UNIVERSITY OF CALIFORNIA
UC RIVERSIDE

Turfgrass & Landscape Research Field Day

September 15, 2016

University *of* California Agriculture and Natural Resources

UCR | Turfgrass Science

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

UC RIVERSIDE UNIVERSITY OF CALIFORNIA

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 2016 UCR Turfgrass and Landscape Research Field Day. This marks the ninth consecutive year of this event under my watch. 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.

Field Day continues to evolve to meet the interests and needs of our industry. The current drought is not over, thus landscape plants and especially turf have taken more than their fair share of criticism in the court of public opinion and from those who regulate water use. UCR has been addressing turfgrass and landscape water conservation practices long before this drought and will continue to do so come future El Niños or not. Today, you will see and hear about cutting edge new and longstanding research that addresses pest, water, and salinity management issues on turf and landscape. For the fifth 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 new website, **turfgrass.ucr.edu**.

As you enjoy today's tours, please take a moment to thank those folks, mostly wearing blue 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 Peggy Mauk, Sue Lee, Steve Ries, Sherry Cooper, Lauren McNees, and Saundra Wais. Production of this publication, signs, and online reports would not have been possible without assistance from Mr. Toan Khuong (Associate Specialist). 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 14, 2017.**

Sincerely,

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

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CIMIS Data Sep. 2015 – Aug. 2016

Los Angeles Basin-U.C. Riverside - #44

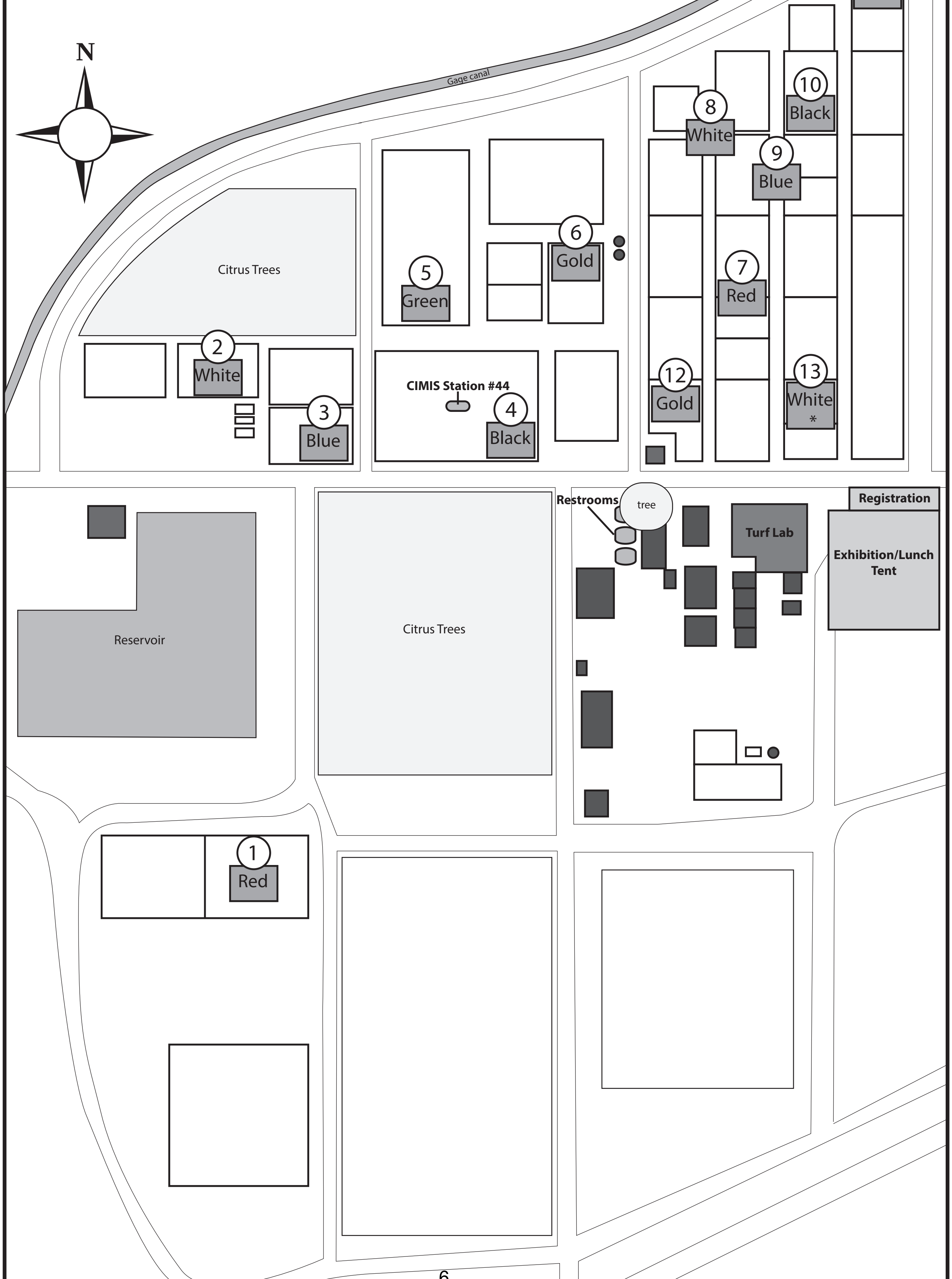
Month Year	Tot ETo (in)	Tot Precip (in)	Avg Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Avg Max Air Tmp (F)	Avg Min Air Tmp (F)	Avg Air Tmp (F)	Avg Max Rel Hum (%)	Avg Min Rel Hum (%)	Avg Rel Hum (%)	Avg Dew Point (F)	Avg Wind Speed (mph)	Avg Soil Temp (F)
Sep 2015	5.81	1.04	502 K	15.7 K	91.4	65.7 L	77.2	74	29	50 K	56.5 K	3.7 K	73.7
Oct 2015	4.21	0.54 K	335 K	13.1 K	84.8	61.8 L	72.3 K	72	29	49 K	50.4 K	4 K	69.4 K
Nov 2015	2.77	0.28 K	183	5.7	71.5	45.9 K	58.4	56	19	35	28.5	4 K	56.4
Dec 2015	2.35	0.70.	214 K	5.6 K	65.1 K	41.7 K	52.9 K	63	25	42 K	27.6 K	4 K	49.9
Jan 2016	2.09	2.35	230	7.8	64.3	43.2 K	53.3	74	38	56	36.5	3.2	50.6
Feb 2016	4.28 K	0.23	409 K	6.1	77.7 K	48.4 K	62.9 K	53	16	32 L	30.1 L	4.3 K	55
Mar 2016	4.92	0.72	481 L	9.3 K	73.1	48.3 K	60.2	77	30	53 K	42 K	4.1 K	60.7 K
Apr 2016	6.03	0.22 K	451 L	9.1 K	73.9 K	53 L	63.6 L	70 K	29 K	48 L	40.7 L	4.3 K	63.2 K
May 2016	6.14 K	0.02 L	474 L	12 L	71.2 L	55.5 L	62.6 L	80 L	40 L	62 L	49.2 L	4 L	67.8 L
Jun 2016	7.21 K	0.00	611 K	13.6 K	89.4 K	61.5 L	74.5 K	74	30	49 K	52.3 K	4.4 K	73
Jul 2016	7.75	0.00	596	14.3 K	93.5 K	64.2	77.5 K	73	25	45 K	53.8 K	4.2	75.9
Aug 2016	6.88	0	531	14.4 K	92.6	63.6	76.5	74	25	47 K	54 K	4	75.4
Totals/Avgs	60.44	6.10	418	10.6	79.0	54.4	66.0	70	28	47	43	4.0	64.3

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/m^2 = 2.065 Ly/day	25.4 mm = inch	C = 5/9 * (F -32)

m/s = 2.24 mph	kPa = 10 mBars

University of California, Riverside
Turfgrass Research and Extension



Turfgrass and Landscape Research Field Day Agenda

7:00 AM	**Exhibitor set-up**
7:30-8:30 AM	**Registration and Trade Show**
8:30 AM	**Welcome and Introductions** Peggy Mauk, Kathryn Uhrich, Michael Anderson, Patricia Springer, and Jim Baird
8:40-10:00 AM	**Field Tour Rotation #1** (20 minutes/station; participants choose 4 out of 6 stops)
Stop #1 *Red Tent*:	**Improvement of Bermudagrass, Kikuyugrass, and Zoysiagrass for Winter Color Retention and Drought Tolerance** Adam Lukaszewski
Stop #2 *White Tent*:	**Evaluation of Fungicides for Control of Anthracnose on Annual Bluegrass Putting Greens** Katarzyna Jagiello-Kubiec and Jim Baird
Stop #3 *Blue Tent*:	**Plant Growth Regulators for Bermudagrass, Kikuyugrass, and Seashore Paspalum Management** Martino Cuccagna and Jose Espeleta
Stop #4 *Black Tent*:	**Postemergence Control of Crabgrass in Tall Fescue** Maggie Reiter
Stop #5 *Green Tent*:	**So, You Think Your Turf/Landscape Plants Have a Disease. What Next?** Alex Putman
Stop #6 *Gold Tent*:	**Evaluation of Products for Salinity Alleviation** Marco Schiavon
10:00 – 10:30 AM	**Break and Trade Show**
10:30 – 11:50 AM	**Field Tour Rotation #2** (20 minutes/station; participants choose 4 out of 7 stops)
Stop #7 *Red Tent*:	**How Much Water Does a Lawn Need? And Products That Can Make Bermudagrass Look Better With Less Water** Marco Schiavon
Stop #8 *White Tent*:	**Evaluation of Turfgrass Species and Cultivars Under Deficit Irrigation** Katarzyna Jagiello-Kubiec and Martino Cuccagna
Stop #9 *Blue Tent*:	**Kurapia! A New and Improved Groundcover for Drought and Saline Conditions** Jim Baird
Stop #10 *Black Tent*:	**Have You Considered Zoysiagrass?** Steve Ries
Stop #11 *Green Tent*:	**Evaluation of Groundcovers with no Supplemental Summer Irrigation for Water Conserving Landscapes** Don Merhaut and Dennis Pittenger
Stop #12 *Gold Tent*:	**Research Update: Minimum Irrigation Requirements of Large Publically and Privately Maintained Landscapes** Janet Hartin, Loren Oki, and Dave Fujino
Stop #13: *White* Tent:*	**A New Nematicide Against the Pacific Shoot-gall Nematode *Anguina pacificae*** J. Ole Becker
12:00 – 1:30 PM	**Barbeque Lunch and Trade Show**
1:30 PM	**Adjourn**

CDPR Credits: 2.5 Hours - Please go on-line and fill out the evaluation form at http://ucanr.edu/turfgrasseval.

Stop #1: Improvement of Bermudagrass, Kikuyugrass, and Zoysiagrass for Winter Color Retention and Drought Tolerance

Adam J. Lukaszewski and Jim Baird
Department of Botany & Plant Sciences
University of California, Riverside

Background and Justification

California is suffering from a serious drought and the future of turfgrass and other landscape plants has never been more uncertain. Use of drought tolerant plant species should be at the forefront of water conservation management plans for golf courses and other landscapes. Warm-season or C4 grasses are better adapted to warmer, drier climates and use at least 20% less water compared to cool-season grasses, yet their use in California and abroad is limited primarily due to the aesthetics of winter dormancy. Despite attempts by the turfgrass industry to develop cool-season turfgrasses with improved drought tolerance, repeated testing in Riverside, CA, a Mediterranean climate characterized by hot, dry summers with less than 200 mm of annual rainfall, has demonstrated that even the most drought tolerant cool-season cultivars do not even come close to the warm-season species in terms of drought tolerance and water use efficiency. Thus, we strive to improve winter color retention in and therefore greater acceptance of warm-season turfgrasses for regions where these grasses are adapted. In addition, drought tolerance is not created equal both among and within warm-season species. While buffalograss is considered to be among the most drought tolerant of the warm-season turfgrass species, the primary mechanism for this is drought avoidance by summer dormancy. In California, general observations are that bermudagrass retains the best quality and green color under drought or deficit irrigation, although differences within cultivars are less substantiated. Other warm-season species appear to possess “lesser” drought tolerance, but zoysiagrass and kikuyugrass are best able retain green color longer in response to cooler temperatures.

Project Objectives

1. Develop bermudagrass, kikuyugrass, and zoysiagrass turf-type genotypes with improved winter color retention and drought tolerance for Mediterranean and arid climates.
2. Utilize Diversity Arrays Technology (DArT) markers to aid in breeding efforts and marker-assisted selection.
3. Develop techniques to reduce kikuyugrass ploidy level to diploid by androgenesis in order to reduce aggressiveness and improve turf quality and playability characteristics.

Bermudagrass

Bermudagrass is commonly used throughout the southern U.S. and is considered the “go to” warm-season species for many golf courses in California. Its major disadvantage is winter dormancy. We have initiated a project to address this issue, with the primary goal of shortening winter dormancy (if it can be eliminated at all, it certainly would not be a single step process). For this purpose we established a collection of all six Cynodon species in Riverside, by requesting samples from the USDA and several other sources. At present the collection exceeds 100 accessions; all six species are represented by at least several genotypes each. We started intercrossing these species and generated a large number of interspecific hybrids. Some of these were created by controlled one x one cross hybridization (both parents are known) using the detached tiller approach; many others were created by open pollination among the collection accessions left unmowed for several months. In this case only the female parent is known. The hybrids show variation for every observable characteristic, including the onset of winter dormancy and spring green-up.

Our immediate plans are to attempt to intercross the hybrids with latest dormancy and the earliest green-up, on the assumption that the next generation hybrids may show reduced dormancy period. In the meantime, the best-looking hybrids are being tested in various environments including: the Coachella Valley Agricultural Research Station in Thermal, CA; Arizona Country Club in Scottsdale, AZ; and The Preserve Golf Club in Carmel, CA. Dramatic differences in their behavior are clearly evident. In addition, a separate area of these grasses were established at UCR and, once established, irrigation was turned off to evaluate relative drought tolerance. New sets of hybrids are also being generated, again by open pollination of selected collection accessions. Presently we are expanding these grasses for further evaluations in larger plots (for more realistic cultural care and better evaluation of quality characteristics) across several climatic zones in California.

To establish the parentage of the existing hybrids, the collection and a sample of hybrids were genotyped using the DArT technology. The results are confusing in some way, as they indicate that in some cases accession designations may be incorrect (some accessions group with species other than those listed); in several cases the accessions appear to be amphiploid, as they share markers of two (or even more, up to four) original known diploid species. This makes tracking the parentage difficult. However, in many cases we were able to infer the paternal parent in hybrids from open pollination. The method is not perfect, as we have too few accession-specific DNA markers. However, species-specific markers show quite clearly the parental contribution.

Kikuyugrass

Kikuyugrass is a warm-season species that originated from the east African Highlands and now inhabits every continent except Antarctica (Mears, 1970). It was first imported into California in the 1920s for soil erosion control on hillsides and riverbanks (Garner, 1925); however, it quickly spread to colonize much of coastal southern and central California. Today, kikuyugrass is officially considered as an invasive weed with sale and transport prohibited in several California counties. Furthermore, it is on the Federal Noxious Weed list, which restricts importation of germplasm into the country and across state boundaries (USDA, 2012). Kikuyugrass spreads aggressively by rhizomes, stolons, and seed (Youngner et al., 1971). Also found in Hawaii and scantly in Arizona, the species is well suited to Mediterranean climates like California because it can photosynthesize across a wide temperature range as evidenced by its superior winter color retention among the warm-season turfgrasses (Wilen and Holt, 1995). These characteristics have allowed kikuyugrass to invade areas including golf courses, athletic fields, and lawns, where it often becomes the dominant managed turfgrass species rather than attempts to selectively remove it (Gross, 2003).

To assess the extent of genetic variation present among available accessions of kikuyugrass, local populations were sampled from throughout California, as well as from the collections at UCR (ca. 20-25 yrs. old), Hawaii and Australia. A total of 20,000 single nucleotide polymorphism (SNP) makers were discovered using the Diversity Arrays Technology sequencing (DArTseq) platform. The hierarchical plot, gap statistics, and the principal coordinate analysis all showed that the 336 accessions in the study separated into three main clusters. Seventy-seven percent of the total genetic variation was due to within population variation, while 23% represented among population variation. The main axis of the principal coordinate analysis accounted for 33% of the total variation. Accessions from California showed the least genetic variation with all but six located in the same cluster. Accessions from Australia and Hawaii showed a much broader degree of genetic diversity and would be valuable stock for breeding should such effort become feasible and the exchange of germplasm possible. The level of variation is not impressive, but it does offer hope that progress by selection is possible, even if no germplasm can be imported. Individual accessions now must be screened for their behavior under standard turf management and under various conditions including drought and winter color retention. Some variation in appearance is evident even under cursory evaluation. Selected accessions will be intercrossed and new hybrids screened and selected.

Kikuyugrass is tetraploid (presumably autotetraploid). It is very vigorous and aggressive. Autotetraploids in general are larger and more vigorous than their diploid predecessors. We assume that ploidy reduction will automatically reduce vigor and plant size, perhaps creating turf with much finer texture, and less aggressive growth. We will attempt to generate haploids of tetraploid kikuyugrass by androgenesis and/or microspore culture. While there is no technology specifically crafted to this particular species it has been tried on some related species, and is routinely used to generate haploids and doubled haploids in many grasses, including economically important cereals. The critical steps that must be tested involve proper stress (specific factor and its intensity) to induce the switch from the gametophytic to sporophytic development of microspores, and culture conditions. Several of these are currently being tried with first clear signs that the microspores can be induced to such switch.

Our assumption in this approach is that reduction of ploidy level to diploid will reduce plant vigor and size. We cannot predict, however, if such diploids will be fertile. In Festulolium where we reduced the ploidy level from tetraploid to diploid (Kopecky et al., 2005), some diploid individuals were in fact fertile and could be intercrossed to generate viable populations. Whether this will work in kikuyugrass is an open question; much depends on the level of differentiation of the genomes in the tetraploid, of which there are no data available.

Zoysiagrass

Zoysiagrass (*Zoysia sp.*) is generally considered to have optimal winter color retention among the warm-season turfgrasses. UCR has some tradition in breeding of

Zoysiagrass. In the 1980's UCR released cv. 'El Toro', a *Z. japonica* accession developed by the late Dr. Victor B. Youngner (Gibeault 2003). El Toro had a much faster establishment rate, better late season color and more rapid spring green-up than other *Z. japonica* grasses, and less thatch production. This release was followed by two cultivars, 'De Anza' and 'Victoria' which were created by a complex hybridization 'El Toro' x hybrid (*Z. matrella* x (*Z. japonica* x *Z. tenuifolia*). De Anza is known for very good winter color retention. Unfortunately, all germplasm from those breeding efforts has disappeared and if the breeding is to be initiated again, a new germplasm collection has to be established. We propose to request sample accessions from existing germplasm collections and breeding programs to be screened under Southern California conditions for their winter color retention and other critical turf characteristics. Early on progress will be slow, given the long establishment time for zoysiagrass. However, once interesting accessions are identified and hybrids are made, progress should accelerate rapidly.

Winter Color Retention Germplasm Evaluation

In an effort to help expedite development of warm-season turfgrasses with improved winter color retention and drought tolerance, bermudagrass germplasm from Oklahoma State University and the University of Florida, zoysiagrass germplasm from Texas A&M University, and germplasm from other breeding programs will be evaluated in Riverside, CA together with bermudagrass, zoysiagrass, and kikuyugrass germplasm from UCR. Replicate space plantings will be established in August 2016 and accessions will be evaluated periodically for establishment vigor, turf quality, winter color retention, spring green-up, and tolerance to deficit irrigation. Ratings will include visual, digital image analysis, and possibly by remote sensing using the latest drone technologies.

References

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Stop #2: Evaluation of Fungicides for Control of Anthracnose on Annual Bluegrass Putting Greens

Katarzyna Jagiełło-Kubiec, Martino Cuccagna, Marco Schiavon and Jim Baird
Department of Botany and Plant Sciences,
University of California, Riverside

Objectives

Thirteen fungicide treatments were evaluated for their ability to control anthracnose disease preventatively on an annual bluegrass green.

Materials and Methods

Inoculation was achieved through core aeration and dragging in order to spread the existing inoculum. The plot was originally established in 2007 from seed with 'Peterson's Creeping' annual bluegrass. The study was completely randomized with eight replications. Fungicide treatments were initiated on 7 June 2016 before disease symptoms were present. Treatments were sprayed every 14 days. The plot receives 0.125 lb N/1000ft^2 every 14 days and was topdressed on 24 August 2016. The most recent rating date before publication was 29 August 2016.

Soil: Hanford fine sandy loam amended with sand

Plot Size: 4′ X 6′

Application Information: CO_2 Backpack sprayer with TeeJet 8004VS nozzles
Output: 2 gal/M

Mowing Regime: 0.125 inches 3 days/wk

Results and Conclusions:

Overall, anthracnose disease pressure and distribution were moderate to heavy, with disease present in every replication by mid-June. All of the fungicide treatments, except treatment 8, significantly reduced disease pressure when compared to the control. No significant differences have been seen when comparing different treatments (Table 1). However, three treatments (Heritage Action + Daconil Action; Syngenta GreenCast Program Poa Greens- CA; and Lexicon) have resulted in consistently high turf quality and the lowest percentage of anthracnose disease cover.

<u>Acknowledgments</u>:
Thanks to BASF, Bayer, Syngenta, and the California Turfgrass & Landscape Foundation (CTLF) for supporting this research.

Table 1. Effect of fungicides and fungicide programs on anthracnose cover (0-100%) and turf quality (1-9, 9 = best). Riverside, CA. 2016.

Trt	Treatment Name	Rate/ 1000 ft^2	Application Code	Anthracnose [%] 08/15/16	Anthracnose [%] 08/29/16	Turf quality 1-9 08/15/16	Turf quality 1-9 08/29/16
1	Heritage Action Daconil Action Primo Maxx	0.2 oz 3.5 oz 0.1 oz	ABCDEFGH ABCDEFGH ABCDEFGH	30.3 bc	34.6 bcd	5.8 abc	5.8 abc
2	Heritage Action Daconil Action Appear	0.2 oz 3.5 oz 6.0 oz	ABCDEFGH ABCDEFGH ABCDEFGH	30.9 bc	30.6 bcd	5.3 abc	5.0 abc
3	Heritage Daconil WS Signature Xtra	0.2 oz 3.6 oz 4.0 oz	ABCDEFGH ABCDEFGH ABCDEFGH	12.6 c	16.3 bcd	6.3 ab	5.9 ab
4	Velista Daconil Action Primo Maxx	0.5 oz 3.5 oz 0.1 oz	ABCDEFGH ABCDEFGH ABCDEFGH	32.5 bc	41.9 abc	5.0 bc	4.3 cd
5	Velista Daconil Action Primo Maxx	0.5 oz 3.5 oz 0.1 oz	ABCDEFGH ABCDEFGH ABCDEFGH	23.3 bc	19.9 bcd	6.0 abc	5.9 ab
6	Heritage Action Daconil Action	0.2 oz 3.5 oz	ABCDEFGH ABCDEFGH	19.0 bc	15.6 bcd	6.0 abc	6.3 a
7	**Syngenta GreenCast Program Poa Greens- CA** Daconil Action Velista Appear Primo Maxx Heritage Action Briskway	 3.5 oz 0.5 oz 6.0 oz 0.1 oz 0.2 oz 0.5 oz	 ACDEGH ADFH ABCEFGH ABCDEFGH BEG C	6.3 c	13.8 cd	6.9 a	6.3 a
8	**Bayer Program** Signature Xtra Daconil Weatherstik Mirage Insignia	 4.0 oz 3.2 oz 1.0 oz 0.7 oz	 ACDEFGH ADFH BEG CE	43.4 ab	43.8 ab	4.4 cd	4.6 bc
9	**Bayer Program** Signature Xtra Daconil Weatherstik Mirage Insignia	 4.0 oz 3.2 oz 1.5 oz 0.7 oz	 ACDEFGH ADFH BEG CE	19.3 bc	25.1 bcd	5.5 abc	5.8 abc
10	**Bayer Program** Signature Xtra Daconil Weatherstik Mirage Insignia Medallion	 4.0 oz 3.2 oz 1.0 oz 0.7 oz 0.5 oz	 ACDEFGH ADH BEG CE F	30.8 bc	34.3 bcd	5.4 abc	5.1 abc

11	**BASF Program** Lexicon Encartis Trinity	 0.47 oz 4.0 oz 1.0 oz	 ACEG BDFH BDFH	25.3 bc	31.0 bcd	5.5 abc	5.0 abc
12	Encartis	4.0 oz	ABCDEFGH	21.4 bc	26.8 bcd	5.8 abc	5.3 ab
13	Lexicon	0.47 oz	ABCDEFGH	9.0 c	8.6 d	6.4 ab	6.1 ab
14	Check			61.8 a	66.1 a	3.1 d	3.0 d

Application code:

A – 06.07.16
B – 06.21.16
C – 07.05.16
D – 07.19.16
E – 08.02.16
F – 08.16.16
G – 08.30.16
H – 09.13.16

Table 2. Anthracnose fungicide trial plot plan. Riverside, CA. 2016.

9	2	8	13	9	7	6	14	5	10	9	12	13	5		12
3	7	1	8	3	2	11	5	8	2	7	7	10	11	3	7
5	2	4	2	10	5	9	3				9	8	10	8	
9	4	14	8	10	5	13	13	1	3	6	1	14	11	1	
13	1	4	11	6	6		10								
8	6	1	2	13	14	4	9	4	8						
5	11	12	7	12	7	7	12	11							
10	13	14	9	4	11	10	2	6	5	13	6	14	4		
11	3	14	3	12	1	12	3	4	1	12	14	2	6		

Stop #3: Plant Growth Regulators for Bermudagrass, Kikuyugrass, and Seashore Paspalum Management

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[2]Department of Agricultural Operations
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Objectives:

This study was conducted to quantify effects of several plant growth regulators (PGRs) on visual turfgrass quality, growth regulation and injury to 'Tifway II' hybrid bermudagrass, 'Whittet' kikuyugrass, and 'Platinum' seashore paspalum maintained as a golf course fairway. Use of adjuvants with Primo Maxx was also evaluated on bermudagrass.

Materials and methods:

The study was conducted on mature hybrid bermudagrass, kikuyugrass, and seashore paspalum turf grown on a Hanford fine sandy loam. Kikuyugrass was mowed at 0.45 inches, and bermudagrass and seashore paspalum were mowed 0.5 inches three times/wk. All three species received verticutting in May 2016 prior to the start of the experiments. The study was setup as a randomized block design, with 4 replications on 4'x10' plots. Treatments were applied with a CO_2-powered backpack sprayer with TeeJet 8003VS nozzles (9-inch spacing; 2 gal/M) beginning on July 28. Plots were evaluated weekly for turf quality and digital image analysis (DIA), and clippings were collected every three weeks before treatment application and oven dried at 105 °C for 24 hours.

Results:

On bermudagrass, crabgrass pressure was extremely high prior to the beginning of the study, hence chemical control was necessary leaving voids in the turf. Although no treatment improved quality in comparison to control after 2 applications, Primo Maxx alone or in combination with Ad-Max 90, and PoaCure herbicide were the only treatments to achieve acceptable quality (Table 1). Clippings collected in plots treated with PoaCure had the highest dry weight in comparison to the rest of the treatments (Table 1). After only one application of treatments and sampling for clipping yield three weeks later, it appeared that adjuvants, especially Sync, tank-mixed with Primo Maxx provided more growth suppression than the PGR alone. However, further investigation is needed to substantiate this observation.

Although no differences were found among PGR treatments on kikuyugrass, Trimmit applied at 24 oz/A caused injury to the plots (Table 2); in fact, plots that received the highest rate of Trimmit were the only ones that did not show sufficient quality on 25 August. All treatments with the exception of Legacy at the lowest rate and PoaCure decreased clipping dry weight in comparison to control (Table 2), with Trimmit at 24 oz/A providing the biggest reduction.

After one month the beginning of the trial there was no effect of PGRs on seashore paspalum visual quality. No statistical differences were found on clipping dry weight either, with the lowest clipping dry weight collected on plots that received the highest rates of Primo Maxx and Cutless (Table 3).

Acknowledgments:

Thanks to Moghu Research Center, Nufarm Americas, Precision Laboratories, SePRO, Simplot Partners, Syngenta, and the California Turfgrass & Landscape Foundation (CTLF) for supporting this research.

Treatment list for bermudagrass trial

Treatment	Rate	Company	Frequency (wks)
1. Untreated control			
2. Primo MAXX	11 oz/A	Syngenta	3
3. Primo MAXX 3. Ad-Max 90	11 oz/A 0.25 % v/v	Syngenta Simplot	3
4. Primo MAXX 4. Sync	11 oz/A 0.0625 % v/v	Syngenta Precision Labs	3
5. Primo MAXX 5. Sync	11 oz/A 0.125 % v/v	Syngenta Precision Labs	3
6. Primo MAXX 6. Sync	11 oz/A 0.25 % v/v	Syngenta Precision Labs	3
7. Legacy	15 oz/A	SePRO	3
8. Cutless MEC	25 oz/A	SePRO	3
9. Cutless MEC	35 oz/A	SePRO	3
10. Anuew	8 oz/A	Nufarm	3
11. Anuew	16 oz/A	Nufarm	3
12. Trimmit 2SC	24 oz/A	Syngenta	3
13. PoaCure	1.2 oz/M	Moghu	3

Bermudagrass PGR trial plot plan

12	4	10	5	
6	11	1	4	
2	9	2	3	
3	12	3	11	
4	5	13	5	
6	7	7	8	
10	9	8	1	North
7	9	13	2	
10	6	1	8	
13	12	12	11	
8	9	10	11	
7	6	5	4	
1	2	3	13	

Treatment list for kikuyugrass trial

Treatment	Rate	Company	Frequency (weeks)
1. Untreated control			
2. Primo MAXX	13 oz/A	Syngenta	3
3. Trimmit	16 oz/A	Syngenta	3
4. Trimmit	24 oz/A	Syngenta	3
5. Anuew	8 oz/A	Nufarm	3
6. Anuew	16 oz/A	Nufarm	3
7. Legacy	5 oz/A	SePRO	3
8. Legacy	10 oz/A	SePRO	3
9. Legacy	20 oz/A	SePRO	3
10. PoaCure	1.2 oz/M	Moghu	3

Kikuyugrass PGR trial plot plan

1	2	3	4	5	6	7	8	9	10
6	2	4	1	10	9	8	3	5	7
5	4	1	6	10	2	3	7	8	9
6	3	10	7	1	9	2	4	5	8

North

Treatment list for seashore paspalum trial

Treatment	Rate	Company	Frequency (weeks)
1. Untreated control			
2. Primo MAXX	9 oz/A	Syngenta	3
3. Primo MAXX	11 oz/A	Syngenta	3
4. Trimmit	16 oz/A	Syngenta	3
5. Anuew	8 oz/A	Nufarm	3
6. Cutless	20 oz/A	SePRO	3
7. Cutless	40 oz/A	SePRO	3
8. Muskateer	20 oz/A	SePRO	3
9. Muskateer	30 oz/A	SePRO	3

Seashore paspalum trial plot plan

North

4		1
6		2
8		3
1		4
2		5
9		6
7		7
5		8
3		9
2		4
1		6
9		1
7		9
6		7
3		3
4		2
8		5
5		8

Table 1. Effect of PGRs on clipping dry weight (g) and visual quality (1-9; 9=best) of hybrid bermudagrass.

Treatment	Rate	Turf Quality (8/24/2016)	Clipping dry weight (g) (8/16/2016)
Untreated control		5.6 AB	5.7 AB
Primo MAXX	11 oz/A	6.5 A	3.1 B
Primo MAXX Ad-Max 90	11 oz/A 0.25 % v/v	6.0 AB	2.6 B
Primo MAXX Sync	11 oz/A 0.0625 % v/v	5.3 AB	1.5 B
Primo MAXX Sync	11 oz/A 0.125 % v/v	5.5 AB	1.8 B
Primo MAXX Sync	11 oz/A 0.25 % v/v	5.3 AB	1.7 B
Legacy	15 oz/A	5.0 AB	5.3 B
Cutless MEC	25 oz/A	4.5 B	3.0 B
Cutless MEC	35 oz/A	5.3 AB	5.2 B
Anuew	8 oz/A	5.8 AB	4.0 B
Anuew	16 oz/A	5.5 AB	3.3 B
Trimmit 2SC	24 oz/A	5.3 AB	4.8 B
PoaCure	1.2 oz/M	6.3 AB	10.6 A

Treatments were applied on 7/28/2016; 08/18/2016; 9/08/2016

Table 2. Effect of PGRs on visual quality (1-9; 9=best) and clipping dry weight (g) of kikuyugrass.

Treatment	Rate	Turf Quality (8/24/2016)	Clipping dry weight (g) (8/16/2016)
Untreated control		6.5 ABC	5.1 AB
Primo MAXX	13 oz/A	7.0 AB	3.0 CDE
Trimmit	16 oz/A	6.5 ABC	2.4 CDE
Trimmit	24 oz/A	5.8 C	1.4 E
Anuew	8 oz/A	7.3 A	3.3 CD
Anuew	16 oz/A	7.0 AB	2.5 CDE
Legacy	5 oz/A	6.8 AB	3.8 BC
Legacy	10 oz/A	6.8 AB	2.8 CDE
Legacy	20 oz/A	6.8 AB	1.7 DE
PoaCure	1.2 oz/M	6.3 BC	5.5 A

Treatments were applied on 7/28/2016; 08/18/2016; 9/08/2016

Table 3: Effect of PGRs on clipping dry weight (g) of seashore paspalum.

Treatment	**Rate**	**Clipping dry weight (g) (8/16/2016)**
Untreated control		19.6 AB
Primo MAXX	9 oz/A	18.5 AB
Primo MAXX	11 oz/A	8.2 B
Trimmit	16 oz/A	14.0 AB
Anuew	8 oz/A	29.0 A
Cutless	20 oz/A	21.6 AB
Cutless	40 oz/A	12.2 B
Muskateer	20 oz/A	24.3 AB
Muskateer	30 oz/A	14.8 AB

Treatments were applied on 7/28/2016; 08/18/2016; 9/08/2016

Stop #4: Postemergence Control of Crabgrass in Tall Fescue

Maggie Reiter
UC ANR CE Environmental Horticulture Advisor
Fresno, Madera, Tulare, and Kings Counties

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Background and Objectives:

Drought, landscape water use restrictions, and self-imposed cutbacks on lawn irrigation have contributed to turf thinning, especially in cool-season species like tall fescue. As a result, warm-season weed species like crabgrass, a summer annual, frequently invade lawns disrupting color, texture, and uniformity during the summer months while creating voids again in late fall with dieback following flowering/seed dispersal and cooler temperatures.

The objectives of this study were to: 1) evaluate new and existing herbicides and combinations for postemergence control of smooth crabgrass (*Digitaria ischaemum*) in tall fescue turf; and 2) determine the effects of adjuvant type and concentration on weed control.

Methods:

Experimental Design: Randomized block; 4 replications

Plot size: 7 ft x 10 ft; 4 ft alleys

Turfgrass Species: Tall fescue (3-inch height of cut)

Weed Species: Smooth crabgrass (*Digitaria ischaemum*)
Growth Stage: 2-3 leaf to tillering at initial application

Application Dates: 10 June 2016 (initial application)
8 July 2016 (4 weeks after initial application)
3 August 2016 (8 weeks after initial application)

Spray Information: CO_2-powered bicycle sprayer
TeeJet 8003VS nozzles; 19-inch spacing; 45 psi; 1 gal/M

Plot Plan: **North**

1	2	3	4	5	6	7	8	9	10	11	12	13	14
7	3	5	1	13	4	6	14	2	11	8	10	9	12
13	8	4	11	7	10	2	9	3	6	14	1	12	5
3	6	9	12	1	8	13	5	11	14	4	7	2	10

Results:

- ✓ Crabgrass was mostly young (2-3 leaf) to first tillering at the time of initial treatment (i.e., not too late for postemergence control).
- ✓ Pylex (topramezone) was the only herbicide that resulted in desirable (near 100%) crabgrass control following two applications. In fact, no other herbicide reached >90% control at 23 days following three applications (Table 1).
- ✓ Addition of Turflon Ester Ultra (triclopyr) helped to reduce bleaching of crabgrass caused by Pylex and Tenacity (mesotrione) herbicides, both carotenoid biosynthesis inhibitors (data not shown). Furthermore, Turflon appeared to increase crabgrass control when tank-mixed with most herbicides. Also, Turflon provides broadleaf control, which was not evaluated in this study due to lack of broadleaf weeds present.
- ✓ When tank-mixed with Tenacity and Turflon, both Sync Activator Adjuvant and Ad-Max 90 caused a slight increase in crabgrass control vs. both herbicides without adjuvant. Also, crabgrass control was slightly better in tank mixes containing Sync compared to Ad-Max 90. However, all aforementioned differences were not statistically significant.
- ✓ It appears that this crabgrass population is resistant to quinclorac (Drive XLR8) herbicide as has been reported elsewhere including the Central Valley of California.
- ✓ Pylex and Last Call (fenoxaprop, fluroxypyr, dicamba) herbicides are not currently registered for turf use in California.

Acknowledgments:

Thanks to BASF, Crop Production Services, Dow AgroSciences, FMC, Loveland Products, Nufarm Americas, Precision Laboratories, Simplot Partners, Syngenta, and the California Turfgrass & Landscape Foundation (CTLF) for supporting this research.

Table 1. Effects of herbicides and adjuvants on postemergence control of smooth crabgrass in tall fescue turf. Riverside, CA. Crabgrass control (0-100%) based on initial crabgrass cover on 10 June 2016.

No.	Treatment	Company	Rate	Crabgrass % Control (07/8/16)	Crabgrass % Control (08/2/16)	Crabgrass % Control (08/26/16)
1 1	Tenacity Ad-Max 90	Syngenta Simplot	5 oz/A 0.25% v/v	17 fgh	8 fg	25 cd
2 2	Tenacity Turflon Ester Ultra	Syngenta Dow	5 oz/A 16 oz/A	32 efgh	32 def	67 b
3 3 3	Tenacity Turflon Ester Ultra Ad-Max 90	Syngenta Dow Simplot	5 oz/A 16 oz/A 0.25% v/v	44 cdef	42 cde	74 ab
4 4 4	Tenacity Turflon Ester Ultra Sync	Syngenta Dow Precision Labs	5 oz/A 16 oz/A 0.062% v/v	50 bcde	46 bcde	83 ab
5 5 5	Tenacity Turflon Ester Ultra Sync	Syngenta Dow Precision Labs	5 oz/A 16 oz/A 0.125% v/v	28 efgh	23 efg	79 ab
6 6 6	Tenacity Turflon Ester Ultra Sync	Syngenta Dow Precision Labs	5 oz/A 16 oz/A 0.25% v/v	44 cdef	61 bc	86 ab
7 7 7	Tenacity Dismiss CA Ad-Max 90	Syngenta FMC Simplot	5 oz/A 4 oz/A 0.25% v/v	38 defg	33 def	31 c
8 8 8 8	Tenacity Dismiss CA Turflon Ester Ultra Ad-Max 90	Syngenta FMC Dow Simplot	5 oz/A 4 oz/A 16 oz/A 0.25% v/v	71 abc	74 ab	81 ab
9	Dismiss CA	FMC	8 oz/A	4 h	0 g	0 d
10 10	Pylex MSO	BASF Loveland	1.5 oz/A 0.5% v/v	81 a	98 a	91 ab
11 11 11	Pylex Turflon Ester Ultra MSO	BASF Dow Loveland	5 oz/A 16 oz/A 0.5% v/v	78 ab	96 a	100 a
12 12	Drive XLR8 MSO	BASF Loveland	64 oz/A 0.5% v/v	20 fgh	0 g	0 d
13 13	Last Call Ad-Max 90	NuFarm Simplot	64 oz/A 0.25% v/v	64 abcd	52 bcd	65 b
14	Control	--	--	12 gh	0 g	0 d

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

Treatments were applied on 10 June, 8 July, and 3 August 2016.

Stop #5: So, You Think Your Turf or Landscape Plants Have a Disease. What's Next?

Alex Putman
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Accurate diagnosis of plant problems is a cornerstone of the economically and environmentally sustainable management of turf and landscapes. A disease is often suspected when unhealthy plants are observed, but abiotic factors such as improper cultural practices, environmental stress, and/or accidental damage are the primary cause of a large percentage of problems. Considering the following questions in roughly this order can help you or someone else piece together what is happening to your turf or plants.

1. **What do the plant parts look like up close?** Examine the leaves and stems closely, and dig up roots. Diseases often form their own distinctive lesions with certain colors, shapes, and borders between healthy tissue. In the early morning, you may see the pathogen itself in the form of a fuzz or fluffy mass. Abiotic problems often exhibit less distinct symptoms without borders.

2. **What is the overall pattern?** Take a step back to see how the unhealthy appearance is distributed among a turf area or adjacent plants.
    - **a.** Affects a large area equally or in straight lines? Might be phytotoxicity or other human error.
    - **b.** Occurs in diffuse blotches? May be a foliar disease, insect, or nematode.
    - **c.** Occurs in defined patches? Probably a soilborne or foliar patch disease.
    - **d.** Follows the water in low areas? Could be an abiotic problem or pathogen brought on by excessive soil moisture.

3. **What is the host?** Key to understanding which pathogens it is commonly susceptible to, how it responds to cultural practices or stresses, and the normal appearance of a healthy plant.

4. **When did the symptoms appear, and what was happening before that time?**
    - **a.** What was the weather like before symptoms appeared? Such as a sudden shift to moist or humid and warm or cool conditions.
    - **b.** What management has been done on the plants before symptoms appeared? Includes irrigation, fertility or pesticide application, or cultural practices. Dropping the mowing height is probably the leading contributor to damage from pathogens or environmental stress in the summer.

5. **Was the previous winter marked by unusual precipitation or temperature?** Winter conditions can affect the population levels of pathogens, insects, and nematodes and therefore the damage caused by these agents during the

following summer. Some pathogens actually infect plants long before symptoms are observed, such as for spring dead spot.

6. **What are the soil and irrigation source like?** Understanding the pH, salinity, and nutrient status of the soil and water source could identify the primary source of the problem or point the diagnostic process toward a disease that is favored by one of those stresses.

Often common diseases or abiotic problems can be diagnosed by answering a few of these questions. If not, use the following procedures to submit a sample to a diagnostic laboratory:

General Instructions

1. Take photos of individual plant parts and the overall pattern from a standing position at about a 45^{o} angle (for turf) or showing whole plants (for landscape) that are in focus and with optimal light (avoid glare during mid-day).
2. Collect samples before applying a pesticide.
3. Place the plugs (turfgrass) or bagged samples (landscape) in a sturdy cardboard box, surround with any good packing material (e.g., paper, bubble wrap), and close well with shipping tape.
4. Fill out the submission form provided by the lab to the best of your ability and enclose with sample if not submitted electronically with photos.
5. Overnight the package. If today is Friday or Saturday, place the sample in a refrigerator and wait until Sunday to ship for Monday arrival.

Turf Samples

1. Take 2-4 cup cutter samples. Each plug surface should contain approximately two-thirds diseased and one-third healthy turf.
2. Shake or cut off soil below the maximum root depth.
3. Wrap the soil snugly in tin foil, leaving the foliage exposed.

North Carolina State University Turf Diagnostics Lab form and instructional videos:
https://turfpathology.plantpath.ncsu.edu/diagnostics-lab/how-to-submit-a-sample/

Landscape Samples

1. Dig up the plant and the bulk of the root system, keeping the root ball intact. Select plants that are partially diseases and partially healthy.
2. Enclose the root ball in a plastic bag, securing the bag around the stem.
3. Enclose the entire plant and root ball in another bag. If the plant is too large, cut portions of leaves, stems, and/or roots representing healthy and diseased and enclose separately.

North Carolina State University Plant Disease and Insect Clinic forms, instructions, videos:
https://projects.ncsu.edu/cals/plantpath/extension/clinic/submit-sample.html

Stop #6: Evaluation of Products for Alleviation of Salinity

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Objectives:

To evaluate the efficacy of products on bermudagrass turf to reduce stress caused by irrigation with saline water.

Methods:

The plot area was sodded with 'Tifway II' bermudagrass on 6 August 2012 on a Hanford fine sandy loam with no pre-existing salinity issues. All treatments were applied initially on 26 May 2016. The turf is mowed three times per week at 0.5 inches. Standard bermudagrass cultural practices are maintained throughout the study, including 5 lbs N/M/yr. Plots are irrigated at 75% ET_0 with water that matches the same ion composition of the Colorado River (see table below). Every two weeks, plots were evaluated for turf quality, NDVI and volumetric soil water content. In addition, Digital Image Analysis and leachate are collected on the same day. Soil samples will be collected at the end of bermudagrass growing season separately for each combination of chemical treatment and replication to assess salinity accumulation in the root zone.

Chemical properties of saline irrigation water used in this study compared to potable irrigation water used elsewhere at the UCR turfgrass facility.

	Saline Irrigation Water	Potable Irrigation Water
pH	7.57	7.82
Hardness	938.23	215.18
Bicarbonate	209.84	214.72
Carbonate	0.01	0.01
EC (dS/m)	4.43	0.61
Na (ppm)	523.90	53.36
Cl (ppm)	996.27	31.13
Boron (ppm)	0.11	0.08
SAR (meq/L)	18.30	3.24
Nitrate Nitrogen (ppm)	5.11	5.18
Phosphate (ppm)	0.40	0.01
Potassium (ppm)	129.76	4.16
Magnesium (ppm)	151.99	12.24
Calcium (ppm)	126.03	66.00
Sulfate (ppm)	707.62	78.10
Manganese (ppm)	0.01	0.01
Iron (ppm)	0.11	0.05

Treatments:

Treatments are applied by hand or using a CO_2 boom sprayer calibrated at 2 gal/M. Treatments are watered in with over 0.4 inches of water immediately following application. For treatment list see table on next page.

Results

For the fourth year in a row, DeSal improved turf quality in comparison to the untreated control. However, UCR002 had the highest benefit on turf quality (Figure 1). No difference in EC was detected in the leachate. Soil analysis at the end of the growing season is needed to determine which treatments have a positive effect on soil chemistry.

Salinity Alleviation Study Treatment List 2016

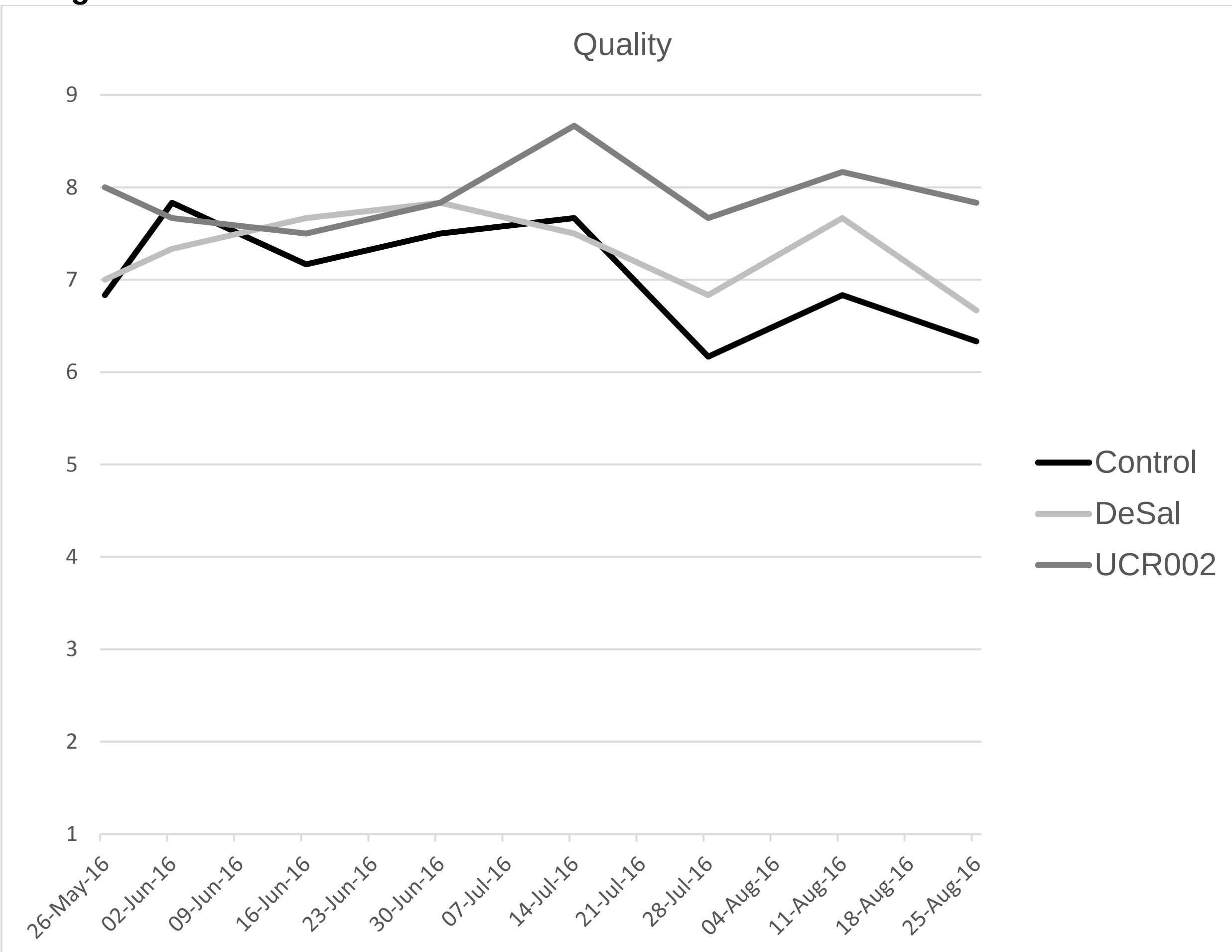
No.	Treatment	Company	Rate	Frequency (wks)
1	Untreated Control	--	--	--
2	ATGS1	Green Industries	1.5 oz/M	2
3	Go Isolates	BioFlora	5 gal/acre	4
4a	TurfRx Saltex	Redox	2.2 oz/M	2
4b	TurfRx PeneCal		1.5 oz/M	2
4c	TurfRx C-85		0.74 oz/M	2
4d	TurfRx Ca Si		1.5 oz/M	2
5a	KaPre Exalt	LidoChem	1 quart/acre	2
5b	Pennamin Perfect=K		2 lb/acre	2
5c	KaPre KelpPlus		1 gal/acre	2
6	Gypsum	--	5 lb/M	
7	DeSal	Ocean Organics	0.75 oz/M	2
7	StressRx		6 oz/M	2
7	XP Micro		6 oz/M	2
8a	UCR001a		0.5 oz/M	4
8b	UCR001b		0.36 oz/M	4
8c	UCR001c		6 oz/M	4
8d	UCR001d		0.0236 oz/M	4
9a	UCR002a		0.25 oz/M	2
9b	UCR002b		0.36 oz/M	2
9c	UCR002c		3 oz/M	2
9d	UCR002d		0.0118 oz/M	2
10	Gypsum	--	10 lb/M	

Acknowledgments:
Thanks to Green Industries, BioFlora, Lidochem, Ocean Organics, LidoChem and the California Turfgrass & Landscape Foundation (CTLF) for supporting this research.

Plot Plan
Salinity Alleviation Study (Field 12F-4)
North

113 1	213 4	313 2	413 5	513 3	613 7
114 2	214 7	314 10	414 4	514 2	614 5
115 3	215 2	315 3	415 7	515 6	615 4
116 4	216 10	316 5	416 10	516 9	616 2
117 5	217 3	317 7	417 1	517 10	617 3
118 6	218 5	318 4	418 8	518 7	618 1
119 7	219 1	319 9	419 2	519 5	619 8
120 8	220 8	320 6	420 9	520 4	620 6
121 9	221 6	321 1	421 3	521 1	621 10
122 10	222 9	322 8	422 6	522 8	622 9

Figure 1. Quality of treatments that performed better than control in at least one rating date.



Stop #7a: How Much Water Does a Lawn Need?

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Objectives:

The primary objective is to quantify the amount of water required to keep lawngrass green and functional in California. Warm-season turf species are known to be more water use efficient and drought tolerant than cool-season turfgrasses; nevertheless, tall fescue remains the predominant species used in California lawns. We hypothesize that proper selection of grasses regionally would minimize irrigation requirements to approximately 30% of estimated evapotranspiration (ET).

Materials and Methods:

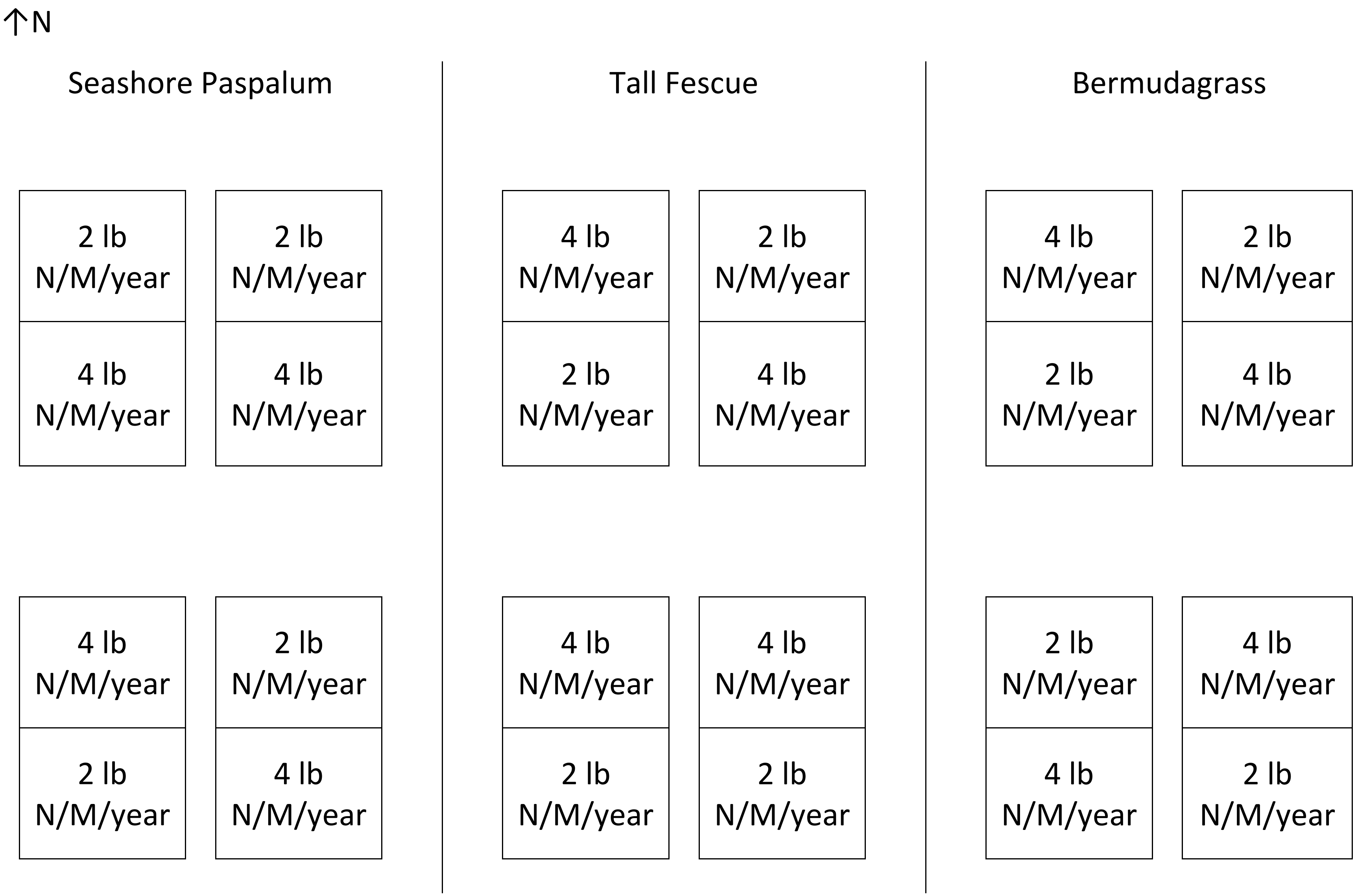
Three species were sodded at UCR on 24 August 2015: 'Tifway II' bermudagrass, 'West Coaster' tall fescue, and 'Platinum' seashore paspalum. Four 8’ x 6’ plots were created per grass species and subsequently split into high (4 lb N/M/year) and low (2 lb N/M/year) fertility. Plots are mowed weekly or biweekly at 2 (warm-season species) or 3 (tall fescue) inches using a rotary mower. Clippings are collected. Starting on 16 May 2016, plots are evaluated twice a week for turf quality, NDVI and digital image analysis. Irrigation occurs on an individual experimental unit basis. For example, if one experimental unit of even just one replication has < 50% green cover, or not sufficient visual quality, it alone receives irrigation. All plots are hand-irrigated using an in-line flow meter (Sotera 850) with water quantity measured and reported for each event. Irrigation is based on previous week ET_0 as determined by an on-site CIMIS station.

Results:

Starting on 16 May 2016, and until 26 August 2016, bermudagrass needed 12.5 inches of water to sustain acceptable quality, and was the grass the required the least amount of water; seashore paspalum was irrigated with 14 inches of water, and lastly, tall fescue received 19.75 inches. No grasses showed improved drought tolerance with high or low fertility levels. Results confirm that conversion from tall fescue to warm-season species is the most important water conservation strategy for California lawns.

Acknowledgments:

Thanks to The Lawn Institute and the California Turfgrass & Landscape Foundation (CTLF) for supporting this research.


↑N
Seashore Paspalum
Tall Fescue
Bermudagrass
2 lb N/M/year
2 lb N/M/year
4 lb N/M/year
2 lb N/M/year
4 lb N/M/year
2 lb N/M/year
4 lb N/M/year
4 lb N/M/year
2 lb N/M/year
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4 lb N/M/year
2 lb N/M/year

Stop #7b: Products That Can Make Bermudagrass Look Better With Less Water

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Objective:

Evaluate if correct management practices such as the use of plant growth regulators (PGRs), wetting agents, proper fertilization, or the combined application of the three can help maintain acceptable turf quality under deficit irrigation.

Methods:

The study was conducted on mature bermudagrass ‘Princess 77’ turf. The 60’ x 90’ field was divided into six 30’ x 30’ plots. Beginning May 18, the plots received either 40% or 70% of previous week ET_0, as determined by an on-site CIMIS station. Treatments are arranged in a split-plot design with 3 different factors randomized within ET_0 replacement plots and 3 replicates. Plant Growth Regulator (Primo Maxx) serves as split plot; wetting agent (Revolution) as split-split-plot; finally, fertilizer products (see table below) were randomized inside the wetting agent plots (plot size 24 ft^2) and applied monthly beginning May 18, 2016. Each treatment received an equivalent of 1 lb N/M/month. Every two weeks, plots were evaluated for turf quality, volumetric soil water content, Normalized Difference Vegetation Index (NDVI), and Digital Image Analysis (DIA).

Results:

All ratings collected at the beginning of the study showed that bermudagrass was significantly affected by lack of N fertilization (Figures 1 and 2). However, grass recovered quickly after the first application of N, and no differences between ET_0 replacements were found until the beginning of July. Moreover, plots treated with Revolution achieved a sufficient rating of 6 or higher for two months even when irrigated at only 40% ET (Figure 2). After 8 July 2016, no plots irrigated at 40% ET_0 achieved acceptable quality, although plots treated with Revolution, alone or in combination with Primo Maxx, showed consistently better quality of plots than those that did not receive Revolution (Figure 2). At 70% ET_0 replacement plots that received both Primo Maxx and Revolution had higher visual quality in comparison to all the other treatments on 4 ratings dates, including during the entire month of August (Figure 1). No differences were observed in fertilizer treatments. Preliminary results suggest that maintaining sufficient fertilization (5 lb N/M/year on bermudagrass) and regular use of Primo Maxx and Revolution are the most powerful tools to manage bermudagrass with less water.

Acknowledgments:

Thanks to Aquatrols, Gro-Power, Ocean Organics, Syngenta, Yara and the California Turfgrass & Landscape Foundation (CTLF) for supporting this research.

PGR, wetting agent, and fertilization study treatment list

Plot	**Treatment**	**Company**	**Rate**	**Frequency (wks)**
Whole Plot	ET_0 replacement	---	40%-70%	Mon-Wed-Fri
Split	Primo Maxx	Syngenta	0.25 oz/M	2
Split-split-plot	Revolution	Aquatrols	6 oz/M	4
Split-split-split-plot	Gro-Power (5-3-1)	Gro-Power	1 lb N/M	4
Split-split-split-plot	SeaBlend (12 4 5) + StressRX + XP Micro	Ocean Organics	1 lb N/M + 6 oz/M + 6 oz/M	4 2 2
Split-split-split-plot	Turf Royale (21-7-14)	Yara	1 lb N/M	4
Split-split-split-plot	Yara Liva (15.5-0-0)	Yara	1 lb N/M	4
Split-split-split-plot	Turf Royale (21-7-14) + ACA 1935	Yara Aquatrols	1 lb N/M + 4 oz/M	4 4
Split-split-split-plot	Turf Royale (21-7-14) + ACA 5000	Yara Aquatrols	1 lb N/M + 4 oz/M	4 2

PGR Wetting Agent and Fertilization Study Treatment List and Plot Plan

Rep 1	70% ET_0	19	20	12	9		13	18	4	3	40% ET_0
		21	22	11	7		15	16	1	2	
		23	24	8	10		17	14	6	5	
		14	18	5	2		9	8	19	21	
		13	17	1	6		11	7	22	24	
		16	15	3	4		10	12	23	20	

Rep 2	70% ET_0	5	6	15	16		5	3	13	17	40% ET_0
		2	3	17	14		6	2	14	16	
		1	4	18	13		1	4	18	15	
		23	19	10	12		9	11	22	19	
		21	22	8	9		10	12	20	21	
		24	20	7	11		8	7	23	24	

Rep 3	40% ET_0	13	16	2	5		23	19	7	11	70% ET_0
		15	17	1	3		22	21	10	12	
		14	18	6	4		20	24	9	8	
		11	8	20	19		2	3	18	14	
		10	7	24	23		1	6	13	17	
		9	12	22	21		4	5	16	15	

Trt #	Fertilizer	Primo Maxx	Revolution	Trt #	Fertilizer	Primo Maxx	Revolution
1	Gro-Power			13	Gro-Power		x
2	SeaBlend + StressRX + XP Micro			14	SeaBlend + StressRX + XP Micro		x
3	Yara Turf Royale			15	Yara Turf Royale		x
4	Yara Liva			16	Yara Liva		x
5	Yara Turf Royale + ACA 1935			17	Yara Turf Royale + ACA 1935		x
6	Yara Turf Royale + ACA 5000			18	Yara Turf Royale + ACA 5000		x
7	Gro-Power	x		19	Gro-Power	x	x
8	SeaBlend + StressRX + XP Micro	x		20	SeaBlend + StressRX + XP Micro	x	x
9	Yara Turf Royale	x		21	Yara Turf Royale	x	x
10	Yara Liva	x		22	Yara Liva	x	x
11	Yara Turf Royale + ACA 1935	x		23	Yara Turf Royale + ACA 1935	x	x
12	Yara Turf Royale + ACA 5000	x		24	Yara Turf Royale + ACA 5000	x	x

Figure 1. Quality of plots irrigated at 70%ET_0 treated with either Primo Maxx, Revolution, a combination of the two or untreated. 2016. Riverside, CA.

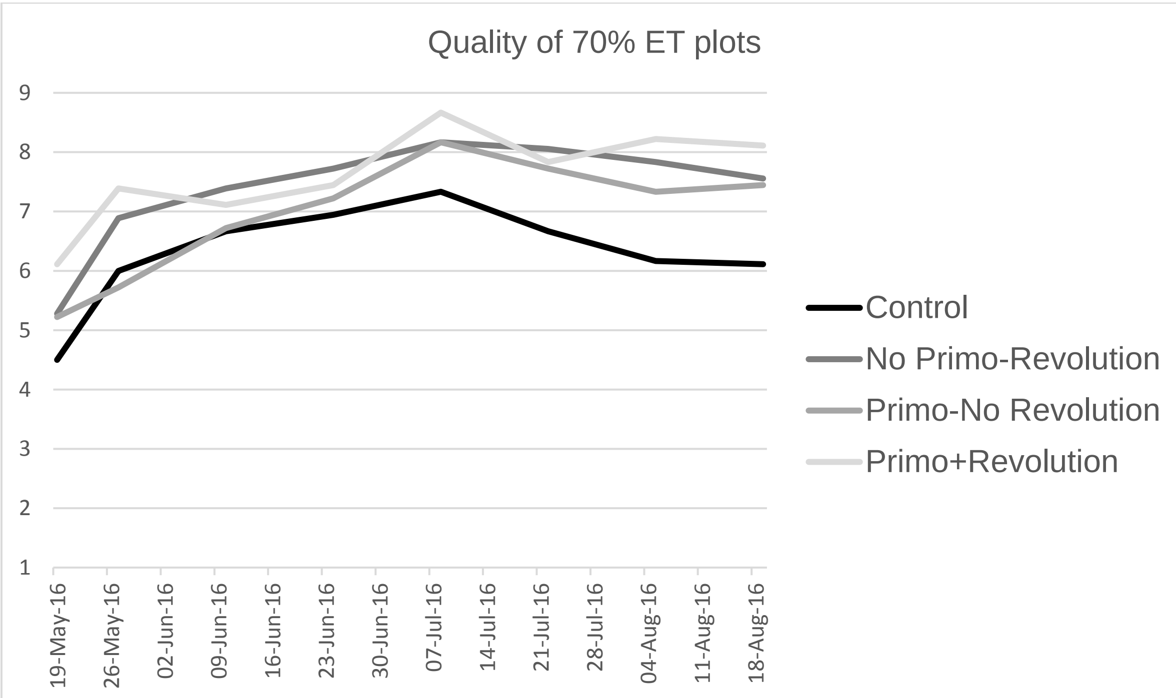
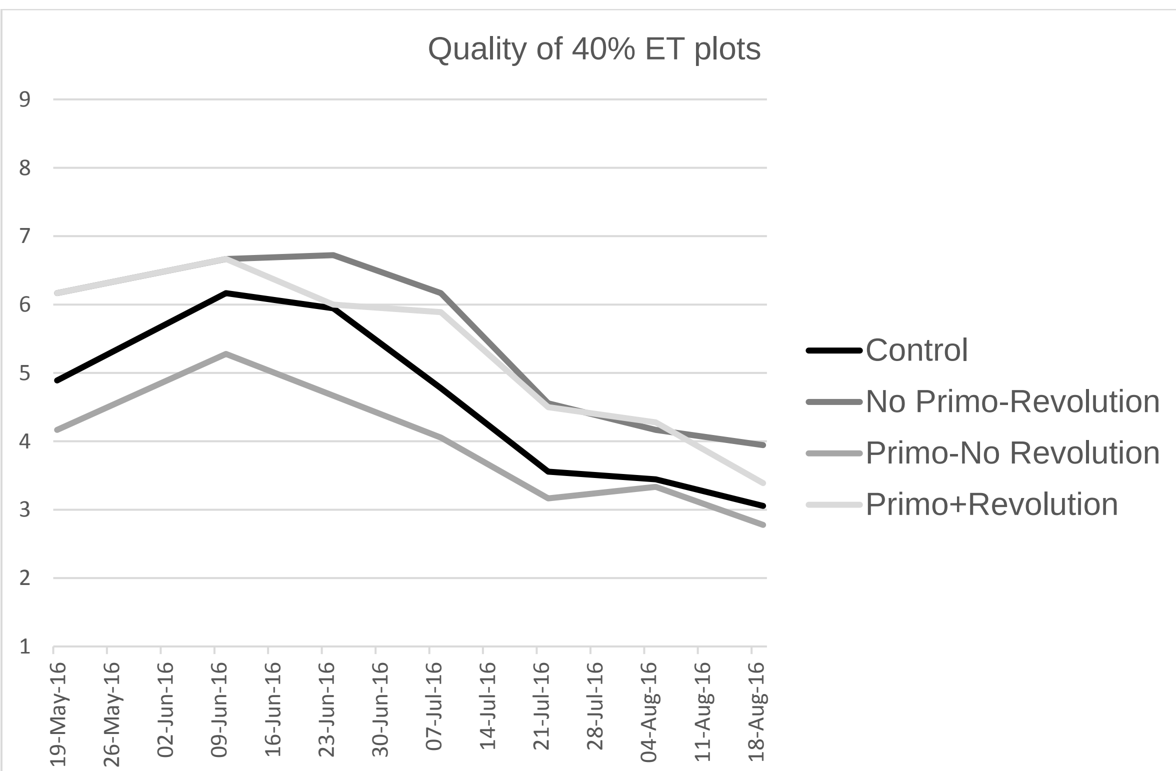


Figure 2. Quality of plots irrigated at 40%ET_0 treated with either Primo Maxx, Revolution, a combination of the two or untreated. 2016. Riverside, CA.



Stop #8: Updates on Evapotranspiration Adjustment Factor Project
(A Contract from CA Dept. of Water Resources)

Principal Investigators: David Fujino[1], Janet Hartin[1], and Loren Oki[2]
Project Cooperators: Karrie Reid[2] and Chuck Ingels[2]
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[2]University of California Cooperative Extension;
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Project Contractor: William Baker & Associates, LLC

California's population exceeded 39 million by the end of 2015 and is expected to reach 45 million by 2020. This projected increase coupled with a severe multi-year drought and a statewide water distribution problem, necessitates further conservation of an already limited water supply. Landscape irrigation uses a significant amount of water. Approximately 40-50 percent of household water use is used outdoors to irrigate urban landscapes.

2016 marks the fifth year of a major drought in California State Assembly Bill 1881 resulted in California enacting a law on January 1, 2010 reducing the Evapotranspiration Adjustment Factor (ETAF) from 0.8 to 07 in new landscapes over 2,500 square feet, mandating enhanced water conserving measures in urban landscapes. In December, 2015 a revised ETAF of 0.55 ETo for new landscapes over 500 square feet replaces the previous 0.7 ETo, necessitating even greater conservation. The 0.55 MAWA represents a 21.4% reduction from 0.70. (It is important to note that in some cases recreational turf and water used to produce food crops will remain exempt.)

The goal of our California Department of Water Resources (DWR) project is to measure water use at 30 large urban landscapes in six climate zones that include a variety of ornamental plants with varying water use rates growing under a wide mixture of plant densities and microclimates. A further goal is to work with site managers to improve irrigation system distribution uniformity (DU) and overall irrigation efficiency at each site.

The Maximum Applied Water Allowance formula follows.

*Maximum Applied Water Allowance (MAWA) = (ETo) (0.7) (LA) (0.62)
ETo = Reference Evapotranspiration (inches per year)
0.7 = ET Adjustment Factor
LA = Landscaped Area (square feet)
0.62 = Conversion factor (to gallons)
*Maximum Applied Water Allowance = _______ gallons/year

Example of MAWA in Riverside, CA at 0.7 ETAF

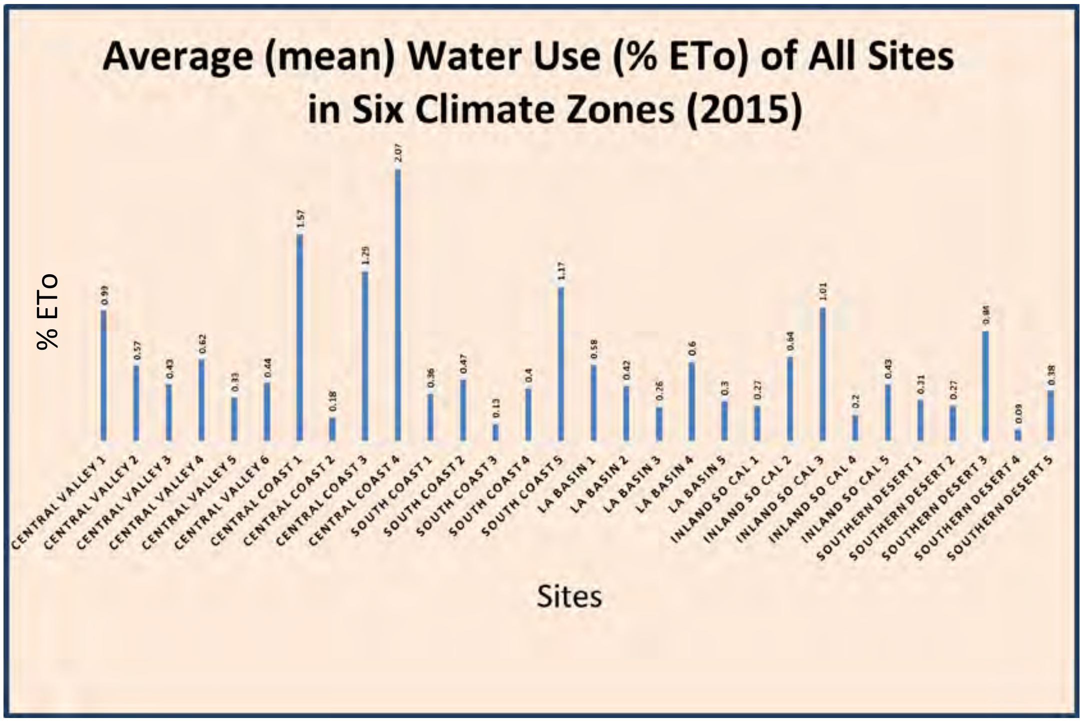
Hypothetical Landscape Area = 50,000 sq ft
MAWA = (ETo) (0.7) (LA) (0.62)
MAWA = (51.1) (0.7) (50,000 sq ft) (0.62)
MAWA = 1,108,870 gallons/year

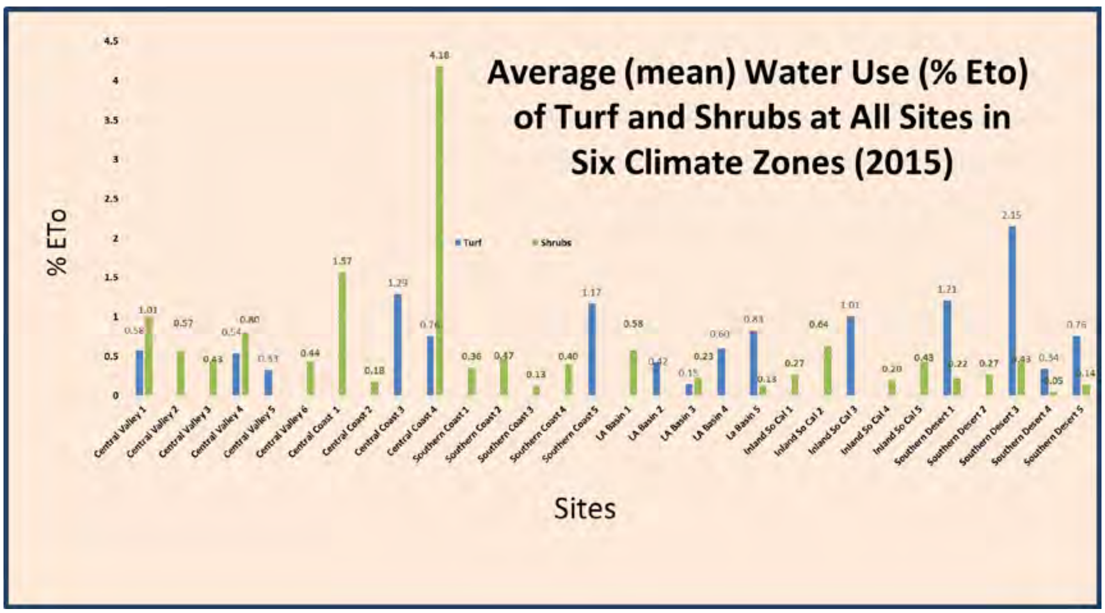
Example of MAWA in Riverside, CA at 0.55 ETAF

Hypothetical Landscape Area = 50,000 sq ft
MAWA = (ETo) (0.55) (LA) (0.62)
MAWA = (51.1) (0.55) (50,000 sq ft) (0.62)
MAWA = 871,255 gallons/year (21.4% reduction from the former 0.7 ETAF)

Results:

The average (mean) change in water use across the 30 sites in 2015 compared to 2014 was -0.29 ETo. The average decrease in water use at the 25 sites which used less water in 2015 was -0.46 Eto and the average increase in water use at the five sites which used more water in 2015 was +0.12 ETo. A combination of hands-on training that included correcting irrigation system hardware issues and scheduling irrigations based on climate zone, plant type, plant density, soil textures, and microclimate considerations led to the overall water savings in 2015 compared to 2014. Sites with turf only used the most water (0.80 % ETo) followed by combined turf and shrub sites (0.65 % ETo) and shrubs only (0.46 % ETo). Implications of this research are: California landscapes consisting solely of cool-season turf deemed non-recreational and therefore not exempt from CA water restriction laws require more water than allowed under the former 0.7 ETo and current 0.55 % ETo legislation. All landscapes consisting solely of very low and low water using plants and some mixed landscapes consisting of mostly low and very low water requiring shrubs with low to moderate levels of medium and high water using plants perform adequately at or below the mandated 0.55 % ETo. Data through 2016 are being taken before statistical evaluations are conducted.





Practical implications:

- Properly functioning irrigation systems can significantly reduce water waste. Systems with matched heads, proper spacing, proper pressure, and unclogged heads can significantly reduce landscape water waste.
- Distribution uniformity can most often be increased without major redesign and installation efforts by switching to rotary sprinkler heads.
- Properly irrigating plants based on species, density, and climate and microclimate considerations can significantly reduce landscape water waste.
- Landscapes consisting solely of cool season turf (not deemed recreational and therefore non-exempt from the regulation) use water in excess of the .7 ETAF standard.

- Landscapes consisting solely of warm season turf (not deemed recreational and therefore non-exempt from the regulation) often exceed .7 ETAF due to poor irrigation uniformity.
- Landscapes consisting of a mixture of mostly medium, low and very low water using plant species that are drip irrigated and mulched can include small areas of turf and not exceed .7 ETAF. When a greater balance of low water using plants is included, ETAF of.55 is achieved.
- A three-inch layer of mulch around ornamental plantings can significantly reduce water waste by reducing water evaporation from soil.

Stop #9: Kurapia! A New and Improved Groundcover for Drought and Saline Conditions

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What is Kurapia?

Kurapia is a low-growing, herbaceous, perennial groundcover belonging to the Verbanaceae or Verbena family. The species [*Phyla (Lippia) nodiflora* (L.) E. Greene] is native or naturalized to California, but is considered invasive. Kurapia is a sterile/non-invasive and cold hardy cultivar selected and developed in Japan, and demonstrates superior landscape performance as compared to the existing species. Kurapia's dense canopy and deep root system provide excellent drought tolerance and soil stabilization, even on steep slopes. It is tolerant of a wide range of soil types and soil conditions, including salinity.

Kurapia reaches a maximum height of 2-3" tall and produces numerous small, white flowers from spring to late summer, which can attract many bees. Mowing is not required. However, regular mowing with a rotary mower as low as 2 inches can be used to minimize flowering and resulting bee populations. Kurapia can tolerate partial shade and light foot traffic when maintained either non-mowed or mowed similar to a lawn, but is not recommended for use under intensive, concentrated foot traffic.

Kurapia is adapted to USDA climate zones of 7b and higher. In regions where average daily temperatures remain above 45F, Kurapia will stay evergreen throughout winter; however, growth will gradually decrease and enter semi-dormancy when average daily temperatures fall to around 38F. Kurapia has been known to survive temperatures as low as 20F. These temperatures are provided as estimates, as Kurapia greenness, dormancy, and survival will depend upon specific location and environmental factors.

Kurapia Planting and Maintenance

Kurapia is available in greenhouse flats containing 72 plugs, or as sod. Recommended plug spacing for Kurapia is 18" on center. Fastest establishment of plugs in most California climates is from March through September, depending on location and weather patterns in a given year. Excessively cold temperatures in winter or hot temperatures in summer can slow rate of establishment. Complete establishment of Kurapia plugs usually occurs within 3 to 4 months from planting, depending upon plug spacing and growing conditions.

Although Kurapia is tolerant of drought and low water conditions, the establishment period is not the time to withhold water. Once fully established, research at UCR has demonstrated that mature Kurapia can be maintained similar to warm-season turfgrasses at 40-60% replacement of reference evapotranspiration (ET_o) in warmer inland climates and <40% in cooler, coastal regions during the growing season. Irrigation usually is not necessary during winter semi-dormancy, which is typically accompanied by rainfall in California. Weekly or bi-weekly irrigation should suffice during the growing season, except during periods of high temperatures and low humidity.

Fertilization of Kurapia is most important during establishment to expedite cover. Once full coverage is achieved, subsequent fertilization is likely not needed. Weed control is best accomplished prior to planting Kurapia. After planting plugs and rooting of sod, application of a preemergence herbicide is the best and safest method of controlling weeds. As previously stated, Kurapia is a sterile cultivar of *Phyla* (*Lippia*) *nodiflora*, which is naturalized in California. Because Lippia is considered a minor plant in the horticultural industry, this species is not likely to be found on herbicide labels. However, provided they are safe, herbicides labeled for use on groundcovers or ornamentals can be used on Kurapia. Please see the following page for further herbicide recommendations. Aside from mowing, lateral spread of Kurapia may need to be controlled with mechanical (edge trimmer) or chemical (non-selective herbicide) trimming.

<u>Where to Buy?</u>

Kurapia plugs can be purchased from Florasourceltd.com, EcoTechServices.net, or ArmstrongGrowers.com. For sod, contact DeltaBluegrass.com or WestCoastTurf.com. For general information, please visit Kurapia.com.

Herbicide Tolerance Guidelines

Product Tested	Common Name	Timing and Target Weed	Rate Tested	Safety Planting	Safety Maturity
Barricade 65WG	Prodiamine	PRE grass/broad	2.3 lb/A	T	T
Pennant Magnum	Metolachlor	PRE grass/broad/sedge	32 oz/A	T	T
Gallery 75DF	Isoxaben	PRE broad	1.3 lb/A	I	I
Specticle FLO	Indaziflam	PRE grass/broad	9 oz/A	S	S
Fusilade II	Fluazifop	POST grass	24 oz/A	T	T
Sedgehammer	Halosulfuron	POST sedge	1.3 oz/A	S	S
Certainty	Sulfosulfuron	POST grass/broad/sedge	1.25 oz/A	I	I
Tenacity	Mesotrione	POST grass/broad	5 oz/A	S	I
Tribute Total	Thiencarbazone + Foramsulfuron + Halosulfuron	POST grass/broad/sedge	3 oz/A	S	S
Celsius	Thiencarbazone + Iodosulfuron + Dicamba	POST broad/grass	4.5 oz/A	S	I
Drive XLR8	Quinclorac	POST broad/grass	64 oz/A	S	I
Turflon Ester Ultra	Triclopyr	POST broad	32 oz/A	S	S
Lontrel	Clopyralid	POST broad	11 oz/A	I	I
Speedzone Southern	2,4D + MCPP + dicamba + carfentrazone	POST broad	64 oz/A	S	S
Mecomec 4	MCPP	POST broad	64 oz/A	I	I

Products tested at California Polytechnic State University, San Luis Obispo (Los Osos loam; plant hardiness zone 9b) and University of California, Riverside (Hanford fine sandy loam; plant hardiness zone 9b) on newly planted Kurapia plugs (March 2015) and mature Kurapia (12 weeks after planting).

T = Tolerant at rate tested with minimal or no injury. For PRE herbicides, sequential applications of lower rates would further maximize weed control and safety to Kurapia.
I = Intermediate tolerance at rate tested. Typically, injury to Kurapia followed by recovery. Sequential applications of lower rates recommended and/or testing first on small area before broadcast application.
S = Sensitive at rate tested with severe injury, slow recovery/spread, or death.

The information provided is for educational purposes only. The user assumes all risks and liability for herbicide use. Not all products or formulations could be tested in one experiment. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the universities is implied. Always read and follow the label of the product(s) being used.

Stop #10: Evaluation of Turfgrass Species and Cultivars Under Deficit Irrigation

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Objectives:

Assess the quality of native sodded cool-season mixes, seeded cool- and warm-season grasses, and mixes during the summer under a deficit irrigation regime.

Material and Methods:

Delta Bluegrass Co. entries (following pages) were sodded in October 2013. The area is divided in three independent separate studies: native sod, no mow sod, and tall fescue mixes sod. The three areas were subjected to one dry down cycle in the summer of 2014 and deficit irrigation (60% ET_0) in 2015. Starting 1 June 2016, the areas were hand watered at 70% ET_0. OreGro mixes (following pages) were seeded in April 2015 and were subjected to a dry down cycle in the summer of 2015. OreGro cool-season species (following pages) were seeded in December 2015. Both OreGro studies were hand watered at 60% ET_0 starting 1 June 2016. Plots were rated every two weeks for quality (1-9 scale, 9 = best), NDVI, and digital image analysis.

Results:

Drought conditions during the two previous summers lead to wilting and eventually turf stand losses in the Delta Bluegrass plots. Therefore, turf quality was already below acceptable levels before the beginning of deficit irrigation in 2016. Nevertheless, at 70% ET_0 no differences between grass species were detected (Fig. 1), and no further turf loss was observed.

OreGro mixes showed the highest potential for water conservation. Plots all started above acceptable quality levels and some of them lasted more than a month at 60% ET_0 replacement before dropping below acceptable levels. Top performing mixes and cultivars are shown in Fig. 2.

OreGro cool-season species did not establish successfully before the beginning of the deficit irrigation. As a consequence, plots never achieved sufficient turf quality, and extreme to complete turf loss was observed in the majority of the plots (data not shown).

Acknowledgments:

Thanks to Delta Bluegrass Co., OreGro, and the California Turfgrass & Landscape Foundation (CTLF) for supporting this research.

Delta Bluegrass Native and No Mow Sod Deficit Irrigation Study

No.	Product/Species/Variety	Company
1	Delta Native Mow Free Mix ➢ *Festuca rubra* Molate 40% - Red Fescue ➢ *Festuca occidentalis* 30% - Western Fescue ➢ *Festuca idahoensis* 30% - Idaho Fescue	Delta Bluegrass Company
2	Delta Native Biofiltration Mix ➢ *Stipa pulchra* - Purple Needlegrass ➢ *Festuca rubra* Molate – Red Fescue ➢ *Hordeum californicum* – California barley ➢ *Hordeum brachyantherum* – Meadow barley	Delta Bluegrass Company
3	Delta Preservation Mix ➢ *Nassella cernua* - Nodding needlegrass ➢ *Nassella pulchra* - Purple needlegrass (California's State Grass) ➢ *Koeleria macrantha* – Junegrass ➢ *Festuca rubra* Molate – Red Fescue	Delta Bluegrass Company
4*	Delta Native Bentgrass ➢ *Agrostis pallens*	Delta Bluegrass Company

*Not included in the no mow study

UCR Delta Sod Tall Fescue Mixes Deficit Irrigation Study

1	Delta Bolero Mix	Delta Bluegrass Company
2	Delta 90/10 Fescue/Blue Mix	Delta Bluegrass Company

UCR Delta Bluegrass Sod Plot Plan

↑ **North**

No Mow

101 1	102 3	103 2
201 3	202 1	203 2
301 2	302 3	303 1

Native grasses

101 3	102 4	103 1	104 2
201 4	202 3	203 2	204 1
301 2	302 1	303 4	304 3

Tall fescue mixes

101 1A	201 1B	301 2A
102 2C	202 2B	302 1C

OreGro Mixes Deficit Irrigation Study

No.	Product/Species/Variety	Company
1	Drought Buster ➢ 'Escalade' tall fescue 34% ➢ '04-WALK' tall fescue 30% ➢ '04-DUST' tall fescue 30%	OreGro
2	Drought Buster ➢ 'Escalade' tall fescue 30% ➢ '04-WALK' tall fescue 30% ➢ '04-DUST' tall fescue 30% ➢ 'Baron' Kentucky bluegrass 10%	OreGro
3	Premium mixture ➢ Drought Buster 40% ➢ Desert Star 40% ➢ 'Baron' Kentucky bluegrass 20%	OreGro
4*	Sport Mix #1 ➢ Desert Star 40% ➢ Drought Buster 30% ➢ Double Play 30%	OreGro
5	Sport Mix #2 ➢ Desert Star 70% ➢ Double Play 30%	OreGro
6	Sport Mix #3 ➢ Desert Star 65% ➢ Baron' Kentucky bluegrass 15% ➢ Double Play 20%	OreGro
7	Slope Control ➢ 'Chancellor' chewings fescue 34% ➢ 'Dall' sheeps fescue 33% ➢ 'Granite' hard fescue 33%	OreGro
8	Contractor's Choice ➢ 'Kentucky 32' tall fescue 70% ➢ '04-WALK' tall fescue 15% ➢ '04-DUST' tall fescue 15%	OreGro
9	'Kentucky 32' tall fescue	OreGro
10	Rapid Turf 600 ➢ Desert Star 60% ➢ 'NuSprint' annual ryegrass 40%	OreGro
11	Rapid Turf 600 TF ➢ Drought Buster 60% ➢ 'NuSprint' annual ryegrass 40%	OreGro
12	Double Play Bermuda ➢ 'Blackjack' bermudagrass 50% ➢ 'Transcontinental' bermudagrass 50%	OreGro
13	Double Play Bermuda ➢ 'Riviera' bermudagrass 50% ➢ 'Transcontinental' bermudagrass 50%	OreGro
14	'Escalade' tall fescue	OreGro
15	'04-DUST' tall fescue	OreGro

OreGro Cool-Season Species and Blends Deficit Irrigation Study

No.	Product/Species/Variety	Company
1	'Continental II' Perennial Ryegrass	OreGro
2	'Ribyer II' Perennial Ryegrass	OreGro
3	'NuSprint' Annual Ryegrass	OreGro
4*	Desert Star #1 ➢ 'Brea' Perennial Ryegrass ➢ 'Ringer' Perennial Ryegrass ➢ 'Pinstripe II' Perennial Ryegrass	OreGro
5	Desert Star #2 ➢ Brea' Perennial Ryegrass ➢ 'Ringer' Perennial Ryegrass ➢ 'Pinstripe II' Perennial Ryegrass	OreGro
6	Sport Mix #4 ➢ Desert Star ➢ Baron' Kentucky bluegrass	OreGro
7	'GreenLink' Annual Ryegrass	OreGro
8	'Ringer' Perennial Ryegrass	OreGro
9	Fall Contractors' Mix	OreGro
10	Rapid Turf 500 ➢ Desert Star 50% ➢ 'NuSprint' annual ryegrass 50%	OreGro
11	Rapid Turf 750 ➢ Desert Star 75% ➢ 'NuSprint' annual ryegrass 25%	OreGro
12	'Pinstripe' Perennial Ryegrass	OreGro
13	'Brea' Perennial Ryegrass	OreGro
14	'Premium turf' Annual Ryegrass	OreGro

OreGro Mixes plot plan

1	2	3	4	5	6	7	
8	9	10	11	12	13	14	15
14	6	8	1	11	7	4	2
10	13	9		12	3	15	5
15	7	6		13	4	8	9
12	3	5	14	2	11	1	10

OreGro Mixes plot plan

1	2	3	4	5	6	7
14	13	12	11	10	9	8
9	11	2	14	1	5	10
12	6	8	7	3	13	4
8	4	9	2	7	14	6
3	12	10	5	13	1	11

↑ **North**

Fig. 1. Quality of native, no mow and tall fescue sod mixes during the summer of 2016. Riverside, CA.

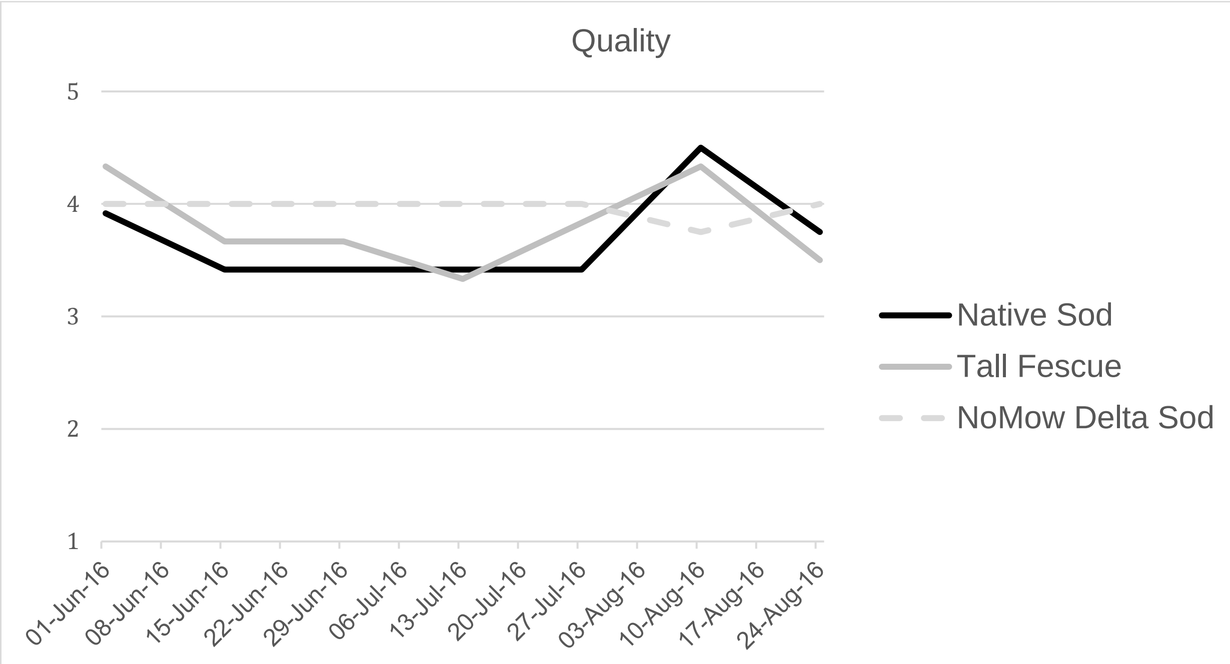
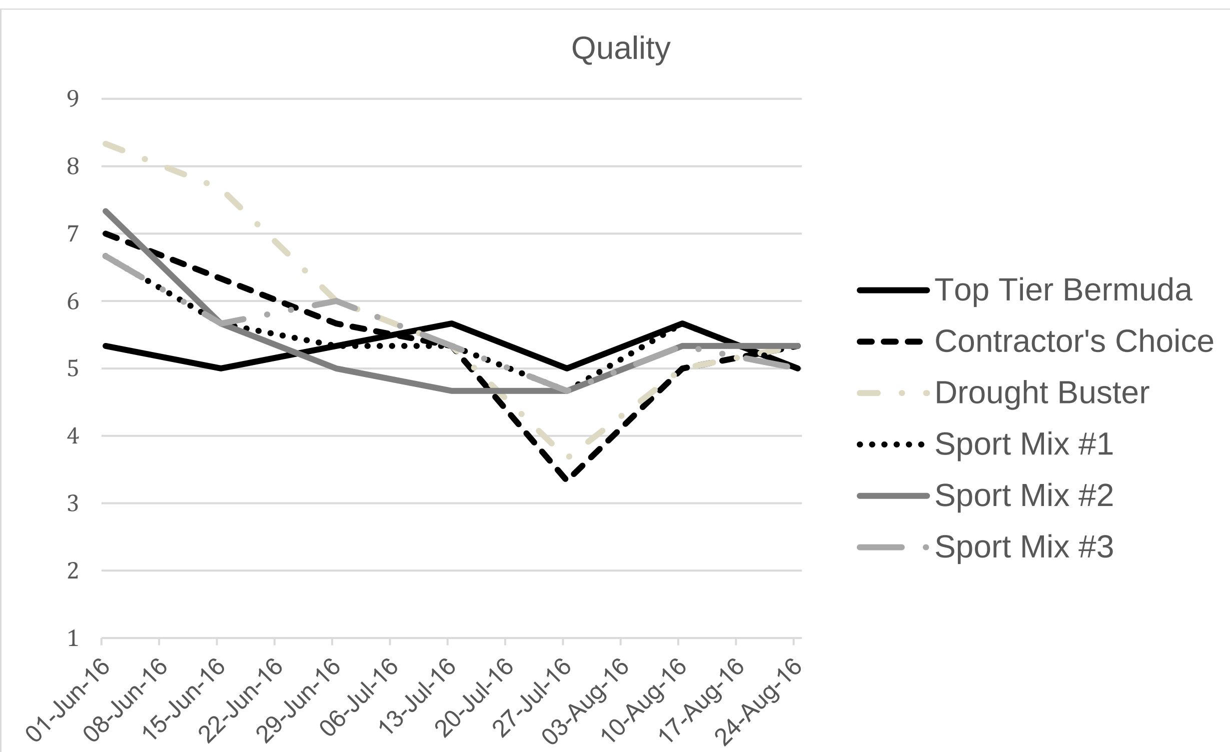


Fig. 2 Quality of top performing OreGro seeded cool-, warm-season species and mixes during the summer of 2016. Riverside, CA.



Stop #11: Have You Considered Zoysiagrass?

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University of California, Riverside

Overview

Zoysiagrass is a warm-season turfgrass with texture, density, uniformity, durability and pest resistance that make it a desirable choice for use on sports fields and golf courses, home lawns, parks and playgrounds. It is well adapted to southern California and can be grown in all area**s** of California where the summers are warm and the winters mild. De Anza (*Zoysia spp.*) is a hybrid cultivar from the UC Riverside breeding program and was patented in 1995. Considered to be a grass with maintenance requirements that are lower than those of most other turfgrasses, zoysiagrasses are tolerant of heat, drought, salinity, heavy traffic, and not commonly susceptible to disease, insect, or weed invasion problems. De Anza differs from earlier zoysiagrasses in faster establishment rate and extended color retention during the winter when most warm season turfgrasses go dormant, including bermudagrass. ‘De Anza’ zoysiagrass is appropriate for applications such as home lawns, parks, golf courses, and general purpose lawns, also having performed successfully on major league sports fields. The best turf performance is at cutting heights 3/8 inch to 3/4 inch, though ‘De Anza’ does well up to 1 1/4 inch height of cut for home lawn use. ‘De Anza’ zoysiagrass is a low thatch producer, with thatch forming more slowly at the lower mowing heights. Nitrogen (N) and iron (Fe) applications during late fall and winter significantly enhance winter color performance, making overseeding unnecessary where winter temperatures and chilling are moderate.

Zoysiagrasses still have a limited market in the region due to several factors, including uncertain responses to cultural practices used in turf maintenance. Verticutting is one cultural practice to maintain a good quality turf surface.

Objective

Determine the effect of verticutting and fertilization timing on zoysiagrass plant density, growth habit, and surface quality.

Methods

De Anza zoysiagrass (*Zoysia spp.*) was sodded in July 2014. Fertilization was applied 6 times per year at a rate of 0.5 lb N/1000 ft^2. Irrigation was non-limiting and changed weekly based on estimated evapotranspiration. Mowing was performed twice weekly during the growing season at 0.625 inch mow height using a triplex reel mower. No verticutting was done prior to the July 2016 treatment (see Table). Barricade 4L and Dimension 2EW were used for pre-emergent weed control and Speedzone Southern and 4-speed XT controlled broadleaf weeds.

Results

First year data will be analyzed in the fall. Early data suggest when managed at 0.625 HOC and low fertility De Anza tends toward a predominantly lateral growth habit with density stabilized at about 80%, suggesting low thatch formation. Vertical mowing in early summer without fertilizer application did not affect the growth habit nor noticeably increase turf density. Vertical mowing in mid-summer and applying fertilizer increased density, while encouraging more upright growth habit.

The “Take Home” is that keeping the growth habit predominantly lateral would provide a faster sports turf surface than encouraging more upright growth.

Figure 1. Research layout showing treatment randomization. Treatments are shown in the Table below.

D	B	A	C	E
C	A	D	E	B
A	C	E	B	D
D	B	A	E	C

↑ N

Table 1. Treatment timing in 2016.

Treatment	Verticut	Fertilizer
A	June	none
B	June	July
C	June, August	July
D	July	July
E	none	none

Stop #12: Evaluation of Groundcovers with No Supplemental Summer Irrigation for Water Conserving Landscapes

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Project Overview

This project has been in progress since 2009. This year, no irrigation has been applied since fall of 2015. What is visible in the plots is what is left of plant material. Surprisingly, there are still some plants left. After this Field Day, plots will be rewatered and we will determine which plants actually regrow. We will then be placing new plant species in for another cycle of plant growth observations. For the next experiment, we will be considering several more plants native to the drier regions of the Southwestern U.S. and northern Mexico. In addition, we will incorporate some Australian and South African species that show promise for drought tolerance and low maintenance. The study will still include Honeysuckle (*Lonicera*) and *Lantana* as standard plants that most people in the Industry can use as a 'measuring stick' to gauge performance with the other lesser-known plant species. The last irrigation event was July 29th, 2015, when the plots received 1.0 in. of water through overhead irrigation. There are 13 groundcover plant materials and one turfgrass managed as a groundcover. Plots have been established for 6 years. The plants represent a mix of native and non-native as well as woody and herbaceous plant materials (Table 1). Replicated field plots were planted in late 2009 through early 2010.

Results from July 2015 (for review)

To date, the best performers are: lantana, star jasmine, honeysuckle, red apple, ice plant, rosemary, sedums, and juniper. These plants show very few signs if any of drought stress. Lantana has smaller leaves that are becoming more purple than green. Rosemary has slowed in growth but has good color. Star Jasmine is beginning to experience a small amount of leaf burn. The growth of honeysuckle has slowed and the new growth has smaller leaves, but there are no symptoms of leaf burn. Sedums have slowed in growth and are off-color with more red pigment in some of the plant material. Red apple and juniper are beginning to become off-color. Ice plant appears normal.

The groundcovers showing significant burning and/or dieback include correa (Australian fushia), salvia, and thyme. Buffalograss is generally dormant. Correa, salvia and thyme appear to be dying in patches rather than showing uniform burning and dieback on the plot.

GROUNDCOVER RESPONSE TO NO SUMMER IRRIGATION STUDY – U.C. RIVERSIDE				
Specific Epithet	**Common Name**	**Source Size[z]**	**Date Planted**	**Notes**
1. Drosanthemum speciosum, Delosperma, Mesembryanthemum??	vygie, iceplant	Altman Plants #1 container	4-2-10	Newer iceplant introduction, spring flowering, re-flowers in summer, So. Africa native, (vygie is Afrikaans term for Mesembryanthemums, fam. Aizoaceae)
2. Rosmarinus officianalis 'Irene'	prostrate rosemary	Native Sons 4-in. pot	11-4-09	Drought tolerant low groundcover
3. Thymus pracox arcticus (T. praecox subsp. Arcticus; T. serpyllum) 'Pink Chintz'	creeping thyme	Native Sons 4-in. pot	11-4-09	Low growing thyme
4. Atriplex cinerea Poir.	coast or grey saltbush	Native Sons #1 container	11-4-09	Silver foliage, low-spreading, dioecious, Australian native
5. Correa X unk. 'Dusky Bells' ('Carmine Bells')	Australian fuchsia	Native Sons #1 container	11-4-09	Reported to be low wide-spreading, deep red flowers, Australian native
6. Juniperus horizontalis 'Wiltonii'	blue rug juniper	Monrovia #1 container	12-2-09	Very flat dense growing, trailing branches, silver blue foliage
7. Hypericum calycinum L.	creeping St. Johnswort, Aaron's beard	Expertise Growers cuttings in flats	10-29-09	Low-growing, widely adapted, flowers primarily in spring and periodically in summer
8. Salvia sonomensis 'Gracias' (S. sonomensis X S. clevelandii)	creeping sage	Las Palitas #1 container	9-11-09	California native, reported low growing, wide spreading, lavender-blue flowers, possibly a hybrid of S. sonomensis X S. clevelandii, flowers winter/spring
9. Aptenia cordifolia (L.f.) N.E. Br. 'Red Apple' (A. cordifolia X A. haeckeliana?)	red apple	Expertise Growers cuttings in flats	10-29-09 add plt 4-2-10	Ice plant relative
10. Lantana montevidensis	trailing purple lantana	Expertise Growers cuttings in flats	10-29-09 add plt 4-8-10	Common landscape lantana, purple flowers spr.-summer
11. Trachelospermum jasminoides	star jasmine	Expertise Growers cuttings in flats	10-29-09	Vigorous once established, widely adapted
12. Sedum spp.	mixed sedums	Altman Plants 8 ft. × 8 ft. mats	3-31-10	Sod-like product with cuttings of 4 sedum spp. Rooted in jute mat under laden with plastic netting
13. Buchloe dactyloides 'U.C. Verde'	buffalograss	Todd Valley Farms plugs	4-8-09	Warm-season grass, a standard of performance under limited irrigation
14. Lonicera japonica 'Halliana'	Hall's honeysuckle, Japanese honeysuckle	Expertise Growers cuttings in flats	10-29-09	Very vigorous, reported to be tolerates drought well

Stop #13: A New Nematicide Against the Pacific Shoot-gall Nematode *Anguina pacificae*

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For the past four decades, the main turf nematode problem along the Northern California coast has been *Anguina pacificae.* This roundworm causes galls at the stem base of annual bluegrass (*Poa annua*). The disease has been found only along an approximately 20-30 mile-wide coastal corridor from Carmel to Mendocino. The often cool, foggy and damp weather conditions create and maintain a water film on the plant surface that allows the second-stage nematodes to move from the soil up the stems and penetrate the shoot apex. There the nematodes initiate a cavity by enzymatic degradation of the middle lamella and puncturing surrounding cells (McClure et al., 2008). Through cell proliferation and enlargement this eventually forms the shoot-gall. Meanwhile, the nematodes in the cavity continue two more molts until they mature and mate. The females may lay as many as 1200 eggs. As with all animals whose body temperature depends on external sources, the rate of their development is dependent on the ambient temperature. After the first molt in the egg, the second-stage juveniles hatch and the gall cavity may contain several hundreds or more of them. Once the gall disintegrates, the nematodes may move back into the soil or attack another shoot or plant. The disease typically stunts the affected shoot, leads to additional branching, with Poa greens becoming sparse and pitted.

From the beginning, crop protection strategies against the Pacific shoot-gall nematode disease have been at best marginally successful (Westerdahl et al., 2005). Short-term disease mitigation with Nemacur® was phased out when Bayer agreed to end sales in 2008. Based on laboratory bioassays, McClure and Schmitt (2012) recommended biweekly application of products with the active ingredient azadirachtin that was derived from the Indian Neem tree (*Azadirachta indica*). Consequently, several golf courses with severe *A. pacificae* infestations have been using Neemix® 4.5 (Certis) throughout the season. Recently Bayer CropScience developed fluopyram as a nematicide with excellent activity against several plant parasitic nematodes. Originally it was discovered as a broad-spectrum acropetal penetrant fungicide (Luna®) in the succinate dehydrogenase inhibitor class (FRAC Code No. 7. However, Luna® is not registered as a turf fungicide. In 2014, we first tested its nematicidal efficacy at the Pebble Beach Golf Links against *A. pacificae* in comparison to biweekly Neemix® 4.5 applications and a non-treated control. Fluopyram significantly reduced the *A. pacificae* population and associated shoot galls. It improved turf quality, *P. annua* biomass, and number of Poa shoots compared to either Neemix® 4.5 or the non-treated control.

From 2015 to present, we have conducted additional turf trials with fluopyram at Links at Half Moon Bay, Links at Bodega Harbour, Pajaro Valley Golf Club in Watsonville, and Pasatiempo Golf Club in Santa Cruz. At Pasatiempo, the trial took place under severe *A. pacificae* disease pressure. Two applications of fluopyram at either 0.195 or 0.39 oz/1,000 ft^2 effectively restored turf health.

In June 2016 Bayer received EPA registration for fluopyram (Indemnify™) turf nematicide; California registration is pending. In our trials 1-2 applications of fluopyram at either the low or high rate have provided season-long protection of *A. pacificae* due in part to long soil residual (> 200 days) of this active ingredient. While previous turf grass nematicides were labeled with the signal word "Danger" (high toxicity) or "Warning" (moderate toxicity), the Indemnify™ label displays only the signal word "caution" (low toxicity).

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UCR Turfgrass & Landscape
Research Field Day

Thursday, September 14, 2017

See you then!

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