A	AB	Sulfentrazone + Metsulfuron-methyl
12	Dismiss South	9.5 oz/A	AB	Sulfentrazone + Imazethapyr
13	Celsius + NIS	3.7 oz/A + 0.25% v/v	AC	Thiencarbazone-methyl + Iodosulfuron-methyl-sodium + Dicamba
14	UCR 001			
15	UCR 002			
16	SpeedZone Southern EW	4 pt/A	AB	2,4-D + Dichlorprop-p + Dicamba + Carfentrazone-ethyl
17	Avenue South	4 pt/A	AB	2,4-D + Dicamba + Penoxsulam + Sulfentrazone
18	QuickSilver + NIS	2.1 oz/A + 0.25% v/v	AB	Carfentrazone-ethyl
19	Dismiss CA	6 oz/A	AB	Sulfentrazone

Application timing: A - 8/19/2021 B - 9/18/2021 C - 9/30/2021

Table 4. Effect of postemergence herbicide treatments on spotted spurge cover (%), common purslane cover (%), spotted spurge injury (%), common purslane injury (%) and NDVI. Riverside, CA. 2021.

Treatment	Spurge cover (%)			Purslane cover (%)			Spurge injury (%)		Purslane injury (%)		NDVI		
	8/19 2021	8/26 2021	9/1 2021	8/19 2021	8/26 2021	9/1 2021	8/26 2021	9/1 2021	8/26 2021	9/1 2021	8/19 2021	8/26 2021	9/1 2021
Trt 01	52	65	68	3	2	2	0 e	0 f	0	0	0.5	0.56	0.597
Trt 02	67	68	63	5	5	4	47 bcdef	73 abcd	70	95	0.657	0.513	0.44
Trt 03	62	56	58	4	4	2	48 bcdef	78 abc	70	95	0.653	0.477	0.427
Trt 04	65	72	65	7	3	5	12 def	42 bcdefg	40	85	0.673	0.583	0.543
Trt 05	78	75	63	2	4	8	47 bcdef	55 abcdef	65	60	0.7	0.583	0.493
Trt 06	67	68	62	1	2	2	58 abcd	88 ab	88	100	0.677	0.42	0.39
Trt 07	88	87	68	0	1	0	57 abcd	83 abc			0.733	0.533	0.417
Trt 08	92	90	67	0	2	3	100 a	100 a	95	100	0.627	0.36	0.317
Trt 09	70	69	62	4	4	4	25 cdef	57 abcde	35	53	0.673	0.507	0.497
Trt 10	67	68	63	3	6	7	67 abc	73 abcd	93	95	0.647	0.43	0.417
Trt 11	83	83	65	2	3	7	77 ab	96 a	90	99	0.65	0.4	0.303
Trt 12	83	90	91	1	2	1	35 bcdef	23 defg	45	70	0.673	0.57	0.58
Trt 13	89	87	90	3	2	2	52 abcde	63 abcd	50	60	0.7	0.583	0.517
Trt 14	68	72	66	3	4	2	38 bcdef	68 abcd	73	65	0.573	0.503	0.437
Trt 15	79	82	80	4	3	7	67 abc	67 abcd	75	60	0.637	0.463	0.413
Trt 16	64	55	50	7	13	16	50 bcde	83 abc	85	95	0.577	0.443	0.367
Trt 17	68	71	67	3	2	5	30 bcdef	33 cdefg	85	80	0.547	0.473	0.463
Trt 18	67	71	72	0	0	0	7 ef	10 efg			0.533	0.513	0.5
Trt 19	66	61	67	0	0	0	17 def	3 fg			0.533	0.45	0.54
p-value	0.978	0.958	0.988	0.953	0.819	0.765	0.000	0.000			0.864	0.627	0.076

Means followed by the same letter in a column are not significantly different (P=0.05).

Plot Plan for Preemergence Control of Spotted Spurge and Common Purslane Study

101 Trt 01	102 Trt 09	103 Trt 02	104 Trt 06	105 Trt 07	106 Trt 08
201 Trt 02	202 Trt 10	203 Trt 11	204 Trt 10	205 Trt 10	206 Trt 06
301 Trt 03	302 Trt 11	303 Trt 05	304 Trt 07	305 Trt 13	306 Trt 14
401 Trt 04	402 Trt 12	403 Trt 15	404 Trt 01	405 Trt 15	406 Trt 01
501 Trt 05	502 Trt 13	503 Trt 14	504 Trt 12	505 Trt 05	506 Trt 16
601 Trt 06	602 Trt 14	603 Trt 03	604 Trt 16	605 Trt 02	606 Trt 04
701 Trt 07	702 Trt 15	703 Trt 09	704 Trt 04	705 Trt 09	706 Trt 11
801 Trt 08	802 Trt 16	803 Trt 13	804 Trt 08	805 Trt 03	806 Trt 12

Plot Plan for Postemergence Control of Spotted Spurge and Common Purslane Study

101	102	103	104	105 Trt 01	106 Trt 02	107 Trt 03
201	202	203	204	205 Trt 06	206 Trt 05	207 Trt 04
301 Trt 07	302 Trt 08	303 Trt 09	304 Trt 10	305 Trt 11	306 Trt 12	307 Trt 13
401 Trt 19	402 Trt 18	403 Trt 17	404 Trt 16	405 Trt 15	406 Trt 14	407 Trt 08
501 Trt 03	502 Trt 05	503 Trt 08	504 Trt 02	505 Trt 11	506 Trt 14	507 Trt 06
601 Trt 10	602 Trt 09	603 Trt 19	604 Trt 05	605 Trt 07	606 Trt 04	607 Trt 11
701 Trt 17	702 Trt 15	703 Trt 01	704 Trt 13	705 Trt 16	706 Trt 02	707 Trt 17
801 Trt 01	802 Trt 19	803 Trt 10	804 Trt 12	805 Trt 07	806 Trt 15	807 Trt 09
901	902	903 Trt 14	904	905 Trt 06	906 Trt 12	907 Trt 03
1001 Trt 18	1002	1003	1004 Trt 16	1005 Trt 13	1006 Trt 04	1007 Trt 18

Bonus Stop: Selective Control of Kikuyugrass and Seashore Paspalum in Bermudagrass Turf

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Objectives:

This study was conducted to evaluate various herbicides, combinations, and timings of application for the selective control of seashore paspalum (*Paspalum vaginatum*) or kikuyugrass (*Cenchrus clandestinus*) in hybrid bermudagrass (*Cynodon dactylon x. C. transvaalensis*) turf maintained as a golf course fairway or athletic field.

Materials and Methods:

Plugs (4.25-in-diam.) of seashore paspalum 'Platinum' and kikuyugrass 'Whittet' were transplanted into hybrid bermudagrass 'Bandera' turf in July 2020. Eight plugs of each species were planted into each plot and allowed to establish before initial herbicide treatments were applied in October. Turf was mowed 3 days/wk at 0.5 inches and received 5 lbs N/1,000 ft^2/yr in 0.5-lb increments. Irrigation was based on warm-season replacement of reference evapotranspiration (ET_o).

Herbicide treatments were applied according to Tables 1 and 2 starting on October 9, 2020. Treatments were applied using a CO_2-powered backpack sprayer equipped with TeeJet 8002VS nozzles calibrated to deliver 1 gallon/1000 ft^2. Experimental design was a complete randomized block with 4 replications. Plot size was 4×4 ft.

Plots were evaluated periodically for bermudagrass herbicide injury (0-10; 10=highest) and % seashore paspalum or kikuyugrass control (0-100%) based on initial populations in each plot. Data were analyzed using Analysis of Variance with Fisher's Protected Least Significant Difference (LSD) test (P =0.05).

Results:

Originally, this study was designed to test herbicide efficacy based on fall applications only. However, as the study progressed spring applications were added based on company requests and/or if additional applications were allowable according to label recommendations.

The most effective selective control of seashore paspalum was provided by both fall and spring applications of Manuscript or Manuscript rotated with Monument (Table 3). Highest bermudagrass injury was observed from rotations of Manuscript and Monument, and also from Drive XLR8.

Several herbicide treatments provided >90% control of kikuyugrass, but only the combination of Manuscript applied twice in the fall followed by three applications of Monument resulted in 100% control nearly one year later (Table 4). This treatment did cause some injury to bermudagrass (<30%), which recovered by spring 2021.

Acknowledgments

Thanks to the CTLF, BASF, Bayer, Corteva, FMC, Nufarm, and Syngenta for supporting this research and/or for providing products.

Table 1. Herbicides tested for selective removal of seashore paspalum in hybrid bermudagrass turf. 2020-21. Riverside, CA.

Trt no.	Treatment	Active ingredient	HRAC & WSSA	Legacy HRAC	Rate		Timing
1	Untreated Control	-	-	-	-		-
2	Drive XLR8	quinclorac	4	O	1	oz/M	AB
	Drive XLR8	quinclorac	4	O	0.9	oz/M	C
3	Monument 75WG	trifloxysulfuron	2	B	22	g/A	ACD
4	Manuscript	pinoxaden	1	A	21	oz/A	ABDE
5	Manuscript	pinoxaden	1	A	42	oz/A	AB
6	Manuscript	pinoxaden	1	A	42	oz/A	AB
	Monument 75WG	trifloxysulfuron	2	B	22	g/A	CDE
7	Monument 75WG	trifloxysulfuron	2	B	22	g/A	ADE
	Manuscript	pinoxaden	1	A	42	oz/A	BC

Application timing: A - 10/9/2020 B - 10/21/2020 C - 11/6/2020 D - 5/5/2021 E - 5/28/2021

Table 2. Herbicides tested for selective removal of kikuyugrass in hybrid bermudagrass turf. 2020-21. Riverside, CA.

Trt no.	Treatment	Active ingredient	HRAC & WSSA	Legacy HRAC	Rate	Timing
1	Untreated Control	-	-	-	-	-
2	Drive XLR8	quinclorac	4	O	1 oz/M	AB
	Drive XLR8	quinclorac	4	O	0.9 oz/M	C
3	Pylex	topramezone	27	F2	1 oz/A	ABCD
4	Revolver	foramsulfuron	2	B	17.4 oz/A	ABCD
5	Tribute Total	thiencarbazone-methyl	2	B	3.2 oz/A	AC
		foramsulfuron	2	B		
		halosulfuron-methyl	2	B		
6	Turflon Ester Ultra	triclopyr	4	O	1 pint/A	ABC
7	UCR 001	classified				ABC
8	Sapphire	penoxsulam	2	B	24 oz/A	ABC
9	Vista XRT	fluroxypyr	4	O	23 oz/A	ABC
10	Quicksilver	carfentrazone-ethyl	14	E	2.1 oz/A	ABC
11	Xonerate 2SC	amicarbazone	5	C1,2	9 oz/A	ABC
12	SureGuard	flumioxazin	14	E	12 oz/A	AC
13	Monument 75WG	trifloxysulfuron	2	B	22 g/A	ACD
14	Manuscript	pinoxaden	1	A	21 oz/A	ABDE
15	Manuscript	pinoxaden	1	A	42 oz/A	AB
16	Drive XLR8	quinclorac	4	O	1 oz/M	AB
	Drive XLR8	quinclorac	4	O	0.9 oz/M	C
	Pylex	topramezone	27	F2	1 oz/A	ABCD
17	Drive XLR8	quinclorac	4	O	1 oz/M	AB
	Drive XLR8	quinclorac	4	O	0.9 oz/M	C
	Revolver	foramsulfuron	2	B	17.4 oz/A	ABCD
18	Drive XLR8	quinclorac	4	O	1 oz/M	AB
	Drive XLR8	quinclorac	4	O	0.9 oz/M	C
	Tribute Total	thiencarbazone-methyl	2	B	3.2 oz/A	AC
		foramsulfuron	2	B		
		halosulfuron-methyl	2	B		
19	Drive XLR8	quinclorac	4	O	1 oz/M	AB
	Drive XLR8	quinclorac	4	O	0.9 oz/M	C
	Turflon Ester Ultra	triclopyr	4	O	1 pint/A	ABC
20	Drive XLR8	quinclorac	4	O	1 oz/M	AB
	Drive XLR8	quinclorac	4	O	0.9 oz/M	C
	Quicksilver	carfentrazone-ethyl	14	E	1.7 oz/A	ABC
21	UCR 002	classified				ABC
22	UCR 003	classified				ABC
23	Quicksilver	carfentrazone-ethyl	14	E	1.7 oz/A	ABC
	Xonerate 2SC	amicarbazone	5	C1,2	9 oz/A	
24	Manuscript	pinoxaden	1	A	42 oz/A	AB
	Monument 75WG	trifloxysulfuron	2	B	22 g/A	CDE
25	Monument 75WG	trifloxysulfuron	2	B	22 g/A	ADE
	Manuscript	pinoxaden	1	A	42 oz/A	BC

Application timing: A - 10/9/2020 B - 10/21/2020 C - 11/6/2020 D - 5/5/2021 E - 5/28/2021

Table 2. Seashore paspalum control (0-100%) and bermudagrass injury (0-10, 10 = highest) in response to herbicide treatments. 2020-21. Riverside, CA.

Trt no.	Seashore paspalum control (%)			Turfgrass injury (0-10)					
	12/16/2020	4/27/2021	9/4/2021	10/2020	11/2020	12/2020	1/2021	2/2021	5/2021
1	5.1 c	17.0 b	8.0 b	0.0 b	0.2 c	0.3 b	0.0 b	0.0	0.0
2	0.0 c	5.0 b	6.0 b	0.0 b	4.7 a	5.2 a	3.8 a	0.7	0.0
3	94.6 ab	10.0 b	18.0 b	0.0 b	0.0 c	0.8 b	0.7 b	0.2	0.0
4	100.0 a	24.0 b	49.0 a	0.2 b	0.0 c	0.0 b	0.0 b	0.0	0.3
5	95.5 ab	57.0 a	11.0 b	1.0 a	0.0 c	0.0 b	0.3 b	0.3	0.0
6	100.0 a	54.0 a	56.0 a	0.7 ab	0.8 c	1.8 b	0.2 b	0.5	0.0
7	91.4 b	54.0 a	63.0 a	0.0 b	3.5 b	5.3 a	0.7 b	0.3	0.0

Means followed by the same letter in a column are not significantly different (P=0.05).

Table 4. Kikuyugrass control (0-100%) and bermudagrass injury (0-10, 10 = highest) in response to herbicide treatments. 2020-21. Riverside, CA.

Trt no.	Kikuyugrass control (%)			Turfgrass injury (0-10)					
	12/16/2020	4/27/2021	9/4/2021	10/2020	11/2020	12/2020	1/2021	2/2021	5/2021
1	0.0 g	2.0 g	12.0 jk	0.0 f	0.0 h	0.0 gh	0.5 gh	0.0 g	0.4 c
2	94.5 a	94.0 a	74.0 abcde	1.8 cd	6.0 cd	3.8 cde	4.6 de	0.8 defg	0.0 c
3	98.8 a	49.0 bcd	79.0 abcd	6.2 b	9.6 a	9.2 ab	7.6 bc	3.8 bc	3.4 a
4	94.7 a	36.0 cdef	51.0 defgh	0.0 f	0.0 h	0.2 gh	0.6 gh	0.0 g	0.2 c
5	88.7 abc	58.0 bc	58.0 cdefg	1.2 cdef	0.0 h	2.6 efgh	2.2 fgh	1.0 defg	0.0 c
6	91.8 a	18.0 efg	19.0 ijk	2.0 cd	9.6 a	9.8 a	9.6 ab	9.0 a	0.0 c
7	86.0 abc	36.0 cdef	42.0 fghij	0.0 f	2.2 fg	2.6 efgh	2.2 fgh	1.2 defg	0.0 c
8	70.0 bcde	23.0 defg	27.0 hijk	0.0 f	1.8 gh	3.0 defg	4.6 de	2.4 cd	0.0 c
9	59.7 ef	9.0 fg	16.0 ijk	1.6 cde	9.8 a	10.0 a	10.0 a	8.8 a	0.2 c
10	2.4 g	0.0 g	4.0 k	0.4 ef	4.0 ef	0.8 fgh	0.2 h	0.2 fg	0.2 c
11	46.4 f	18.0 efg	27.0 hijk	0.0 f	0.0 h	1.2 efgh	0.0 h	0.6 efg	0.0 c
12	100.0 a	96.0 a	88.0 abc	8.2 a	7.2 bc	3.6 cdef	2.2 fgh	2.2 cde	0.0 c
13	90.7 ab	50.0 bcd	67.0 bcdef	0.0 f	0.2 h	3.2 def	0.2 h	0.4 fg	0.0 c
14	69.0 cde	51.0 bcd	73.0 abcde	0.0 f	2.2 fg	2.8 efgh	1.8 fgh	1.0 defg	1.6 b
15	69.7 bcde	33.0 cdef	28.0 ghijk	0.8 def	0.0 h	0.0 h	1.2 gh	0.0 g	0.2 c
16	97.3 a	87.0 a	90.0 ab	6.0 b	8.4 ab	6.4 bc	5.8 cd	4.4 b	3.4 a
17	92.3 a	92.0 a	93.0 ab	0.2 f	2.4 efg	4.0 cde	3.8 def	0.6 efg	0.0 c
18	97.5 a	88.0 a	91.0 ab	1.2 cdef	4.2 de	3.4 def	2.6 efg	1.0 defg	0.0 c
19	100.0 a	89.0 a	80.0 abcd	1.2 cdef	9.8 a	10.0 a	9.6 ab	9.4 a	0.0 c
20	100.0 a	69.0 ab	77.0 abcde	2.2 c	6.4 c	3.6 cdef	2.8 efg	1.6 defg	0.0 c
21	81.9 abcd	13.0 efg	32.0 ghijk	1.8 cd	9.8 a	10.0 a	9.2 ab	8.0 a	0.8 bc
22	86.5 abc	47.0 bcd	46.0 efghi	0.2 f	1.6 gh	2.8 efgh	1.6 fgh	1.2 defg	0.0 c
23	60.7 def	39.0 cde	20.0 ijk	0.2 f	3.8 ef	1.6 efgh	0.0 h	1.8 def	0.0 c
24	100.0 a	95.0 a	100.0 a	0.4 ef	1.0 gh	2.6 efgh	2.8 efg	0.2 fg	0.2 c
25	92.8 a	48.0 bcd	91.0 ab	0.0 f	3.8 ef	5.8 cd	1.4 gh	0.0 g	0.2 c

Means followed by the same letter in a column are not significantly different (P=0.05).

Plot Plan for Seashore Paspalum and Kikuyugrass Control Study

Seashore Paspalum Control Study

101	102	103	104	105	106	107	108	109	110	111	112	113	114
2	1	3	4	7	6	5	6	5	7	1	2	4	3

201	202	203	204	205	206	207	208	209	210	211	212	213	214
5	3	6	4	1	2	7	4	7	5	6	3	2	1

301	302	303	304	305	306	307	308	309	310	311	312	313	313
1	7	2	5	3	6	4	2	1	6	4	5	3	7

Kikuyugrass Control Study

101	102	103	104	105	106	107	108	109	110	111	112	113	**114**
17	19	21	23	25	24	10	11	16	13	22	15	14	**1**

201	202	203	204	205	206	207	208	209	210	211	212	213	214
22	16	19	18	20	9	8	3	6	12	5	4	7	2

301	302	303	304	305	306	307	**308**	309	310	311	312	313	X
5	23	25	14	11	17	3	**1**	15	24	8	10	20	

401	402	403	404	405	406	407	408	409	410	411	412	413	414
22	20	16	24	14	18	12	2	9	13	7	21	4	6

501	502	503	504	505	506	507	**508**	509	510	511	512	513	514
12	4	2	6	18	10	5	**1**	23	25	17	19	11	13

601	602	603	604	605	606	607	608	609	610	611	612	613	614
5	6	12	10	11	16	19	24	9	8	21	7	15	3

701	702	**703**	704	705	706	707	708	709	710	711	712	713	714
8	7	**1**	2	3	9	20	18	4	13	22	15	21	25

801	802	803	804	805	806	807	808	**809**	810	811	812	813	814
22	4	16	5	2	15	10	12	**1**	8	11	17	14	23

901	902	903	904	905	906	907	908	909	910	911	912	913	914
19	14	21	13	17	25	23	24	3	7	6	18	9	20

CIMIS data September. 2020 – Aug. 2021

Los Angeles Basin – U.C. Riverside #44

Month Year	Total ETo	Total Precip	Avg Sol Rad	Avg Vap Pres	Avg Max Air Temp	Avg Min Air Temp	Avg Air Temp	Avg Max Rel Hum	Avg Min Rel Hum	Avg Rel Hum	Avg Dew Point	Avg Wind Speed	Avg Soil Temp
	(in)	(in)	(Ly/day)	(mBars)	(°F)	(°F)	(°F)	(%)	(%)	(%)	(°F)	(mph)	(°F)
Sep 2020	6.33K	0	514	13.2K	95.1K	62.8K	77.7K	71	21	43L	51.2L	3.5K	73
Oct 2020	4.81K	0	416K	11K	86.4	59K	71.6K	68K	25K	44K	44.8K	3.8K	68.4
Nov 2020	3.22K	0.01	329K	7.4	75.1K	47.5	60.4K	69	23	42K	35.1K	3.5K	58.5
Dec 2020	2.7	1.29	244K	5.4	69K	44.1	55.8	61	21	38	26.6	3.7	51.5
Jan 2021	2.98K	1.63	304K	6.3	67.5K	43.4K	55.1K	70K	28K	47K	31.7K	4	50.9
Feb 2021	3.51K	0.01	409K	6.9K	68	44.2	55.5	71	27	47K	33K	4.1K	53.3
Mar 2021	4.66	1.14	503K	7.6K	67.6	43.4K	54.8K	80	32	54K	36.1K	4K	55.5
Apr 2021	5.87	0	583K	9.7K	75.5	50.6K	61.9	80	33	54K	43.1K	4.4K	62.3
May 2021	6.45K	0	632K	12.5	77.1	54.5	64.1	87	39	62	50.1	4.3K	68
Jun 2021	7.41K	0.14	695K	14.5	87.9	59.5K	72.1K	81	32	54K	54K	3.9	72.9
Jul 2021	8.1K	0.12	676K	15.9	92.7	65.3	77.5	78	29	50	56.9	3.8	76
Aug 2021	7.14K	0K	601K	15K	91.1K	64.2	76.3K	75K	30K	50	55	3.6K	74.4K
Tots/Avgs	63.2	4.3	492.2	10.5	79.4	53.2	65.2	74.3	28.3	48.8	43.1	3.9	63.7

M - All Daily Values Missing	K - One or More Daily Values Flagged
J - One or More Daily Values Missing	L - Missing and Flagged Daily Values

W/m2 = 2.065 Ly/day	25.4 mm = inch	C = 5/9 * (F -32)

m/s = 2.24 mph	kPa = 10 mBars

Save the date

UCR Turfgrass and Landscape Research Field Day

Thursday, September 15, 2022

See you then!

UC RIVERSIDE
Turfgrass Science

Booklet cover and field map: Marta Pudzianowska
CA drought map: The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC.