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# TURFGRASS & LANDSCAPE RESEARCH FIELD DAY

September 11, 2025

'Coachella' Bermudagrass at

THE FARMS
GOLF CLUB
Rancho Santa Fe, CA

UC RIVERSIDE Turfgrass Science

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

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

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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 2025 UCR Turfgrass and Landscape Research Field Day. This marks the 18th consecutive year of this event under my watch. Time flies when you're having fun! Once again, we're happy to have everyone back as 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. We are most excited about the commercial release of our very own 'Coachella' hybrid bermudagrass, which has been licensed to West Coast Turf. Coachella possesses a dark blue-green genetic color and improved drought resistance coupled with a shorter winter dormancy period throughout much of California and similar climates. We are very proud that Coachella has already been established at The Farms Golf Club in Rancho Santa Fe (pictured on the cover) with another golf course in southern California soon to follow. More information about Coachella will be provided at today's event and inside this booklet.

For the 14th 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 blue-colored UCR Turfgrass Science shirts, who assisted with preparation for this event. Special thanks go to my fellow Field Day planning committee members including Dr. Christian Bowman, Sandra Glegola, Peggy Mauk, Sue Lee, Steve Ries, PJ Kelly, and Maya Maniar. Production of this publication, signs, and online reports would not have been possible without assistance from Christian, Sandra and our team. 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 17, 2026**.

Sincerely,

James H. Baird, Ph.D.
Professor & Cooperative Extension Turfgrass Specialist

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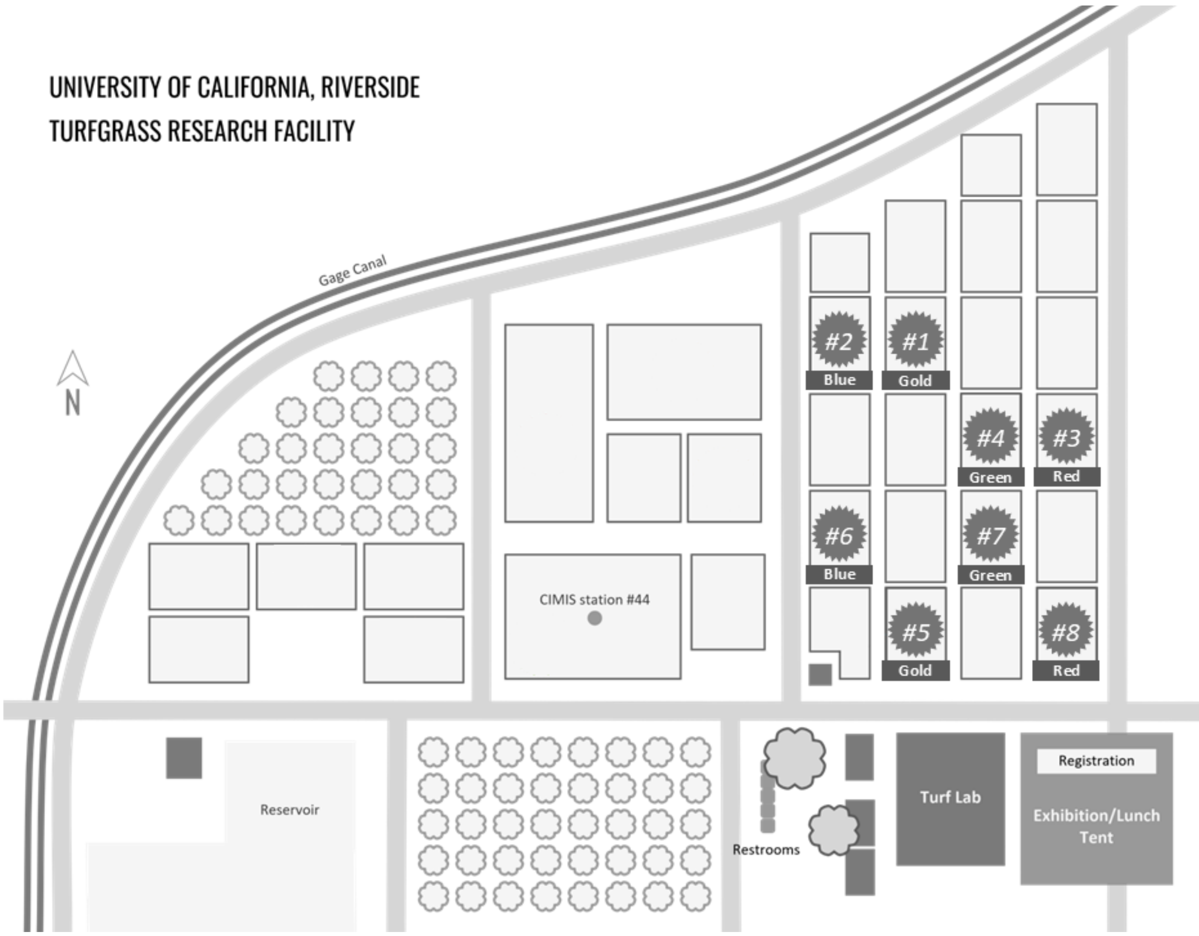
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N
Gage Canal
#2
Blue
#1
Gold
#4
Green
#3
Red
#6
Blue
#7
Green
#5
Gold
#8
Red
CIMIS station #44
Reservoir
Restrooms
Turf Lab
Registration
Exhibition/Lunch Tent

# 2025 Turfgrass and Landscape Research Field Day Agenda

| | |
|---|---|
| ***7:45 AM*** | **Exhibitor Set-Up** |
| ***8:15-9:15 AM*** | **Registration and Trade Show Open** |
| ***9:15 AM*** | **Welcome and Introductions**<br>Peggy Mauk and Jim Baird |
| ***9:40-11:00 AM*** | **Field Tour Rotation (20 minutes per Stop)** |
| *Stop #1 Gold tent* | **Introduction and Management of 'Coachella' Hybrid Bermudagrass**<br>Jim Baird and Adam Lukaszewski |
| *Stop #2 Blue tent* | **Postemergence Control of Crabgrass in Bermudagrass Turf**<br>Melissa Murillo and Evelyn De La Cruz |
| *Stop #3 Red tent* | **Preemergence Control of Kikuyugrass and Annual Bluegrass**<br>Christian Bowman |
| *Stop #4 Green tent* | **Evaluation of Products for Water Conservation on Bermudagrass Turf**<br>Sandra Glegola |
| ***11:00-11:30 AM*** | **Break and Trade Show** |
| ***11:30-12:50 PM*** | **Field Tour Rotation (20 minutes per Stop)** |
| *Stop #5 Gold Tent* | **Improvement of Bermudagrass, Kikuyugrass, and Zoysiagrass for Winter Color Retention and Drought Tolerance**<br>Adam Lukaszewski and Christian Bowman |
| *Stop #6 Blue Tent* | **Evaluation of Products for Water Conservation on Bermudagrass Turf (Part II)**<br>Sandra Glegola |
| *Stop #7 Green Tent* | **Updating Crop Coefficients and Plant Factors for Warm-season Turfgrasses and 2025 NTEP Bermudagrass Test**<br>Jim Baird |
| *Stop #8 Red Tent* | **Postemergence Control of Weeds in Bermudagrass Turf**<br>Evelyn De La Cruz and Melissa Murillo |
| ***12:50-2:00 PM*** | **Barbeque Lunch and Trade Show** |
| ***2:00 PM*** | **Adjourn** |

## Stop #1: Introduction and Management of 'Coachella' Hybrid Bermudagrass

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

The UCR Turfgrass Breeding & Genetics Program was born in the 1950s by Dr. Victor B. Youngner, who began his academic career at UCLA before coming to UCR. Dr. Youngner developed several commercial turfgrass cultivars, some of which are still used today including 'Santa Ana' hybrid bermudagrass and 'El Toro', 'Victoria', and 'De Anza' zoysiagrass. Upon his untimely passing in 1984, the program remained quiescent until 2012 when Drs. Lukaszewski and Baird started a new venture aimed at developing new bermudagrass and kikuyugrass cultivars with improved winter color retention, drought resistance, and turf quality traits. Support for the breeding program came from the United States Golf Association (USGA), Metropolitan Water District (MWD), Western Municipal Water District (WMWD), California Turfgrasss & Landscape Foundation (CTLF), and West Coast Turf. The first fruit of our labor was "Bermudagrass named UCR TP6-3", Patent No.: US PP35,441, with filed Trademark 'Coachella'. West Coast Turf is the exclusive licensee for 'Coachella' hybrid bermudagrass in the U.S. and Mexico. The first commercial installation of 'Coachella' was at The Farms Golf Club in Rancho Santa Fe. Sixty-five acres of sod was installed on tees, fairways, and rough, with a scheduled grand re-opening of the golf course in October 2025. The next planned large-scale installation of 'Coachella' will begin this Fall at Big Canyon Country Club in Newport Beach.

'Coachella' is a hybrid bermudagrass (*Cynodon dactylon x C. transvaalensis*) established vegetatively by sod, sprigs, or plugs only. Besides golf course tees, fairways, and rough, 'Coachella' is suitable for home lawns, parks, athletic fields, and other managed turf areas. Mowing height range is ca. 0.25-2.5 inches. 'Coachella' possesses a very dark bluish-green genetic color, which visually sets it apart from most other newer and existing cultivars. It was selected for improved winter color retention or shortened winter dormancy period in Riverside. When compared to other commercially available bermudagrass cultivars, 'Coachella' possesses as good or better winter color retention. However, winter dormancy of any cultivar is largely dependent upon location and severity/longevity of winter temperatures. Turf quality characteristics of 'Coachella' are like or better than existing or the latest bermudagrass cultivar releases. It possesses a more vertical growth habit, which may lend itself to better ball lie, especially at taller heights of cut. 'Coachella' also possesses better drought resistance than most cultivars, especially when no irrigation is applied. In general, bermudagrass is considered tolerant to salinity in comparison with most other turfgrass species. Among bermudagrass cultivars, 'Coachella' has moderate tolerance to extreme, worst case scenario irrigation and soil salinity. Recently, 'Coachella' was discovered to be more tolerant to Roundup (glyphosate) herbicide, which can be potentially used as another chemical tool for winter weed control. Overall, 'Coachella' represents one of the most consistent performing commercial hybrid bermudagrass cultivars for California and the Southwest. Just like humans, all turfgrasses have their good days as well as their bad days. 'Coachella' is more consistent from month to month and throughout the year. One example of this is flowering or inflorescence production, a common occurrence with bermudagrasses in the springtime that can be aesthetically displeasing and disrupt uniformity. Although 'Coachella' is not immune to flowering, inflorescence production is typically less obtrusive and shorter-lived than other hybrid bermudagrass cultivars that share similar traits.

Management of 'Coachella' will be discussed at Field Day, including mowing, fertilization, irrigation, cultivation, pest management, and use of plant growth regulators (PGRs).

**Stop #2: Postemergence Control of Crabgrass in Bermudagrass Turf**

Melissa Murillo, Evelyn De La Cruz, Sandra Glegola and Jim Baird
Department of Botany and Plant Sciences
University of California, Riverside

## Introduction:

Crabgrass (*Digitaria* spp.) is a fast-growing, common annual weedy grass that can quickly dominate thin or stressed turf during the summer months. Its aggressive growth habit reduces turf quality and playability, creating difficulties for turf managers on golf courses, athletic fields, and home lawns. While preemergence herbicides remain the foundation of most crabgrass control programs, breakthrough infestations are common, especially when applications are mistimed or when extended germination windows occur in warm climates like southern California. In these situations, postemergence herbicides become essential tools for regaining control and maintaining uniform turf stands.

## Objectives:

This study was conducted to evaluate the efficacy of multiple postemergence herbicide programs for the control of mature (tillering) smooth crabgrass (*Digitaria ciliaris*). Treatments included single active ingredients and combinations with adjuvants or tank-mix herbicides, reflecting options currently available to turfgrass managers.

## Materials and Methods:

The study was conducted on mature hybrid bermudagrass (*Cynodon* spp.) 'GN-1' turf established on a Hanford fine sandy loam at the University of California, Riverside. Turf was mowed twice weekly at 0.5 in., and received only 1.0 lb N/1000 $ft^2$ for the season, applied in two applications of 0.5 lb N in May and September.

The experimental area contained a natural infestation of smooth crabgrass (*Digitaria ciliaris*) that has a history of tolerance to quinclorac herbicide. Herbicide treatments (Table 1) were applied on July 31, 2025, with a sequential application on August 28, 2025 (28-day interval). Applications were made using a $CO_2$-pressurized backpack sprayer equipped with a 5-ft boom fitted with TeeJet 8002VS nozzles, calibrated to deliver 1 gal/1000 $ft^2$ at 1.5 mph.

The study was arranged as a randomized complete block design with five replications. Individual plots measured 5 × 10 ft with 2-ft alleys separating plots. Plots were visually evaluated every two weeks for percent crabgrass cover and turf injury, both on a 0–100% scale (0 = none, 100 = complete cover or injury). Weed control (%) was calculated using the Henderson-Tilton equation to account for variability in initial crabgrass populations. Treatment differences were analyzed using the Kruskal-Wallis test, and pairwise comparisons were conducted using the Mann–Whitney U-test at $P \leq 0.05$.

**Results:**

Crabgrass pressure was extremely high and dominated the turf stand in almost all plots. Bermudagrass injury was most severe from Velocity PM followed by Pylex and, to a lesser extent, treatments containing Monument or Manuscript herbicides (Table 2). Overall, this was a very worst-case scenario study in which crabgrass had already reached full maturity prior to herbicide treatment. Under these circumstances, only Dimension and Manuscript provided >20% crabgrass control one month after initial application. Hopefully, greater control will be achieved after the sequential application of herbicide treatments.

**Acknowledgments:**

We thank Corteva, Syngenta, PBI-Gordon, BASF, and Nufarm for providing products and the California Turfgrass & Landscape Foundation (CTLF) for supporting this research.

**Plot Plan**
**Postemergence Crabgrass Study**

N

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 5 | 1 | 12 | 4 | 2 | 11 | 9 | 6 | 10 | 3 | 7 |
| 12 | 4 | 10 | 9 | 2 | 11 | 1 | 7 | 3 | 6 | 8 | 5 |
| 1 | 11 | 6 | 3 | 10 | 8 | 2 | 5 | 12 | 7 | 4 | 9 |
| 6 | 10 | 8 | 4 | 1 | 12 | 3 | 11 | 2 | 5 | 7 | 9 |
| 10 | 5 | 11 | 1 | 3 | 12 | 9 | 2 | 4 | 7 | 8 | 6 |

Table 1. Herbicide treatments applied in postemergence Crabgrass control study in Riverside, CA. 2025.

| No. | Treatment | Active ingredient | Company | Rate | | No. of apps | Freq. (wks) | Timing |
|---|---|---|---|---|---|---|---|---|
| 1 | Untreated Control | - | - | - | - | - | - | - |
| 2 | Dimension 2EW | Dithiopyr | Corteva | 32 | fl oz/A | 2 | 4 | AB |
| | Activator 90 | Non-ionic surfactant | Loveland | 0.5 | % v/v | 2 | 4 | AB |
| 3 | Tenacity 4SC | Mesotrione | Syngenta | 5 | fl oz/A | 2 | 4 | AB |
| | Activator 90 | Non-ionic surfactant | Loveland | 0.5 | % v/v | 2 | 4 | AB |
| 4 | Tenacity 4SC | Mesotrione | Syngenta | 5 | fl oz/A | 2 | 4 | AB |
| | Monument 75WG | Trifloxysulfuron-sodium | Syngenta | 0.4 | oz/A | 2 | 4 | AB |
| | Activator 90 | Non-ionic surfactant | Loveland | 0.5 | % v/v | 2 | 4 | AB |
| 5 | Monument 75WG | Trifloxysulfuron-sodium | Syngenta | 0.5 | oz/A | 2 | 4 | AB |
| | Activator 90 | Non-ionic surfactant | Loveland | 0.5 | % v/v | 2 | 4 | AB |
| 6 | Manuscript | Pinoxaden | Syngenta | 42 | fl oz/A | 2 | 4 | AB |
| 6 | Adigor | Methylated seed oil + Organosilicone surfactant | Syngenta | 0.5 | % v/v | 2 | 4 | AB |
| 7 | Q4 Plus | Quinclorac + Sulfentrazone + 2,4-D + Dicamba | PBI Gordon | 112 | fl oz/A | 2 | 4 | AB |
| 8 | Drive XLR8 | Quinclorac | BASF | 64 | fl oz/A | 2 | 4 | AB |
| | MSO Concentrate | Methylated seed oil | Loveland | 24 | fl oz/A | 2 | 4 | AB |
| 9 | Velocity PM | Bispyribac-sodium | Nufarm | 4.5 | fl oz/A | 2 | 4 | AB |
| | Activator 90 | Non-ionic surfactant | Loveland | 0.5 | % v/v | 2 | 4 | AB |
| 10 | Velocity PM | Bispyribac-sodium | Nufarm | 2.3 | fl oz/A | 2 | 4 | AB |
| | Activator 90 | Non-ionic surfactant | Loveland | 0.5 | % v/v | 2 | 4 | AB |
| 11 | Velocity PM | Bispyribac-sodium | Nufarm | 3 | fl oz/A | 2 | 4 | AB |
| | Certainty | Sulfosulfuron | Nufarm | 1.3 | fl oz/A | 2 | 4 | AB |
| | Activator 90 | Non-ionic surfactant | Loveland | 0.5 | % v/v | 2 | 4 | AB |
| 12 | Pylex | Topramezone | BASF | 0.8 | fl oz/A | 2 | 4 | AB |
| | Drive XLR8 | Quinclorac | BASF | 64 | fl oz/A | 2 | 4 | AB |
| | MSO Concentrate | Methylated seed oil | Loveland | 24 | fl oz/A | 2 | 4 | AB |

Application timing**:**

A – 7/31/2025

B – 8/28/2025

Table 2. Effect of postemergence herbicide treatments on bermudagrass injury (0-100%; 100% = highest) and smooth crabgrass (*Digitaria ciliaris*) control (0-100%, 100=highest) in Riverside, CA. 2025.

| No. | Treatment | Active ingredient | Turf injury (%) | | | | | | Weed control (%) |
|---|---|---|---|---|---|---|---|---|---|
| | | | *8/7* | *8/10* | *8/14* | *8/17* | *8/21* | *8/27* | *8/27* |
| 1 | Untreated Control | - | 0.0 C* | 0.0 D | 0.0 D | 0.0 E | 1.0 D | 1.0 E | 0 |
| 2 | Dimension 2EW<br>Activator 90 | Dithiopyr<br>Non-ionic surfactant | 0.0 C | 0.0 D | 1.6 CD | 3.0 CDE | 2.4 BCD | 2.0 CDE | 29 |
| 3 | Tenacity 4SC<br>Activator 90 | Mesotrione<br>Non-ionic surfactant | 0.0 C | 3.0 D | 2.6 CD | 4.0 DE | 4.0 CD | 3.6 B-E | 10 |
| 4 | Tenacity 4SC<br>Monument 75WG<br>Activator 90 | Mesotrione<br>Trifloxysulfuron-sodium<br>Non-ionic surfactant | 14.0 ABC | 20.0 BC | 10.8 AB | 13.0 ABC | 11.6 AB | 10.2 ABC | 14 |
| 5 | Monument 75WG<br>Activator 90 | Trifloxysulfuron-sodium<br>Non-ionic surfactant | 4.0 BC | 19.0 BC | 12.0 AB | 15.0 AB | 14.0 A | 12.0 AB | 7 |
| 6<br>6 | Manuscript<br>Adigor | Pinoxaden<br>Methylated seed oil + Organosilicone surfactant | 11.0 ABC | 16.0 A-D | 8.8 ABC | 10.0 A-D | 7.6 A-D | 5.6 B-E | 21 |
| 7 | Q4 Plus | Quinclorac + Sulfentrazone + 2,4-D + Dicamba | 0.0 C | 6.0 CD | 5.8 BC | 7.0 CD | 6.0 C | 6.2 BCD | 14 |
| 8 | Drive XLR8<br>MSO Concentrate | Quinclorac<br>Methylated seed oil | 0.0 C | 6.0 D | 1.6 CD | 3.0 DE | 3.2 CD | 2.6 CDE | 13 |
| 9 | Velocity PM<br>Activator 90 | Bispyribac-sodium<br>Non-ionic surfactant | 23.0 A | 35.0 A | 19.6 A | 21.0 A | 21.0 A | 19.6 A | 17 |
| 10 | Velocity PM<br>Activator 90 | Bispyribac-sodium<br>Non-ionic surfactant | 18.0 AB | 28.0 AB | 6.4 BC | 8.0 BCD | 6.6 A-D | 3.6 B-E | 12 |
| 11 | Velocity PM<br>Certainty<br>Activator 90 | Bispyribac-sodium<br>Sulfosulfuron<br>Non-ionic surfactant | 19.8 A | 22.0 AB | 8.2 AB | 11.0 ABC | 8.6 ABC | 5.8 BCD | 10 |
| 12 | Pylex<br>Drive XLR8<br>MSO Concentrate | Topramezone<br>Quinclorac<br>Methylated seed oil | 23.0 A | 34.0 A | 4.0 BCD | 4.0 DE | 2.6 CD | 1.6 DE | 18 |
| | | **p-value** | **0** | **0** | **0.001** | **0** | **0.001** | **0.002** | 0.411 |

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

## Stop #3: Preemergence Control of Kikuyugrass and Annual Bluegrass

Christian S. Bowman, Parker Stevens, and Jim Baird
Department of Botany & Plant Sciences
University of California, Riverside

### Introduction:

Preemergence herbicides can offer an effective means of protection against a variety of weeds that may appear in or around turf. When applied at the right time, they can prevent the emergence of weeds and ultimately reduce the number of postemergence herbicide applications required to maintain a clean lawn, golf course, or sports field. In some cases, preemergence herbicides can also exhibit postemergence effects, both on weeds and desirable turf.

Kikuyugrass (*Cenchrus clandestinus*) is either a desirable turf species or invasive and aggressive warm-season grass that has become established throughout much of coastal and inland California. It can be found commonly throughout Southern California and has been discovered as far north as coastal Sonoma County. Kikuyugrass can be difficult to remove once it becomes established due to its weedy nature and its morphology; seeds are formed within the terminal leaf sheath and are not easily removed through mechanical means such as mowing. For most turf managers, kikuyugrass is undesirable and requires much effort to remove; however, there are some golf courses in Southern California and many homeowners that maintain kikuyugrass as a turfgrass with moderate drought tolerance (warm-season species) and exceptional winter color retention. While other facets of our program focus on improving the genetics of kikuyugrass, we must also consider the management aspects for it. Part of our work in kikuyugrass breeding has been in the development of new hybrids with little to no anther production (See **Stop #5**). To maintain the purity of these hybrids, we need to make sure that seeds produced through unintentional outcrossing will not germinate, thus the need for finding a preemergence herbicide that is also not injurious to mature kikuyugrass. On the other hand, development of a new male-sterile cultivar will require successful post- and preemergence control of existing kikuyugrass which can produce viable seed. Herbicides that can eradicate kikuyugrass turf and also prevent kikuyugrass seedling establishment will be important for existing kikuyugrass-to-improved kikuyugrass conversion strategies.

Annual bluegrass (*Poa annua*) is a cool-season grass that is ubiquitous throughout California and throughout much of the world. Golf courses and other turf facilities that do not manage annual bluegrass as a turf, most certainly combat it as a winter annual weed. Although much is known about herbicide efficacy for preemergence control of annual bluegrass in turf, fewer studies have been conducted to examine a broad range of active ingredients and modes of action in soil that is void of turf.

### Objectives:

This study was conducted to:

• evaluate and compare the efficacy of various preemergence herbicides for kikuyugrass and annual bluegrass seed germination in bare soil.

• evaluate postemergence effects of applying preemergent herbicides on mature kikuyugrass turf.

**Materials and Methods:**

The study was conducted on bare soil (Hanford fine sandy loam) with either kikuyugrass (cv. 'Whittet') or annual bluegrass (cv. 'Two Putt') seeded at a rate of 0.5 lbs pure live seed (PLS) /1000 $ft^2$. Fourteen treatments (13 preemergence herbicides + 1 control) were tested. Treatments were applied using a $CO_2$-powered backpack sprayer equipped with a single TeeJet AI9505E nozzle calibrated to deliver 1 gallon/1000 $ft^2$. The experimental design was a randomized complete block with 5 replications. Plot sizes were 3 x 3 ft with 2-ft alleys. The study was initiated on August 15, 2025. Plots were raked, seeded, then raked again to increase seed-to-soil contact and seeding uniformity. Following seeding, herbicide treatments were applied and allowed to dry before irrigation (ca. 0.1 inch) to incorporate herbicides into soil. Treatment information is presented in Table 1 and a plot plan can be found in Figure 1. Plots were evaluated weekly for kikuyugrass or annual bluegrass cover (%) (Table 1). Data were analyzed using an analysis of variance (ANOVA), followed by Fisher's least significant difference (LSD) test to identify mean separation. Cover data were not recorded for other weeds that might have germinated, though the species were recorded.

A second study was conducted on a mature turf monostand of 'Whittet' kikuyugrass maintained at a height of 0.5 inches. The same preemergence herbicides used in the seeded study were used here, but at 3 different rates: 1x, 2x, and 4x. 40 treatments (13 preemergent herbicides x 3 rates + 1 control) were tested. The experimental design was a randomized complete block with 3 replications. Plot sizes were 3 x 3 ft with 2-ft alleys. The study was initiated on August 12, 2025. Treatments were applied and allowed to dry before irrigation as described above. Treatments were applied using a $CO_2$-powered backpack sprayer equipped with a single TeeJet AI9505E nozzle calibrated to deliver 1 gallon/1000 $ft^2$. Treatment information is presented in Table 2. Plots were evaluated every 4 days for visual injury (1-9; 9 = no visible injury) starting on August 14, 2025. Data were analyzed using ANOVA, followed by Fisher's LSD test to identify mean separation.

**Results:**

Results from the seeded kikuyu and annual bluegrass studies are summarized in Table 3. For both weed species, germination occurred in plots treated with Kerb (4), Sencor (6), Princep (9), SureGuard (10), Tenacity (13), and Dismiss CA (14). Germination rates did not appear to be impacted in plots treated with Tenacity (13) or Dismiss CA (14) when compared with the untreated control (1). No other weed species besides kikuyugrass or annual bluegrass have germinated in either study; however, results from a preliminary study show that the herbicides that are effective at controlling kikuyugrass preemergence are also effective at controlling thistle (*Salsola tragus*), pigweed (*Amaranthus retroflexus*), spotted spurge (*Euphorbia maculata*), purslane (*Portulaca oleracea*), and crabgrass (*Digitaria ciliaris*) when compared to the untreated control (data not shown).

Results from the study measuring herbicide injury to kikuyugrass are summarized in Table 4. Injury was apparent for some treatments as early as 1 day after application. Injury to the turf was recorded as either foliar burning or bleaching. In general, visual injury among treatments peaked around 6 days after the initial application, with injury in the form of foliar burning recorded for all rates of Sencor (6), Ronstar (7), and SureGuard (10). Plots treated with Tenacity (13) exhibited foliar bleaching that continued to increase in injury severity until 10 days after application. Minor injury was recorded for plots treated with Dismiss CA (14), though recovery occurred quickly (within 6 days of application).

Major injury was still visible for SureGuard (10) 18 days after the application and continues now in plots treated with the highest rate, while plots treated with Tenacity (13) exhibits minor to moderate injury that increased with higher application rates. Mild discoloration of plots treated with Princep (9) was noted at 18 days after application, though it did not appear to significantly affect the overall quality of the turf.

Overall, turf managers should select preemergence herbicides based on the specific weeds they would like to target, with consideration for potential desirable/undesirable injury to established turf that may result from herbicide applications. When paired with findings from the seeded kikuyugrass and annual bluegrass studies, Specticle (8) was the only treatment that controlled both weed types and did not injure the established kikuyugrass turf. Although SureGuard (10) provided the best overall combination of kikuyugrass turf injury and prevention of seedling establishment, this herbicide has extended soil residual activity that would negatively impact establishment of improved kikuyugrass or any other turfgrass species.

**Acknowledgements:**

Thanks to the CTLF, USGA, MWD, WMWD, Syngenta, BASF, Corteva, Envu, and Nufarm for their support of this research.


**Plot Plan**
**Preemergence Trial for Kikuyugrass and Annual Bluegrass**

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

Kikuyugrass (white: columns 1–5)
Annual Bluegrass (grey: columns 6–10)

Table 1. Treatments applied to seeded kikuyugrass and annual bluegrass on bare soil on August, 15, 2025. Riverside, CA.

| No. | Treatment | Active ingredient | Rate | Rate units |
|---|---|---|---|---|
| 1 | Untreated Control | - | - | - |
| 2 | Barricade | Prodiamine | 24 | fl oz/A |
| 3 | Pendulum | Pendimethalin | 60.5 | fl oz/A |
| 4 | Kerb | Pronamide | 28 | fl oz/A |
| 5 | Tower | Dimethenamid | 16 | fl oz/A |
| 6 | Sencor | Metribuzin | 5.36 | oz/A |
| 7 | Ronstar | Oxadiazon | 80 | fl oz/A |
| 8 | Specticle | Indaziflam | 5 | fl oz/A |
| 9 | Princep | Simazine | 32 | fl oz/A |
| 10 | SureGuard | Flumioxazin | 6 | fl oz/A |
| 11 | Dimension | Dithiopyr | 16 | fl oz/A |
| 12 | Pennant | Metolachlor | 21 | fl oz/A |
| 13 | Tenacity | Mesotrione | 4 | fl oz/A |
| 14 | Dismiss CA | Sulfentrazone | 6 | fl oz/A |

Table 2. Treatments applied to mature kikuyugrass turf on August, 12, 2025. Riverside, CA. The rates (shown below) were applied once, twice or four times to represent 1X, 2X, or 4X times to evaluate turf tolerance. Riverside, CA.

| No. | Treatment | Active ingredient | Rate | Rate units |
|---|---|---|---|---|
| 1 | Untreated Control | - | - | - |
| 2 | Barricade | Prodiamine | 24 | fl oz/A |
| 3 | Pendulum | Pendimethalin | 60.5 | fl oz/A |
| 4 | Kerb | Pronamide | 28 | fl oz/A |
| 5 | Tower | Dimethenamid | 16 | fl oz/A |
| 6 | Sencor | Metribuzin | 5.36 | oz/A |
| 7 | Ronstar | Oxadiazon | 80 | fl oz/A |
| 8 | Specticle | Indaziflam | 5 | fl oz/A |
| 9 | Princep | Simazine | 32 | fl oz/A |
| 10 | SureGuard | Flumioxazin | 6 | fl oz/A |
| 11 | Dimension | Dithiopyr | 16 | fl oz/A |
| 12 | Pennant | Metolachlor | 21 | fl oz/A |
| 13 | Tenacity | Mesotrione | 4 | fl oz/A |
| 14 | Dismiss CA | Sulfentrazone | 6 | fl oz/A |

Table 3. Percent kikuyugrass or annual bluegrass cover (%) for each treatment after a single application on bare soil on August 15, 2025. Riverside, CA.

| Treatment No. | Kikuyugrass | | | Annual Bluegrass | | |
|---|---|---|---|---|---|---|
| | *8/22* | *8/29* | *9/2* | *8/22* | *8/29* | *9/2* |
| **Trt 1** | 6.2 a* | 15 a | 23 a | 1.6 bc | 10 a | 19 a |
| **Trt 2** | 0 d | 0 d | 0.8 de | 0 c | 0 d | 0 f |
| **Trt 3** | 0 d | 0 d | 0.2 e | 0 c | 0 d | 0 f |
| **Trt 4** | 4.2 ab | 13.2 ab | 20.2 ab | 0.4 c | 1.4 cd | 2.2 ef |
| **Trt 5** | 0 d | 0 d | 0.6 e | 0 c | 0 d | 0 f |
| **Trt 6** | 4.2 ab | 7 c | 8 cde | 2.2 abc | 5.2 b | 8.2 cd |
| **Trt 7** | 0 d | 0 d | 0.2 e | 0 c | 0 d | 0 f |
| **Trt 8** | 0 d | 0 d | 0 e | 0 c | 0 d | 0 f |
| **Trt 9** | 4.4 ab | 8 c | 12 bc | 1.6 bc | 5 b | 6.2 de |
| **Trt 10** | 0.2 cd | 0.8 d | 0.6 e | 1.2 bc | 4 bc | 5 def |
| **Trt 11** | 0.2 cd | 0.2 d | 0.2 e | 0 c | 0 d | 0 f |
| **Trt 12** | 0 d | 0 d | 0 e | 0 c | 0 d | 0 f |
| **Trt 13** | 2.6 bc | 8 c | 9 cd | 4.4 a | 8 a | 13 bc |
| **Trt 14** | 4.2 ab | 9 bc | 10 c | 3 ab | 10 a | 18 ab |
| **p-value** | **0** | **0** | **0** | **0.0079** | **0** | **0** |

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

Table 4. Visual injury (1-9; 9 = no injury) of treatments after one application (August 12, 2025) on mature kikuyugrass turf. Riverside, CA.

| Trt No. | 1x Rate | | | | | 2x Rate | | | | | 4x Rate | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *8/14* | *8/18* | *8/22* | *8/26* | *8/30* | *8/14* | *8/18* | *8/22* | *8/26* | *8/30* | *8/14* | *8/18* | *8/22* | *8/26* | *8/30* |
| **Trt 1** | 9 a* | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 8.33 ab | 8.33 a | 9 a |
| **Trt 2** | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 8.33 a | 8 ab | 8 abc | 9 a | 9 a | 9 a | 8.67 ab | 8.67 a | 9 a |
| **Trt 3** | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 8.67 a | 8.33 ab | 8.33 a | 9 a |
| **Trt 4** | 9 a | 8.33 ab | 8.67 a | 8.67 a | 9 a | 9 a | 8.67 a | 8.67 a | 8.67 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a |
| **Trt 5** | 9 a | 8.67 ab | 8.67 a | 8.67 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a |
| **Trt 6** | 7.67 b | 7.33 c | 9 a | 9 a | 9 a | 7 bc | 4.67 c | 5.67 d | 7.33 bc | 9 a | 6.33 c | 5 b | 5.33 c | 6.33 b | 8.33 a |
| **Trt 7** | 7.67 b | 6.33 d | 6.67 b | 7.67 b | 9 a | 7.33 b | 5 c | 6 cd | 7 c | 8.67 a | 7 c | 3.67 c | 4.67 c | 6.33 b | 8.67 a |
| **Trt 8** | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 8.67 a | 8.33 a | 8 abc | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a |
| **Trt 9** | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 8 b | 8 a | 9 a |
| **Trt 10** | 2 c | 2 f | 2.33 d | 3 d | 5 c | 1.67 d | 1 d | 1.67 e | 2 d | 3 c | 1 e | 1 e | 1 d | 1 c | 1.33 c |
| **Trt 11** | 8.67 a | 8.67 ab | 8.67 a | 8.67 a | 9 a | 9 a | 9 a | 9 a | 9 a | 9 a | 8.67 ab | 9 a | 8.67 ab | 8.67 a | 9 a |
| **Trt 12** | 9 a | 9 a | 9 a | 9 a | 9 a | 8.67 a | 8.67 a | 8.67 a | 8.67 a | 9 a | 8 b | 9 a | 9 a | 9 a | 9 a |
| **Trt 13** | 9 a | 4 e | 3.33 c | 5 c | 7.33 b | 8.67 a | 4.33 c | 1.67 e | 2.67 d | 5 b | 9 a | 2.67 d | 1 d | 1.67 c | 4 b |
| **Trt 14** | 7.67 b | 8 bc | 8.67 a | 8.67 a | 9 a | 6.67 c | 6 b | 7 bc | 8.33 ab | 9 a | 3.33 d | 3.67 c | 5 c | 6.67 b | 9 a |
| **p-value** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |

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

## Stop #4: Evaluation of Products for Water Conservation on Bermudagrass Turf

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### Introduction:

California's climate and growing population make water a precious resource and create persistent drought challenges. With limited precipitation and heavy competition from agriculture and urban use, every sector is under pressure to conserve water. Turfgrass, a major component of golf courses, sports fields, and landscaping, typically requires substantial irrigation to maintain quality. Consequently, golf courses and other irrigated greenspaces face scrutiny and regulation: for example, California's government has mandated significant water-use reductions and industry experts emphasize strategies like reducing turf area, upgrading irrigation, and switching to drought-tolerant grasses as keys to long-term water management.

One proven approach is deficit irrigation, where less water is applied than full evapotranspiration demand. While this strategy saves significant amounts of water, it often reduces turf quality unless supported by additional tools. Commercial products such as plant growth regulators, soil surfactants and wetting agents, fertilizers/biostimulants, and pigments with plant health promoters are marketed to improve turf performance and stress tolerance under drought. These products act in different ways, whether improving soil water movement and retention, enhancing stress resistance, slowing growth, or improving appearance, but their effectiveness can vary widely.

Our program has conducted summer trials on hybrid bermudagrass at the UC Riverside research station for several years. Summers in our region are ideal for this work because natural rainfall is virtually absent, allowing consistent, water-limited testing. This year's study includes 24 commercial treatments plus an untreated control under two deficit irrigation regimes (45% and 65% $ET_{os}$). In addition to testing individual products, we have expanded the scope to include tank-mix combinations, reflecting how turf managers may apply these products in practice. Conducting trials over multiple summers builds confidence in results and helps identify strategies that consistently support turf quality when water is limited.

### Objective:

This study aimed to evaluate the effectiveness of different products in managing bermudagrass turf under deficit irrigation conditions. By assessing their performance, this research aims to identify practical solutions that support the health and aesthetics of bermudagrass while simultaneously conserving water.

**Materials and Methods:**

The study was conducted on hybrid bermudagrass (*Cynodon* spp.) 'Tifway II' turf on a Hanford fine sandy loam. The 60' x 90' field is divided into 6 (30' x 30') blocks. Treatments are arranged in a split-plot design with 25 treatments (plot size 9 $ft^2$) randomized within $ET_{os}$ replacement zones and 3 replicates. Treatments (Table 1) were applied according to company recommendations beginning on June 10, 2025. All plots received non-limiting irrigation until July 7, 2025. From July 7th through October, blocks receive either 45% or 65% of previous week reference evapotranspiration ($ET_{os}$) by hand watering to maximize water distribution uniformity as determined by an on-site CIMIS weather station. Hose output is calibrated weekly to minimize errors from changing pressure. Turf was mowed three days per week at a height of 0.5 inches and fertilized with 0.5 lb N/1,000 $ft^2$/month using a complete granular formulation from May thru October. Treatments were applied as granular formulations or as liquids with a $CO_2$-powered backpack sprayer (TeeJet AI9505E nozzle) calibrated to deliver 1 gallon/1000 $ft^2$. According to company recommendations, application of certain products (and granular fertilizer applications) was followed by 0.2 inches of water to incorporate the products into the soil. Plots were evaluated biweekly for visual quality (1-9, 9 = best), color (1-9, 9 = darkest), turfgrass injury (0-100%), Normalized Difference Vegetation Index (NDVI; 0-1) using a GreenSeeker instrument, soil volumetric water content (VWC; %) at 3-inch depth using a Field Scout 350, and percent cover using Digital Image Analysis (DIA). Data were analyzed using Analysis of Variance with Tukey's honest significant difference (HSD) test (P=0.05).

**Results:**

In general, this summer in Riverside was milder than usual. At the higher irrigation replacement level (65% $ET_{os}$), which is usually considered mild stress deficit irrigation, turf maintained generally good quality and uniform appearance across all treatments. Statistical differences among treatments were rare, and no single product or category consistently outperformed the control. By late summer, percent green cover remained very high (around 95-99%) for all treatments at 65% $ET_{os}$ with no significant variation, indicating that the turf stayed dense and healthy regardless of treatment application under this level of deficit irrigation. In comparison to a similar study field study conducted in 2024, we had to increase the crop coefficient to 75% $ET_{os}$ midway through the study to account for the effects of higher heat and ET demand on bermudagrass turf in Riverside.

At 45% $ET_{os}$, differences among treatments were more noticeable this year. Turf visual quality declined in August and early September, reflecting stress under more restrictive irrigation. Still, several treatments (e.g., Trt. 9, Trt. 11, and Trt. 25) sustained higher quality ratings and darker color compared with the control. These plots also maintained strong percent green cover (>95%), indicating resilience despite reduced irrigation. In contrast, some treatments fell to lower quality ratings (<6) late in the season, suggesting limited benefits under water stress.

These results highlight two key points: (1) under higher deficit irrigation (65% $ET_{os}$), product differences were minimized and turf quality remained acceptable across treatments; and (2) under more severe deficit irrigation (45% $ET_{os}$), product performance diverges, with certain treatments sustaining quality and cover better than others. While no single product category consistently outperformed the rest, select treatments provided measurable benefits under stress. The study will continue through October and we expect turf drought stress to mount at both irrigation replacement levels.

**Acknowledgments:**

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N

**Plot Plan**

**Deficit Irrigation Study 2025**

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

65% ETo

45% ETo

Table 1. Treatments applied in the deficit irrigation study. Riverside, CA. 2025.

| Trt No. | Treatment | Company | Rate | Rate units | Timing |
|---|---|---|---|---|---|
| 1 | Untreated Control | - | | | |
| 2 | OO-WJ Surfactant | Ocean Organics | 6 then 3 | fl oz/M | ACEGIKM |
| 2 | OO-SRX Foliar | Ocean Organics | 6 | oz/M | ACEGIKM |
| 2 | OO-XP Foliar | Ocean Organics | 6 | oz/M | ACEGIKM |
| 2 | OO-GG Foliar | Ocean Organics | 10 | oz/M | ACEGIKM |
| 3 | OO-WJ Surfactant | Ocean Organics | 6 then 3 | oz/M | ACEGIKM |
| 3 | OO-SRX Foliar | Ocean Organics | 6 | oz/M | ACEGIKM |
| 3 | OO-XP Foliar | Ocean Organics | 6 | oz/M | ACEGIKM |
| 3 | OO-GG Foliar | Ocean Organics | 10 | oz/M | ACEGIKM |
| 3 | Civitas | Intelligro | 8.5 | oz/M | ACEGIKM |
| 4 | OO-SB 12-4-5 | Ocean Organics | 4.25 | lbs/M | AE |
| 4 | OO-WJ Surfactant | Ocean Organics | 6 then 3 | oz/M | ACEGIKM |
| 4 | OO-SRX Foliar | Ocean Organics | 6 | oz/M | ACEGIKM |
| 4 | OO-XP Foliar | Ocean Organics | 6 | oz/M | ACEGIKM |
| 4 | OO-GG Foliar | Ocean Organics | 10 | oz/M | ACEGIKM |
| 5 | Primo Maxx | Syngenta | 0.25 | oz/M | ACEGIKM |
| 6 | Gary's Green Ultra | Brandt | 9 | oz/M | ACEGIKM |
| 7 | Civitas | Intelligro | 8.5 | oz/M | ACEGIKM |
| 8 | Primo Maxx | Syngenta | 0.25 | oz/M | ACEGIKM |
| 8 | Gary's Green Ultra | Brandt | 9 | oz/M | ACEGIKM |
| 9 | Primo Maxx | Syngenta | 0.25 | oz/M | ACEGIKM |
| 9 | Civitas | Intelligro | 8.5 | oz/M | ACEGIKM |
| 10 | Gary's Green Ultra | Brandt | 9 | oz/M | ACEGIKM |
| 10 | Civitas | Intelligro | 8.5 | oz/M | ACEGIKM |
| 11 | Primo Maxx | Syngenta | 0.25 | oz/M | ACEGIKM |
| 11 | Gary's Green Ultra | Brandt | 9 | oz/M | ACEGIKM |
| 11 | Civitas | Intelligro | 8.5 | oz/M | ACEGIKM |
| 12 | UCR001 | - | - | | - |
| 13 | UCR002 | - | - | | - |
| 14 | UCR003 | - | - | | - |
| 15 | UCR001 | - | - | | - |
| 15 | UCR003 | - | - | | - |
| 16 | UCR003 | - | - | | - |
| 16 | UCR004 | - | - | | - |
| 17 | UCR020 | - | - | | - |
| 18 | UCR021 | - | - | | - |
| 19 | UCR022 | - | - | | - |
| 20 | Anuew EZ | Nufarm | 26 | oz/A | ACEGIKM |
| 20 | NIS 0.25% v/v | - | 0.25% | v/v | ACEGIKM |
| 21 | UCR023 | - | - | | - |
| 22 | UCR04 | - | - | | - |
| 23 | PBS 150 | Aqua-Aid | 5 | oz/M | AEK |
| 24 | PBS 150 | Aqua-Aid | 5 | oz/M | AEK |
| 24 | Civitas | Intelligro | 8.5 | oz/M | ACEGIKM |
| 25 | PBS 150 | Aqua-Aid | 5 | oz/M | AEK |
| 25 | Civitas | Intelligro | 8.5 | oz/M | ACEGIKM |
| 25 | Gary's Green Ultra | Brandt | 9 | oz/M | ACEGIKM |

**Application Intervals:** A=6/10/25; C=6/24/25; E=7/7/25; G=7/22/25; I=8/5/25; K=8/19/25; M=9/2/2025

Table 2. Visual quality (1–9 scale, 9 = best), turf color (1–9 scale, 9 = best), soil volumetric water content (%VWC), and percent green cover (0-100%) of bermudagrass maintained at 45% of reference evapotranspiration ($ET_{os}$). Treatments were applied in Riverside, CA, 2025.

| Treatment No. | 45% $ET_{os}$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Visual Quality | | | | | | | | Color | | %VWC | Percent Cover |
| | *6/10* | *6/23* | | *7/21* | *8/18* | | *9/2* | | *8/18* | | *9/2* | *8/29* |
| **Trt 1** | 7 | 7 | AB* | 7.3 | 5 | C | 5 | AB | 6.7 | AB | 13.8 | 81.9 |
| **Trt 2** | 7 | 8 | A | 7.7 | 7.3 | AB | 5.7 | AB | 7 | AB | 12.4 | 93.7 |
| **Trt 3** | 7 | 7.7 | AB | 7 | 6.7 | ABC | 6.3 | A | 7.7 | AB | 15.5 | 95.1 |
| **Trt 4** | 7 | 7 | AB | 7.7 | 6.7 | ABC | 4.7 | AB | 7.3 | AB | 11.4 | 93.1 |
| **Trt 5** | 6.7 | 6.3 | AB | 7.7 | 5.7 | ABC | 5 | AB | 7 | AB | 13.6 | 89.2 |
| **Trt 6** | 7 | 7.3 | AB | 7.3 | 6.3 | ABC | 4.7 | AB | 6.7 | AB | 11.4 | 77.4 |
| **Trt 7** | 7 | 7.3 | AB | 6.7 | 7 | ABC | 5.7 | AB | 7.3 | AB | 11.7 | 96.5 |
| **Trt 8** | 6.7 | 6.3 | AB | 7.7 | 6 | ABC | 5.7 | AB | 7.3 | AB | 12.8 | 94.2 |
| **Trt 9** | 7 | 7 | AB | 8 | 7.3 | AB | 6.3 | A | 8 | AB | 14.8 | 98.8 |
| **Trt 10** | 7 | 7.3 | AB | 7.7 | 6.3 | ABC | 5 | AB | 6.7 | AB | 10.6 | 93.1 |
| **Trt 11** | 6.7 | 6.7 | AB | 8.3 | 7.7 | A | 6 | AB | 8.3 | A | 13.3 | 97.1 |
| **Trt 12** | 7 | 7 | AB | 7.7 | 5.7 | ABC | 4.3 | AB | 6.7 | AB | 12.2 | 83.5 |
| **Trt 13** | 7 | 7.7 | AB | 7.3 | 5.7 | ABC | 3.3 | B | 6.3 | B | 11.3 | 78.6 |
| **Trt 14** | 7 | 6.7 | AB | 6.7 | 6 | ABC | 5.3 | AB | 7 | AB | 13.3 | 95.5 |
| **Trt 15** | 7 | 7 | AB | 8 | 7 | ABC | 6 | AB | 7 | AB | 14.8 | 93.7 |
| **Trt 16** | 6.7 | 6.7 | AB | 6.7 | 5.7 | ABC | 5 | AB | 7 | AB | 12.0 | 92.4 |
| **Trt 17** | 7 | 6 | B | 6.7 | 6.3 | ABC | 5.3 | AB | 7.3 | AB | 17.3 | 94.8 |
| **Trt 18** | 6.7 | 6.7 | AB | 7 | 6.3 | ABC | 5 | AB | 6.7 | AB | 14.7 | 95.1 |
| **Trt 19** | 7 | 6.7 | AB | 7.7 | 6.7 | ABC | 5 | AB | 7 | AB | 17.1 | 89.9 |
| **Trt 20** | 6.7 | 7 | AB | 8.7 | 5.7 | ABC | 4 | AB | 7 | AB | 9.5 | 87.3 |
| **Trt 21** | 6.7 | 7 | AB | 6.7 | 6 | ABC | 5.3 | AB | 7 | AB | 13.3 | 91.3 |
| **Trt 22** | 6.7 | 6.7 | AB | 7.7 | 6 | ABC | 4.7 | AB | 6.3 | B | 14.1 | 91.6 |
| **Trt 23** | 7 | 7 | AB | 6.7 | 5.3 | BC | 5.3 | AB | 6.7 | AB | 12.3 | 93.6 |
| **Trt 24** | 7 | 7.3 | AB | 8 | 7.3 | AB | 6 | AB | 7.3 | AB | 13.6 | 96.7 |
| **Trt 25** | 7 | 7.7 | AB | 7.3 | 6.7 | ABC | 6.3 | A | 7 | AB | 12.2 | 97.0 |
| **p-value** | 0.819 | **0.005** | | 0.072 | **0.001** | | **0.030** | | **0.005** | | 0.970 | 0.654 |

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

Table 3. Visual quality (1–9 scale, 9 = best), turf color (1–9 scale, 9 = best), soil volumetric water content (%VWC), and percent green cover (0-100%) of bermudagrass maintained at 65% of reference evapotranspiration ($ET_{os}$). Riverside, CA. 2025.

| Treatment No. | 65% $ET_{os}$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Visual Quality | | | | | | Color | | %VWC | Percent Cover |
| | *6/10* | *6/23* | | *7/21* | *8/18* | *9/1* | *8/18* | | *9/1* | *8/29* |
| **Trt 1** | 7 | 7 | ABC* | 7.7 | 6.3 | 5.7 | 7 | B | 19.8 | 94.7 |
| **Trt 2** | 7 | 7.3 | ABC | 6.7 | 7.3 | 7.3 | 7 | B | 19.7 | 97.3 |
| **Trt 3** | 7 | 8 | A | 8.7 | 7.3 | 6.7 | 7.3 | AB | 18.7 | 95.4 |
| **Trt 4** | 7 | 7.7 | AB | 7.7 | 7 | 7 | 7 | B | 21.1 | 95.9 |
| **Trt 5** | 6.7 | 6 | C | 6.3 | 6.7 | 6.7 | 7 | B | 18.7 | 97.4 |
| **Trt 6** | 7 | 7 | ABC | 7.3 | 6.3 | 6 | 6.7 | B | 18.4 | 94.4 |
| **Trt 7** | 7 | 7.3 | ABC | 7 | 7.3 | 7.7 | 7 | B | 19.1 | 97.6 |
| **Trt 8** | 6.7 | 7 | ABC | 7 | 7 | 6.7 | 7 | B | 22.9 | 97.8 |
| **Trt 9** | 6.7 | 6.7 | ABC | 7.7 | 7.7 | 7 | 7.7 | AB | 25.0 | 99.3 |
| **Trt 10** | 7 | 8 | A | 7.3 | 7 | 7 | 7 | B | 17.6 | 98.4 |
| **Trt 11** | 7 | 7 | ABC | 8.3 | 7.7 | 6.7 | 8.3 | A | 16.0 | 98.3 |
| **Trt 12** | 6.7 | 7.3 | ABC | 8 | 7.3 | 6.3 | 6.7 | B | 20.7 | 93.0 |
| **Trt 13** | 7 | 7.3 | ABC | 7.3 | 7.3 | 6.7 | 7 | B | 20.8 | 97.2 |
| **Trt 14** | 7 | 7 | ABC | 7.3 | 7 | 6.7 | 7 | B | 18.6 | 96.3 |
| **Trt 15** | 6.7 | 7 | ABC | 7.7 | 7 | 6.3 | 7 | B | 20.4 | 98.3 |
| **Trt 16** | 6.7 | 7.3 | ABC | 7.7 | 7 | 6.7 | 7 | B | 21.1 | 95.5 |
| **Trt 17** | 6.7 | 6 | C | 6.3 | 7 | 6.3 | 7.3 | AB | 20.6 | 97.9 |
| **Trt 18** | 6.7 | 6.3 | BC | 6.7 | 7 | 6.3 | 7.7 | AB | 19.1 | 97.4 |
| **Trt 19** | 6.7 | 6.3 | BC | 7 | 7 | 5.7 | 7.7 | AB | 22.0 | 95.5 |
| **Trt 20** | 6.7 | 7 | ABC | 8.3 | 6.3 | 6.3 | 7 | B | 22.2 | 98.2 |
| **Trt 21** | 7 | 7 | ABC | 7.7 | 6.7 | 6 | 7 | B | 18.6 | 96.6 |
| **Trt 22** | 6.7 | 7.3 | ABC | 8.3 | 6.3 | 6 | 7 | B | 18.0 | 95.3 |
| **Trt 23** | 7 | 7 | ABC | 7.7 | 6.3 | 6 | 6.7 | B | 19.0 | 92.5 |
| **Trt 24** | 7 | 8 | A | 8.3 | 7 | 7.3 | 7 | B | 20.8 | 99.0 |
| **Trt 25** | 7 | 7.7 | AB | 8.3 | 7.3 | 7 | 7.3 | AB | 17.0 | 98.3 |
| **p-value** | 0.923 | **0** | | 0.061 | 0.165 | 0.290 | **0** | | 0.777 | 0.497 |

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

**Stop #5: Improvement of Bermudagrass, Kikuyugrass, and Zoysiagrass for Winter Color Retention and Drought Tolerance**

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**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, and much of the Southwest, has been experiencing drought for several years, affecting water availability and costs for both commercial and non-commercial users alike. Given the natural adaptations of warm-season grasses to arid climates, emphasis should be placed on extending their use and further improving their drought stress resistance to combat this issue. The warm-season turfgrass breeding program at the University of California, Riverside (UCR) was re-established in 2012, by planting a bermudagrass collection and making the first crosses among those 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. In bermudagrass and kikuyugrass, we place an emphasis on improving drought resistance and winter color retention. Winter dormancy hampers the replacement of cool-season with warm-season grasses, so selection is also aimed at reducing the winter dormancy period. New cultivars with improved winter color retention are likely to increase acceptance of warm-season grasses. Additionally, efforts are being made in kikuyugrass to reduce its invasive behavior and enhance its acceptability as a turfgrass through both traditional breeding and lab-based methods.

**Project milestones since Field Day 2024:**

- Continued evaluation of replicated test plots of advanced bermudagrass hybrids selected for drought and/or shade tolerance, as well as for fairways/sports fields across Arizona, California, Colorado, Nevada, and New Mexico.
- Continued evaluation of replicated test plots of kikuyugrass selected for reduced/no anther production in California.
- Established a new kikuyugrass germplasm collection.
- Continued evaluation of bermudagrass hybrids selected for roughs/lawns
- Continued evaluation of bermudagrass and kikuyugrass hybrids selected for fairways/sports fields.
- Continued evaluation of bermudagrass hybrids under shade.
- Continued evaluation of bermudagrass and kikuyugrass nurseries.
- Continued evaluation of experimental bermudagrass lines within the USDA-NIFA Specialty Crop Research Initiative (SCRI) for remote sensing/prediction of performance under drought.

**Establishment of advanced bermudagrass hybrids for drought trials:**

With the successful release of 'Coachella' hybrid bermudagrass to the market, the UCR turfgrass breeding program continues to create and evaluate grasses for the future.

Last year, eight bermudagrass hybrids were selected and planted at seven locations throughout the Southwest in two replicates during the summer of 2024. These hybrids were selected based on their performance when evaluated under drought or shade, as well as under different mowing heights (1/2 in. or 2 in.). 'Coachella' (UCR TP6-3) and UCR 17-8, as well as commercial cultivars ('TifTuf' / 'Tahoma 31' / 'Santa Ana'), were added as checks. One or two other local checks were included for some of the locations.

The multi-location trial overall experienced a few disruptions, and drought trials were postponed for all locations except Riverside, CA. In both Colorado and New Mexico, winter conditions were colder than expected, resulting in mortality for most entries in Colorado and all entries in New Mexico. In Colorado, 'Tahoma 31', 'TifTuf', 'Coachella', and 'Presidio' survived, with 'Tahoma 31' and 'TifTuf' demonstrating full recovery. Plugs were harvested from the trial at UCR and transplanted to the trial locations at Colorado and New Mexico June 28-29, 2025, to reestablish the entries that did not survive.

In Stockton, CA, a complete loss of one experimental replication occurred due to unintentional soil disturbance from field maintenance in an adjacent area October 2024. Replacement of these replicates was not possible due to space constraints. 7 of the 14 entries were affected and therefore we have only one replicate at this location.

Despite setbacks at external locations, a drought trial was performed at the UCR field site. Complete drought (0% $ET_{os}$ replacement) was imposed on August 1, 2025, and irrigation was restored on September 1, 2025. Plots were evaluated weekly for turf quality (1-9; 9 = best), visual color (1-9; 9 = dark green), flowering/seedhead production (1-9; 9 = no visible seedheads), and injury (1-9; 9 = no visible injury). Each plot was also split into two different mowing heights (1/2 in. or 2.0 in.). Turfgrass quality data are summarized in Table 1. Data were analyzed using an analysis of variance (ANOVA) for each rating date, followed by Fisher's least significant difference (LSD) test to identify entries with significantly improved turf quality under drought. Data from this study show a few advanced UCR bermudagrass lines with even better drought tolerance than commercial varieties. UCRC180557 was the top performing entry at a mowing height of 2 inches, and among the top performers at a height of 0.5 inches. UCR 17-8 proved to have slightly better drought tolerance than 'Coachella' and performed on par with 'TifTuf'. These results are promising and confirm our ability to further improve drought tolerance in bermudagrass for the future.

**Advances in kikuyugrass breeding:**

Kikuyugrass exhibits a moderate level of drought tolerance and exceptional winter color retention. Though it has some undesirable traits, such as an aggressive growth habit, the UCR turfgrass breeding program is working to improve kikuyugrass through both traditional selection and *in vitro* methods.

*Kikuyugrass hybrids with reduced anther production:*

Kikuyugrass can be easily distinguished by their unique male flowers (white filament with anther). When the anthers exert in a large stand of turf, it can often give a silvery—almost "snowy"—appearance and requires frequent mowing to remove. Six kikuyugrass hybrids were selected and planted in Riverside, CA and in Winchester, CA in two replicates during the summer of 2024. These hybrids were selected from among the 2019 and 2022 kikuyugrass nurseries, as well as the germplasm collection established in 2016, for having noticeably reduced anther production. ‘Whittet’ was added as a check, for a total of seven entries. Results from regular evaluations can be seen in Table 2. Data were analyzed using an ANOVA for all data collected from May through August 2025, followed by Fisher’s LSD test. While no significant differences were noted in stigma production, significant differences were noted in anther production when comparing all 6 UCR kikuyugrass hybrids against ‘Whittet’. All UCR hybrids showed reduced anther production, and most showed improved mowing quality/reduced mechanical injury when mowed weekly at a height of 1.5 inches. UCRK220003 shows the most promise with little to no anther production and improved overall turf quality at both locations.

**Acknowledgements:**

Thanks to the CTLF, USGA, MWD, WMWD, USDA NIFA, West Coast Turf, Delta Bluegrass Co., Evergreen Turf, Green Valley Turf, Shadow Creek GC, The Club at Las Campanas, and A-G Sod Farms for their support of this research.

Table 1. Turfgrass quality (1-9; 9 = best) of 13 UCR bermudagrass hybrids, including UCR 17-8 and 'Coachella' (UCR TP6-3), as well as 'TifTuf' and 'Tahoma 31' under drought at UCR (Riverside, CA). Complete drought (0% $ET_{os}$ replacement) was initiated August 1, 2025.

| Entry | 5/8 in. | | | | 2.0 in. | | | |
|---|---|---|---|---|---|---|---|---|
| | *8/6* | *8/13* | *8/21* | *8/28* | *8/6* | *8/13* | *8/21* | *8/28* |
| Coachella | 8 a* | 8 a | 6 | 5.5 | 7.5 ab | 7 a-c | 6 a-c | 5.5 bc |
| UCR 17-8 | 8 a | 8 a | 6.5 | 5.5 | 8 a | 8 a | 7 a | 7 ab |
| Tahoma 31 | 7.5 ab | 7.5 ab | 4 | 3 | 6.5 a-c | 7 a-c | 4.5 d | 3 d |
| TifTuf | 6.5 b-d | 6.5 a-d | 6 | 6 | 8 a | 8 a | 7 a | 6.5 a-c |
| UCRC180060 | 6 cd | 7 a-c | 6.5 | 6.5 | 6 b-d | 6.5 a-d | 6 a-c | 6 a-c |
| UCRC180118 | 7 a-c | 7 a-c | 5.5 | 5 | 8 a | 8 a | 7 a | 7 ab |
| UCRC180127 | 7 a-c | 7 a-c | 6 | 5 | 7 ab | 7 a-c | 6.5 ab | 6 a-c |
| UCRC180146 | 6 cd | 5.5 cd | 5 | 4.5 | 6.5 a-c | 6 b-d | 5.5 b-d | 5 c |
| UCRC180174 | 8 a | 7.5 ab | 6 | 5 | 7.5 ab | 7.5 ab | 6 a-c | 5.5 bc |
| UCRC180211 | 6 cd | 6 b-d | 5.5 | 5 | 6 b-d | 6 b-d | 5.5 b-d | 5 c |
| UCRC180217 | 6 cd | 5.5 cd | 5.5 | 5.5 | 4.5 d | 5.5 cd | 6 a-c | 6 a-c |
| UCRC180557 | 7 a-c | 7 a-c | 6.5 | 6 | 6.5 a-c | 7 a-c | 7 a | 7.5 a |
| UCRC190272 | 6 cd | 5 d | 4.5 | 4.5 | 7 ab | 6 b-d | 5.5 b-d | 5 c |
| BF2 | 5.5 d | 5 d | 5 | 4.5 | 5 cd | 5 d | 5 cd | 5 c |
| BH 10-9 | 7 a-c | 7 a-c | 6 | 6 | 7 ab | 7.5 ab | 7 a | 6.5 a-c |
| **p-value** | **0.0068** | **0.0488** | 0.0699 | 0.176 | **0.0087** | **0.0352** | **0.0039** | **0.0101** |

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

Table 2. Overall turfgrass quality (TQ) (1-9; 9 = best), stigma production (FP) (1-9; 9 = no visible stigmas), anther production (MP) (1-9; 9 = no visible anthers), and scalping/mechanical injury from mowing at 1.5 inches (MI) (1-9; 9 = no visible injury) of 6 UCR kikuyugrass hybrids and 1 commercial check, 'Whittet', at UCR, Riverside, CA and Winchester, CA from May to September of 2025.

| Entry | Riverside, CA | | | | Winchester, CA | | | |
|---|---|---|---|---|---|---|---|---|
| | TQ | FP | MP | MI | TQ | FP | MP | MI |
| Whittet | 5 d* | 7 | 6 b | 4.5 c | 5 | 7 | 6.67 b | 6.5 b |
| UCRK000095 | 6.5 ab | 9 | 8.25 a | 7.5 a | 6 | 6.67 | 9 a | 8 a |
| UCRK000090 | 5.5 cd | 9 | 7.75 ab | 7 ab | 4.8 | 6.83 | 8.5 a | 9 a |
| UCRK000025 | 6.25 a-c | 8.5 | 8.75 a | 8 a | 5.67 | 6.67 | 9 a | 9 a |
| UCRK190336 | 6 bc | 8 | 7.5 ab | 6 a-c | 6.17 | 6.67 | 8.67 a | 5.5 b |
| UCRK220003 | 7 a | 9 | 8.25 a | 7.5 a | 6.5 | 6.67 | 9 a | 8.5 a |
| UCRK220070 | 6.25 a-c | 8 | 6.25 b | 5 bc | 6.33 | 6.83 | 8 a | 6.5 b |
| **p-value** | **0.0030** | 0.632 | **0.0287** | **0.0316** | 0.063 | 1 | **0.0005** | **0.0015** |

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


**Plot Plan**

**Advanced Bermudagrass Trial Under Drought (Top)**

**Advanced Kikuyugrass Trial (Bottom)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Presidio | UCRC 180557 | UCRC 180127 | UCR BH10-9 | Coachella | UCR BF2 | |
| TifTuf | UCRC 180217 | Coachella | UCRC 180146 | UCRC 180211 | UCRC 180174 | |
| UCR BF2 | UCR BH10-9 | Tahoma 31 | UCRC 180127 | UCRC 180060 | UCRC 180557 | |
| UCRC 180174 | UCRC 180146 | UCRC 180060 | TifTuf | UCRC 190272 | Tahoma 31 | |
| UCRC 180118 | UCRC 190272 | UCRC 180211 | Presidio | UCRC 180217 | UCRC 180118 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| UCRK 220070 | UCRK 000025 | UCRK 000095 | Whittet | UCRK 000090 | UCRK 220003 | UCRK 190336 |
| UCRK 000025 | UCRK 000090 | Whittet | UCRK 220003 | UCRK 000095 | UCRK 190336 | UCRK 220070 |

**Stop #6: Evaluation of Products for Water Conservation on Bermudagrass Turf (Part II)**

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## Introduction:

Water use on turfgrass is a major component of landscape irrigation, with lawns and golf courses accounting for a large share of outdoor consumption. Inefficient irrigation can waste up to half of applied water, highlighting the need for conservation strategies. One promising approach is the use of soil surfactants (wetting agents), amphiphilic compounds that reduce water surface tension and improve soil wettability. These products can alleviate localized dry spots, promote uniform rootzone moisture, and help maintain turf quality under deficit irrigation. However, wetting agents vary widely in chemistry and performance. Unlike pesticides, they are not subject to strict federal registration or standardized testing, so many products enter the market with strong claims but little independent data. Field trials often confirm that not all wetting agents are effective, and performance can differ by site and application rate. To address this, many manufacturers now commission independent research to run randomized field studies that follow protocols. Such trials provide turf managers with credible, comparative data on how products perform under real-world conditions. Our work contributes to this body of research. We conducted a split-plot field trial on hybrid bermudagrass (*Cynodon* spp*.* 'Santa Ana') with two irrigation regimes (45% and 65% of reference evapotranspiration or $ET_{os}$) and 20 treatments (19 surfactants plus a control). Although a single-season trial, it was designed to compare products under summer stress, offering practical insights into water-conservation strategies for turfgrass management. Field trials like this provide critical comparative data on product performance. Demonstrating variability among products underscores the importance of testing each wetting agent rather than assuming all will perform equally.

## Objective

The objective of this study was to evaluate the efficacy of turf soil surfactant products for improving water conservation in hybrid bermudagrass under deficit irrigation. Specifically, we compared 20 treatments (including Revolution, TriCure AD as a standard and an untreated control) in a split-plot field experiment at two irrigation levels (45% and 65% of reference evapotranspiration). This trial was carried out to provide independent, practical data on product performance.

## Materials and Methods:

The study was conducted on hybrid bermudagrass (*Cynodon* spp. 'Santa Ana') established on a Hanford fine sandy loam. The 60′ × 60′ field was divided into six blocks (each 20′ × 30′) and arranged in a randomized split-plot design with three replicates under two irrigation regimes (45% or 65% of reference evapotranspiration or $ET_{os}$, based on data from an on-site CIMIS station). Within each irrigation regime, 20 surfactant treatments (9 $ft^2$ plots) were randomized (Table 1). Treatments included an untreated control and two industry-standard wetting agents (Revolution and TriCure AD) as benchmarks, plus a range of other commercial and experimental formulations, all applied at label-recommended rates beginning June 11, 2025.

All plots received non-limiting irrigation until July 7, 2025. From July 7 through October 2025, plots were hand-irrigated to supply their assigned irrigation level (45% or 65% of the previous week $ET_{os}$), maximizing uniform water distribution. Hose output was calibrated weekly to ensure consistent application. Turf was mowed three days per week at a height of 0.5 inches and fertilized with 0.5 lb N/1,000 $ft^2$/month from May through October. Treatments were applied with a $CO_2$-powered backpack sprayer (TeeJet AI9505E nozzle) calibrated to deliver 1 gallon/1000 $ft^2$, with each application (and fertilizer application) followed by 0.2 inches of water to incorporate the product into the soil. Turf response was monitored biweekly using both subjective ratings and objective sensor measurements. Every two weeks, plots were evaluated for turf quality (1-9; 9 = best), visual color (1-9; 9 = dark green), and Normalized Difference Vegetation Index (NDVI; 0-1) data were collected using a GreenSeeker instrument. Volumetric soil water content (VWC; %) was measured using time domain reflectometry (TDR) at 3-inch depth using a Field Scout 350. Dark green color index (DGCI; 0-0.666), as well as percent green cover were determined using Digital Image Analysis (DIA). All data were analyzed by analysis of variance (ANOVA) with Tukey's honest significant difference (HSD) test (P = 0.05) to identify treatments that significantly improved turf performance or moisture retention under the deficit irrigation.

**Results:**

At 45% $ET_{os}$, turf quality declined steadily under drought stress, and treatment effects became evident early in the summer. On July 7, visual quality ratings ranged from 6.0 to 8.0, showing clear separation among treatments. By August 29, ratings dropped down to as low as 4.0 in the untreated control but reached 7.3 in Trt 20 (TriCure AD). Several wetting agents, including Revolution (Trt 19), TriCure AD (Trt 20), and multiple experimental formulations, sustained significantly higher quality compared to the control. In contrast, the untreated control repeatedly had the lowest ratings under the deficit irrigation, confirming the measurable benefits of surfactant products under drought stress. At 65% $ET_{os}$, turf quality remained higher overall, typically between 6 and 8, reflecting greater water availability. Treatment differences were less pronounced but still detectable on certain dates. On July 7, ratings again diverged significantly (range 6.0–8.0). By August 29, scores ranged from 5.3 (Trt 4) to 7.7 (Trt 19), with significant separation among treatments. Most products clustered between 6.3 and 7.3, suggesting relatively minor differences when irrigation was less limiting, though TriCure achieved the highest quality rating at this date.

Green cover remained near 100% under the 65% $ET_{os}$ irrigation throughout the study, with no significant treatment differences detected. Even during the warmest period, all plots receiving the higher level of deficit irrigation maintained at least 95% cover. Under 45% $ET_{os}$, cover gradually declined as stress accumulated, and treatment separation became more evident later in the season. On August 29, percent green cover ranged from about 65% in the untreated control to 97% in Trt 20. Several treatments, including both commercial standards and certain experimental products, maintained significantly higher cover than the control, highlighting performance variability under deficit conditions.

Other turf performance metrics followed similar trends. NDVI values were consistently higher in the 65% $ET_{os}$ plots but did not differ significantly among treatments on most dates at either irrigation level. DGCI values also remained uniformly high across treatments, with no statistical differences detected under either regime. Soil volumetric water content (VWC) clearly reflected irrigation level, higher in 65% $ET_{os}$ plots than in 45% $ET_{os}$, but did not vary significantly among treatments within each irrigation regime. No phytotoxicity or turf injury was observed in any treatment across the entire study. All wetting agents, including commercial standards and experimental products, were safe on bermudagrass under both irrigation regimes.

**Acknowledgments:**

Thanks to Aquatrols, Mitchell Products and the California Turfgrass & Landscape Foundation (CTLF) for providing products and/or supporting this research.

**Plot Plan**

**Deficit Irrigation Study (Part II) 2025**

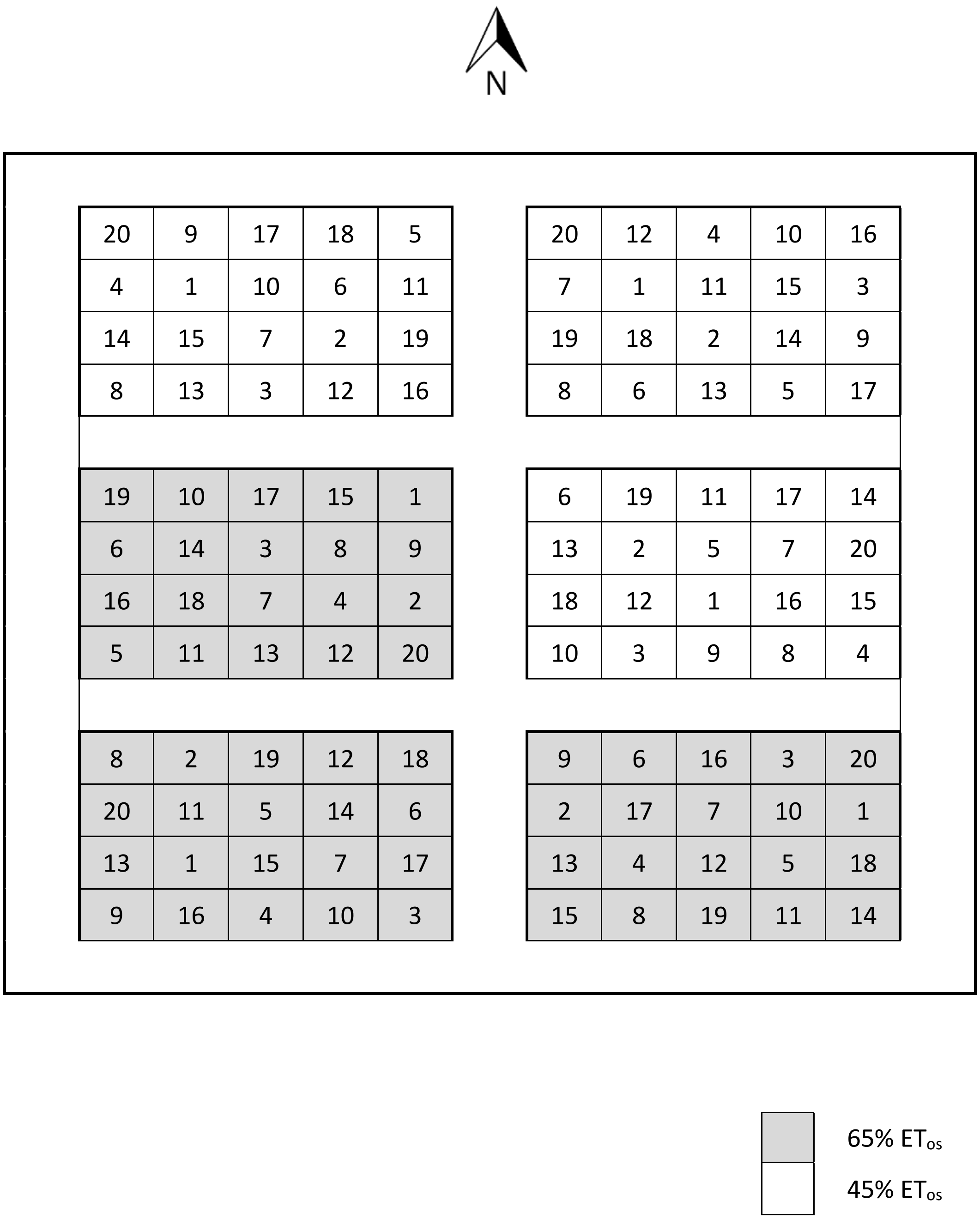

Table 1. Treatments applied in the deficit irrigation study. Riverside, CA. 2025.

| Trt No. | Treatment | Company | Rate | Rate units | Timing |
|---|---|---|---|---|---|
| 1 | Untreated Control | | | | |
| 2 | UCR-001 | - | 5 | oz/M | AEK |
| 3 | UCR-002 | - | 5 | oz/M | AEK |
| 4 | UCR-003 | - | 6 | oz/M | AEIM |
| 5 | UCR-004 | - | 6 | oz/M | AEIM |
| 6 | UCR-005 | - | 6 | oz/M | AEIM |
| 7 | UCR-006 | - | 6 | oz/M | AEIM |
| 8 | UCR-007 | - | 5 | oz/M | AEIM |
| 9 | UCR-008 | - | 1 | oz/M | AEIM |
| 10 | UCR-009 | - | 4 | oz/M | AEIM |
| 11 | UCR-010 | - | 4 | oz/M | AEIM |
| 12 | UCR-111 | - | 4 | oz/M | AEIM |
| 13 | UCR-112 | - | 1.3 | g/M | AEIM |
| 14 | UCR-113 | - | 0.37 | oz/M | AEIM |
| 15 | UCR-114 | - | 0.73 | oz/M | AEIM |
| 16 | UCR-115 | - | 0.37 | oz/M | AEIM |
| 17 | UCR-116 | - | 5 | oz/M | AEIM |
| 18 | UCR-117 | - | 5 | oz/M | AEIM |
| 18 | UCR-118 | - | 3 | oz/M | AEIM |
| 19 | Revolution | Aquatrols | 6 | oz/M | AEIM |
| 20 | TriCure AD | Mitchell Products | 6 | oz/M | AEIM |

**Application Intervals:** A = 6/11/2025;  E = 7/9/2025; I = 8/6/2025;  K = 8/22/2025; M = 9/3/2025

Table 2. Visual quality (1-9, 9 = best) of treatments on bermudagrass, irrigated at 45% $ET_{os}$. Riverside, CA. 2025.

| Trt No. | 45% $ET_{os}$ | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Visual Quality | | | | | | | %VWC | Percent Cover | |
| | *6/10* | *7/7* | | *8/18* | | *8/29* | | *8/29* | *8/29* | |
| **Trt 1** | 8 | 6.3 | BC* | 4 | C | 4 | C | 13.5 | 65.4 | B |
| **Trt 2** | 8 | 6 | C | 4.3 | BC | 4.3 | BC | 7.7 | 72.8 | AB |
| **Trt 3** | 8 | 7.3 | ABC | 6.3 | ABC | 5.7 | ABC | 17.4 | 89.6 | AB |
| **Trt 4** | 7.7 | 7 | ABC | 5.3 | ABC | 4.7 | ABC | 17.4 | 87.5 | AB |
| **Trt 5** | 8 | 7.7 | ABC | 6.3 | ABC | 7 | AB | 19.0 | 95.6 | AB |
| **Trt 6** | 8 | 7 | ABC | 6.7 | AB | 6.3 | ABC | 18.0 | 95.0 | AB |
| **Trt 7** | 8 | 7.7 | ABC | 6.3 | ABC | 6 | ABC | 11.6 | 93.6 | AB |
| **Trt 8** | 7.3 | 8 | AB | 6.3 | ABC | 7 | AB | 27.9 | 96.2 | AB |
| **Trt 9** | 7.7 | 6.7 | ABC | 5.3 | ABC | 5.3 | ABC | 14.0 | 79.9 | AB |
| **Trt 10** | 7.3 | 7.7 | ABC | 6.7 | AB | 6 | ABC | 19.1 | 96.0 | AB |
| **Trt 11** | 7.7 | 7.3 | ABC | 7 | A | 6.3 | ABC | 11.0 | 94.6 | AB |
| **Trt 12** | 7.7 | 7.3 | ABC | 6 | ABC | 6 | ABC | 16.7 | 91.2 | AB |
| **Trt 13** | 8 | 6.7 | ABC | 4.3 | BC | 4.7 | ABC | 9.9 | 77.9 | AB |
| **Trt 14** | 8 | 6.3 | BC | 5.3 | ABC | 4.7 | ABC | 11.5 | 81.6 | AB |
| **Trt 15** | 7.7 | 6.3 | BC | 5.3 | ABC | 5 | ABC | 21.8 | 86.4 | AB |
| **Trt 16** | 7.7 | 6.3 | BC | 5.7 | ABC | 6 | ABC | 16.2 | 86.9 | AB |
| **Trt 17** | 7.7 | 7 | ABC | 6 | ABC | 6 | ABC | 17.7 | 91.3 | AB |
| **Trt 18** | 7.7 | 6.7 | ABC | 5 | ABC | 5.3 | ABC | 13.5 | 86.9 | AB |
| **Trt 19** | 8 | 7.7 | ABC | 6 | ABC | 6 | ABC | 13.9 | 90.6 | AB |
| **Trt 20** | 8 | 8.3 | A | 7 | A | 7.3 | A | 18.9 | 97.4 | A |
| **p-value** | 0.784 | **0** | | **0.001** | | **0.001** | | 0.426 | **0.019** | |

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

Table 3. Visual quality (1-9, 9 = best) of treatments on bermudagrass, irrigated at 65% $ET_{os}$. Riverside, 2025.

| Treatment No. | 65% $ET_{os}$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | Visual Quality | | | | | %VWC | Percent Cover |
| | *6/10* | *7/7* | | *8/18* | *8/29* | | *8/29* | *8/29* |
| **Trt 1** | 7.3 | 6 | B* | 6.7 | 6 | AB | 33.3 | 97.6 |
| **Trt 2** | 7.7 | 7 | AB | 6.3 | 6.3 | AB | 29.3 | 96.0 |
| **Trt 3** | 8 | 7.7 | AB | 7 | 6.3 | AB | 26.5 | 96.9 |
| **Trt 4** | 7 | 6.7 | AB | 5.7 | 5.3 | B | 20.1 | 87.0 |
| **Trt 5** | 7.3 | 7.3 | AB | 7.3 | 7 | AB | 32.2 | 97.5 |
| **Trt 6** | 8 | 7 | AB | 7 | 7 | AB | 27.5 | 97.9 |
| **Trt 7** | 7.7 | 7 | AB | 6.7 | 6.3 | AB | 21.8 | 96.9 |
| **Trt 8** | 7.7 | 8 | A | 7.3 | 7.3 | AB | 31.0 | 98.1 |
| **Trt 9** | 7.7 | 6.7 | AB | 6.3 | 7 | AB | 34.0 | 98.1 |
| **Trt 10** | 7.3 | 8 | A | 7 | 7.3 | AB | 33.2 | 98.3 |
| **Trt 11** | 7.7 | 8 | A | 7.3 | 7.3 | AB | 30.9 | 98.2 |
| **Trt 12** | 7.7 | 7 | AB | 7 | 6.7 | AB | 29.0 | 97.6 |
| **Trt 13** | 7.3 | 6 | B | 6.7 | 6.3 | AB | 33.3 | 96.4 |
| **Trt 14** | 7.7 | 6.3 | AB | 7 | 6.3 | AB | 25.1 | 92.7 |
| **Trt 15** | 7.7 | 6 | B | 6.3 | 6.3 | AB | 30.4 | 98.4 |
| **Trt 16** | 7.7 | 6.3 | AB | 6.3 | 7 | AB | 30.0 | 97.7 |
| **Trt 17** | 7.7 | 6.7 | AB | 6 | 6.7 | AB | 26.9 | 93.7 |
| **Trt 18** | 7 | 7 | AB | 6.7 | 6.7 | AB | 25.9 | 97.3 |
| **Trt 19** | 7.3 | 8 | A | 7 | 7.7 | A | 30.3 | 99.1 |
| **Trt 20** | 7.7 | 8 | A | 7 | 7 | AB | 34.2 | 97.4 |
| **p-value** | 0.666 | **0** | | 0.280 | **0.046** | | 0.063 | 0.448 |

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

**Stop #7: Updating Crop Coefficients and Plant Factors for Warm-Season Turfgrasses and 2025 NTEP Bermudagrass Test**

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**Background and Objectives:**

Historically, irrigation water requirements of warm- and cool-season turfgrass species have been broadly advised as 0.6 and 0.8 $ET_{os}$ (reference evapotranspiration for short grass), respectively. However, adoption of deficit irrigation strategies for water conservation and advancements in turfgrass breeding & genetics with respect to drought resistance advocate that turfgrasses use much less water, contrary to popular belief. Recent State legislation, e.g., AB 2947, supported incentivization for conversion of existing turfgrass to more drought resistant turfgrass species and cultivars. Although not passed, acceptance of future legislation must also be accompanied by validation of the water requirements among existing and new turfgrass species and cultivars. This study aims to refine the crop coefficients for the major warm-season turfgrass species and cultivars grown in California, with particular emphasis on hybrid bermudagrass (*Cynodon* spp.) which possesses the greatest drought resistance of all species and use potential throughout most of the State. A similar cool-season study is warranted in a cooler climate outside of Riverside.

**Materials and Methods:**

A total of 16 entries were selected for this study, comprising seven warm-season species and nine cultivars or genotypes of hybrid bermudagrass. The broadleaf groundcover Kurapia (*Phylla nodiflora*) and tall fescue 'West Coaster' were also included for comparison. Each entry was sodded in 4×4 ft plots with 2-ft alleys in between plots, and 8-ft alleys in between irrigation zones. Turf was mowed once per week with a rotary mower at 2 inches, except for buffalograss and tall fescue that are mowed at 3 inches. Mowing was not performed on Kurapia.

Beginning in October 2025, plant material will be irrigated based on three average annual crop coefficients: 30%, 50%, and 70% of $ET_{os}$ measured by an on-site California Irrigation Management Information System (CIMIS) weather station located approximately 200 ft from the study area. Each entry will be replicated twice for each irrigation replacement level. Plots will be hand watered using a calibrated hose with known flow rate from 0-3 days weekly based on the previous week's $ET_{os}$ and considering natural precipitation. Because evapotranspiration is dependent on several factors including temperature, the following irrigation strategies will be employed:

| Jan-Mar | Apr-Jun | Jul-Sep | Oct-Dec | Avg $ET_{os}$ |
|---|---|---|---|---|
| 0 | 0.4 | 0.6 | 0.2 | **0.3** |
| 0.2 | 0.6 | 0.8 | 0.4 | **0.5** |
| 0.4 | 0.8 | 1.0 | 0.6 | **0.7** |

Data collected will included visual and digital image analysis. The study will continue for at least 2 years and afterwards each species and cultivar will be categorized according to Water Use Classification of Landscape Species (WUCOLS) standards and extrapolated by region.

**Acknowledgements:**

Thanks to the CTLF, USGA, MWD, WMWD, USDA NIFA, West Coast Turf, Delta Bluegrass Co., and A-G Sod Farms for their support of this research.


| | | | |
|---|---|---|---|
| 9 | 5 | 20 | 12 |
| 13 | 19 | 11 | 8 |
| 16 | 10 | 22 | 17 |
| 24 | 23 | 14 | 21 |

| | | | |
|---|---|---|---|
| 23 | 8 | 14 | 17 |
| 16 | 11 | 24 | 12 |
| 22 | 9 | 10 | 21 |
| 5 | 19 | 20 | 13 |

| | | | |
|---|---|---|---|
| 11 | 19 | 16 | 23 |
| 17 | 5 | 24 | 14 |
| 8 | 21 | 12 | 9 |
| 22 | 10 | 20 | 13 |

| | | | |
|---|---|---|---|
| 19 | 17 | 5 | 16 |
| 13 | 28 | 9 | 23 |
| 11 | 24 | 8 | 10 |
| 21 | 12 | 14 | 22 |

| | | | |
|---|---|---|---|
| 21 | 12 | 16 | 8 |
| 5 | 22 | 13 | 10 |
| 19 | 9 | 11 | 14 |
| 17 | 20 | 24 | 23 |

| | | | |
|---|---|---|---|
| 23 | 17 | 19 | 16 |
| 24 | 14 | 13 | 20 |
| 5 | 8 | 22 | 12 |
| 10 | 21 | 9 | 11 |

| No. | Entry |
|---|---|
| 5 | Kurapia |
| 8 | Bermudagrass (Latitude 36) |
| 9 | Bermudagrass (Iron Cutter) |
| 10 | Bermudagrass (Tifway) |
| 11 | Bermudagrass (Tahoma 31) |
| 12 | Bermudagrass (Santa Ana) |
| 13 | Bermudagrass (Coachella) |
| 14 | Bermudagrass (UCR 17-8) |
| 16 | Kikuyugrass (Whittet) |
| 17 | Bermudagrass (TifTuf) |
| 19 | Buffalograss (UC Verde) |
| 20 | Zoysiagrass (De Anza) |
| 21 | Seashore paspalum (Platinum) |
| 22 | St Augustinegrass (CitraBlue) |
| 23 | Tall fescue (West Coaster) |
| 24 | Bermudagrass (North Bridge) |

Figure 1. Plot plan for the warm-season turfgrass crop coefficient trial including tall fescue and Kurapia groundcover for comparison. Beginning October 2025, plots will be irrigated annually at 30%, 50% or 70% ETos (reference evapotranspiration). Riverside, CA. 2025.

***2025 NTEP Bermudagrass Test***

**Objectives:**

*The National Turfgrass Evaluation Program (NTEP) is designed to develop and coordinate uniform evaluation trials of turfgrass varieties and promising selections in the United States and Canada. Test results can be used by national companies and plant breeders to determine the broad picture of the adaptation of a cultivar. Results can also be used to determine if a cultivar is well adapted to a local area or level of turf maintenance.* (From NTEP.org)

**Materials and Methods:**

The 2025 NTEP bermudagrass test includes thirty-one vegetative and four seeded entries of bermudagrass from several companies and universities. Three standard vegetative entries ('Tifway', 'TifTuf', and 'Tahoma 31') and one standard seeded entry ('Monaco') were included in this test. The study was planted at UC Riverside, CA on July 3, 2025 on a Hanford fine sandy loam in a randomized complete block design with three replicates per entry. Vegetative and seeded entries were planted in separate blocks. Plots were 5 x 5 ft with 1.5-ft alleys, and mowed at a height of 0.5 inches. For the vegetative entries, twenty-four plugs per 5 x 5 ft plot were planted. Seeded entries were seeded at a rate of 1.35 lb/1000 $ft^2$. Data collection includes establishment, genetic color, quality, winter color retention, and pest tolerance. Initial results are provided in Table 1. The study will continue for the next 3-5 years.

**Acknowledgments:**

Thanks to the National Turfgrass Evaluation Program (NTEP) and California Turfgrass & Landscape Foundation (CTLF) for support of this research.

N

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 12 | 11 | 23 | 31 | 30 | 29 | 28 | 7 | 11 |
| 2 | 18 | | 25 | 10 | 18 | 8 | 31 | 19 | 12 |
| 3 | 24 | 28 | | 9 | 14 | 16 | 20 | 27 | |
| 4 | 7 | 21 | 5 | 27 | 25 | 26 | 18 | 4 | 30 |
| 5 | 9 | 10 | 8 | 11 | | 24 | 16 | 24 | 29 |
| 6 | 15 | 26 | 30 | 17 | 7 | 23 | 10 | | 2 |
| 7 | 16 | 19 | 4 | 13 | 12 | 19 | 22 | 26 | 9 |
| 8 | 6 | 22 | 14 | 22 | 21 | 20 | 15 | 6 | 21 |
| 9 | 2 | 13 | 31 | 15 | | 6 | 17 | 14 | 1 |
| 10 | 3 | 20 | 29 | 5 | 3 | 4 | 23 | 3 | 25 |
| 11 | 27 | 1 | 17 | 2 | 28 | 1 | 13 | 5 | 8 |
| 12 | | 32 | 33 | 35 | 34 | | 34 | 32 | |
| 13 | | 35 | 34 | 33 | 32 | | 33 | 35 | |

| Entry | Name |
|---|---|
| 1 | 11-T-483 |
| 2 | 10-T-789 |
| 3 | 13-T-890 |
| 4 | 16-T-3068 |
| 5 | Tifway |
| 6 | TifTuf |
| 7 | 9Iron |
| 8 | OKC2501 |
| 9 | OKC2502 |
| 10 | OKC2503 |
| 11 | OKC2504 |
| 12 | OKC2505 |
| 13 | OKC2506 |
| 14 | OKC2507 |
| 15 | OKC2508 |
| 16 | OKC2509 |
| 17 | OKC2510 |
| 18 | OKC2511 |
| 19 | OKC2512 |
| 20 | OKC2514 |
| 21 | OKC2515 |
| 22 | OKC2516 |
| 23 | Tahoma 31 |
| 24 | OSU1656 |
| 25 | OSU2081 |
| 26 | OSU1337 |
| 27 | JSC SFDL141 |
| 28 | FB 2824 |
| 29 | UCR 17-8 |
| 30 | Scarlet-1 |
| 31 | MSB-1080 |
| 32 | Florida |
| 33 | Monaco |
| 34 | 2CD-5009 |
| 35 | Rio |

Figure 1. Plot plan for the 2025 National Turfgrass Evaluation Program (NTEP) for bermudagrass. Vegetative entries (above) were established July 3, 2025. Seeded entries (below) were established July 8, 2025. Riverside, CA.

Table 1. Turfgrass quality (TQ) (1-9; 9 = best) and establishment (%) for entries in the 2025 National Turfgrass Evaluation Program (NTEP) for bermudagrass. Vegetative entries were established July 3, 2025. Seeded entries were established July 8, 2025. Riverside, CA.

| Entry No. | Name | Type | Sponsor | TQ (1-9; 9 = best) | | Establishment (%) | |
|---|---|---|---|---|---|---|---|
| | | | | 7/30 | 8/29 | 7/30 | 8/29 |
| 1 | 11-T-483 | Vegetative | University of Georgia | 2.33 de* | 5 a-d | 21.67 fg | 55 e-i |
| 2 | 10-T-789 | Vegetative | University of Georgia | 2.33 de | 5.33 a-c | 21.67 fg | 70 a-e |
| 3 | 13-T-890 | Vegetative | University of Georgia | 3.33 a-c | 4.33 c-f | 23.33 e-g | 48.33 g-i |
| 4 | 16-T-3068 | Vegetative | University of Georgia | 2.67 c-e | 4.67 b-e | 21.67 fg | 50 f-i |
| 5 | Tifway | Vegetative | Standard Entry | 2 e | 4 d-f | 18.33 g | 61.67 c-i |
| 6 | TifTuf | Vegetative | Standard Entry | 3.67 ab | 6 a | 30 c-e | 81.67 ab |
| 7 | 9Iron | Vegetative | Sod by Sherry, Inc. | 4 a | 5.33 a-c | 43.33 a | 85 a |
| 8 | OKC2501 | Vegetative | Oklahoma Ag. Expt. Station | 3 b-d | 4.33 c-f | 31.67 b-d | 68.33 a-f |
| 9 | OKC2502 | Vegetative | Oklahoma Ag. Expt. Station | 3.33 a-c | 5 a-d | 38.33 ab | 68.33 a-f |
| 10 | OKC2503 | Vegetative | Oklahoma Ag. Expt. Station | 2.67 c-e | 3.67 ef | 20 g | 43.33 i |
| 11 | OKC2504 | Vegetative | Oklahoma Ag. Expt. Station | 3 b-d | 4.67 b-e | 23.33 e-g | 58.33 d-i |
| 12 | OKC2505 | Vegetative | Oklahoma Ag. Expt. Station | 3 b-d | 4.33 c-f | 25 d-g | 58.33 d-i |
| 13 | OKC2506 | Vegetative | Oklahoma Ag. Expt. Station | 2.67 c-e | 4.67 b-e | 28.33 c-f | 63.33 b-h |
| 14 | OKC2507 | Vegetative | Oklahoma Ag. Expt. Station | 2.33 de | 4.67 b-e | 21.67 fg | 66.67 a-g |
| 15 | OKC2508 | Vegetative | Oklahoma Ag. Expt. Station | 3.33 a-c | 5.67 ab | 28.33 c-f | 61.67 c-i |
| 16 | OKC2509 | Vegetative | Oklahoma Ag. Expt. Station | 2.67 c-e | 4 d-f | 20 g | 55 e-i |
| 17 | OKC2510 | Vegetative | Oklahoma Ag. Expt. Station | 3.33 a-c | 5.67 ab | 38.33 ab | 76.67 a-d |
| 18 | OKC2511 | Vegetative | Oklahoma Ag. Expt. Station | 4 a | 5.33 a-c | 38.33 ab | 75 a-d |
| 19 | OKC2512 | Vegetative | Oklahoma Ag. Expt. Station | 2.33 de | 4.33 c-f | 21.67 fg | 53.33 e-i |
| 20 | OKC2514 | Vegetative | Oklahoma Ag. Expt. Station | 3 b-d | 4.33 c-f | 25 d-g | 58.33 d-i |
| 21 | OKC2515 | Vegetative | Oklahoma Ag. Expt. Station | 3 b-d | 4.67 b-e | 31.67 b-d | 60 d-i |
| 22 | OKC2516 | Vegetative | Oklahoma Ag. Expt. Station | 3 b-d | 4 d-f | 30 c-e | 61.67 c-i |
| 23 | Tahoma 31 | Vegetative | Standard Entry | 3.67 ab | 5.67 ab | 30 c-e | 66.67 a-g |
| 24 | OSU1656 | Vegetative | Sod Production Services | 2.67 c-e | 3.33 f | 23.33 e-g | 46.67 hi |
| 25 | OSU2081 | Vegetative | Sod Production Services | 2.67 c-e | 5.67 ab | 25 d-g | 66.67 a-g |
| 26 | OSU1337 | Vegetative | Sod Solutions | 4 a | 4.67 b-e | 25 d-g | 60 d-i |
| 27 | JSC SFDL141 | Vegetative | Johnston Seed Company | 2.33 de | 3.67 ef | 21.67 fg | 48.33 g-i |
| 28 | FB 2824 | Vegetative | University of Florida | 3.67 ab | 6 a | 33.33 bc | 80 a-c |
| 29 | UCR 17-8 | Vegetative | UC Riverside | 3 b-d | 5.33 a-c | 21.67 fg | 63.33 b-h |
| 30 | Scarlet-1 | Vegetative | Rutgers University | 2 e | 5.33 a-c | 28.33 c-f | 85 a |
| 31 | MSB-1080 | Vegetative | Mississippi State University | 2.33 de | 4.33 c-f | 23.33 e-g | 43.33 i |
| | | | **p-value** | **0.0001** | **0.0001** | **0** | **0.0003** |
| 32 | Florida | Seeded | Semillas Fito, S. A. | 3.00 | 6.33 | 35.00 | 95.00 |
| 33 | Monaco | Seeded | Standard Entry | 2.33 | 5.33 | 16.67 | 98.33 |
| 34 | 2CD-5009 | Seeded | Barenbrug USA | 3.67 | 5.67 | 30.00 | 98.33 |
| 35 | Rio | Seeded | Mountain View Seeds | 2.33 | 5.67 | 21.67 | 98.33 |
| | | | **p-value** | **0.579** | **0.48** | **0.5194** | **0.8018** |

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

**Stop #8: Postemergence Control of Weeds in Bermudagrass Turf**

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## Introduction:

Common turf weeds observed in bermudagrass lawns include summer annual grasses like smooth crabgrass (*Digitaria ciliaris*), aggressive perennial grasses like kikuyugrass (*Cenchrus clandestinus*), sedges like green Kyllinga (*Kyllinga brevifolia*) and a variety of broadleaf weeds such as spotted spurge (*Euphorbia maculata*), common dandelion (*Taraxacum officinale*), black medic (*Medicago lupulina*), English daisy (*Bellis perennis*), cudweed (*Gnaphalium* spp.) and slender celery (*Cyclospermum leptophyllum*). These species can crowd out desirable turf, reduce aesthetic quality, and even create safety concerns on athletic fields. Selective postemergence herbicides are critical for suppressing these weeds after germination, and numerous commercial products are available that selectively target broadleaf or grassy weeds while remaining safe on bermudagrass.

## Objectives:

The objective of this study was to assess the efficacy and spectrum of multiple postemergence herbicide products or combinations for common turf weeds. Ultimately, the trial aimed to identify practical postemergence herbicide programs that provide effective, broad-spectrum weed control while preserving high-quality bermudagrass turf.

## Materials and Methods:

The study was conducted on mature hybrid bermudagrass (*Cynodon* spp.) 'Bandera' turf established on a Hanford fine sandy loam at the University of California, Riverside. Turf was mowed twice weekly at 0.5 inches and received only 1.0 lb N/1000 $ft^2$ for the season, applied in two applications of 0.5 lb N in May and September.

The experimental area contained a natural infestation of smooth crabgrass, kikuyugrass, green Kyllinga, spotted spurge, common dandelion, black medic, English daisy, black medic, cudweed, and slender celery. Herbicide treatments (Table 1) were applied on July 31, 2025, with a sequential application on August 28, 2025 (28-day interval). Applications were made using a $CO_2$-pressurized backpack sprayer equipped with a 5-ft boom fitted with TeeJet 8002VS nozzles, calibrated to deliver 1 gal/1000 $ft^2$ at 1.5 mph.

The study was arranged as a randomized complete block design with five replications. Individual plots measured 5 × 10 ft with 2-ft alleys separating plots. Plots were visually evaluated every two weeks for percent weed cover and turf injury, both on a 0–100% scale (0 = none, 100 = complete cover or injury). Weed control (%) was calculated using the Henderson-Tilton equation to account for variability in initial crabgrass populations. Treatment differences were analyzed using the Kruskal-Wallis test, and pairwise comparisons were conducted using the Mann–Whitney U-test at $P \leq 0.05$.

## Results:

Bermudagrass injury was minimal (<20%) and short-lived (<14 days), yet greatest from treatments containing Triplet + Velocity PM (data not shown). Dominant weed species throughout the entire study area were slender celery, dandelion, and spotted spurge. One month following initial application of treatments and prior to the second application, the greatest control or suppression of all 10 species collectively was observed with Triplet + Velocity and the same combination with Celero (Fig. 1). GameOn and Q4 Plus provided the next best cumulative control of all species. Cumulative control of 43% in untreated plots reflects the experimental error in visual estimation (0-100% scale) of 10 weed species in each plot at each rating date. Relative efficacy of herbicide treatments in controlling each weed species is estimated in Table 2, based mostly on the initial application of treatments. In time, after the second sequential application of herbicide treatments, we expect that the data and results provided in this report may change.

## Acknowledgments:

We thank Corteva, Syngenta, PBI-Gordon, BASF, and Nufarm for providing products and the California Turfgrass & Landscape Foundation (CTLF) for supporting this research.

**Plot Plan**
**Postemergence Control of Weeds**


| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 9 | 6 | 10 | 3 | 7 | 1 | 2 | 11 | 8 | 4 | 12 |
| 8 | 6 | 7 | 3 | 1 | 5 | 2 | 10 | 4 | 12 | 9 | 11 |
| 6 | 9 | 2 | 12 | 8 | 11 | 3 | 10 | 1 | 7 | 5 | 4 |
| 12 | 1 | 6 | 10 | 3 | 2 | 7 | 9 | 4 | 8 | 5 | 11 |
| 10 | 1 | 6 | 2 | 8 | 5 | 11 | 3 | 12 | 4 | 9 | 7 |

Table 1. Herbicide treatments applied for postemergence weed control in bermudagrass turf. Riverside, CA. 2025.

| No. | Treatment | Active ingredient | Company | Rate | | No. of apps | Freq. (wks) | Timing |
|---|---|---|---|---|---|---|---|---|
| 1 | Untreated Control | - | - | - | - | - | - | - |
| 2 | Sapphire | Penoxsulam | Corteva | 12 | fl oz/A | 2 | 4 | AB |
| | Activator 90 | Non-ionic surfactant | Loveland | 0.5 | % v/v | 2 | 4 | AB |
| 3 | GameOn | Arylex® active + 2,4-D + Choline + Fluroxypyr | Corteva | 48 | fl oz/A | 2 | 4 | AB |
| 4 | Surge | Carfentrazone-ethyl + 2,4-D + Mecoprop-p + Dicamba | PBI Gordon | 64 | fl oz/A | 2 | 4 | AB |
| 5 | SpeedZone Southern | 2,4-D + Dicamba + Sulfentrazone + Penoxsulam | PBI Gordon | 64 | fl oz/A | 2 | 4 | AB |
| 6 | Avenue South | 2,4-D + Dicamba + Penoxsulam + Sulfentrazone | PBI Gordon | 72 | fl oz/A | 2 | 4 | AB |
| 7 | Trimec Southern | 2,4-D + Mecoprop-p + Dicamba | PBI Gordon | 32 | fl oz/A | 2 | 4 | AB |
| 8 | Q4 Plus | Quinclorac + Sulfentrazone + 2,4-D + Dicamba | PBI Gordon | 112 | fl oz/A | 2 | 4 | AB |
| 9 | Tenacity 4SC | Mesotrione | Syngenta | 5 | fl oz/A | 2 | 4 | AB |
| | Monument 75WG | Trifloxysulfuron-sodium | Syngenta | 0.4 | oz/A | | | |
| | Activator 90 | Non-ionic surfactant | - | 0.5 | % v/v | 2 | 4 | AB |
| 10 | Manuscript | Pinoxaden | Syngenta | 42 | fl oz/A | | | |
| | Adigor | Adjuvant | Syngenta | 0.5 | % v/v | | | |
| 11 | Triplet SF | 2,4-D + Mecoprop-p + Dicamba | Nufarm | 4.5 | fl oz/A | 2 | 4 | AB |
| | Celero | Imazosulfuron | Nufarm | 4.5 | fl oz/A | | | |
| | Velocity PM | Bispyribac-sodium | Nufarm | 4.5 | fl oz/A | | | |
| | Activator 90 | Non-ionic surfactant | Loveland | 0.5 | % v/v | | | |
| 12 | Triplet SF | 2,4-D + Mecoprop-p + Dicamba | Nufarm | 4.5 | fl oz/A | 2 | 4 | AB |
| | Velocity PM | Bispyribac-sodium | Nufarm | 4.5 | fl oz/A | | | |
| | Activator 90 | Non-ionic surfactant | Loveland | 0.5 | % v/v | | | |

Application timing:

A – 7/31/2025

B – 8/28/2025

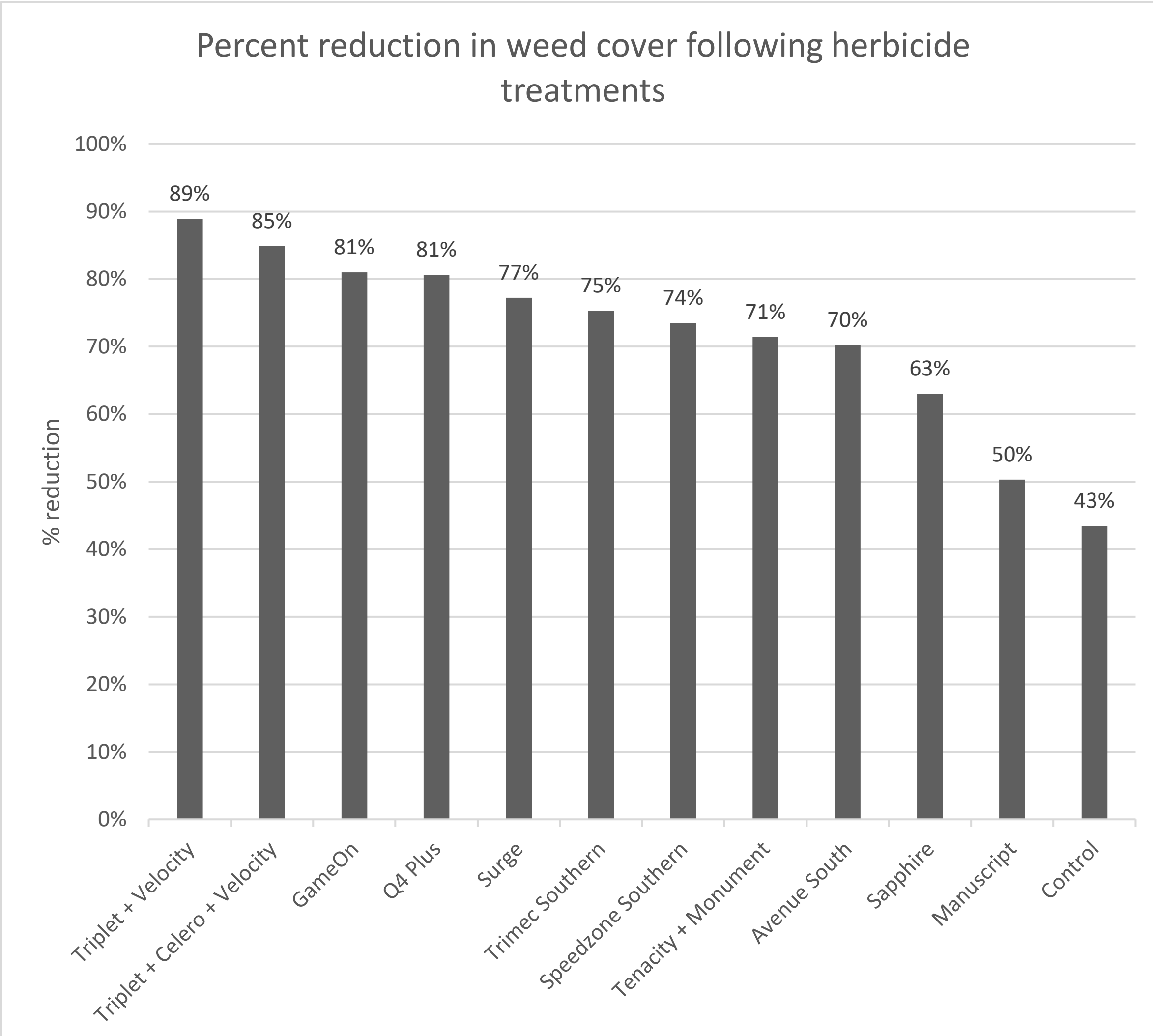


Figure 1. Cumulative percent reduction in cover of all weed species following herbicide treatments, averaged across five replicates, 28 days after initial application. Riverside, CA 2025.

Table 2. Efficacy of herbicides applied for postemergence weed control. Data are based on ratings taken up to 5 days after the second sequential application. Riverside, CA, 2025.

| Weed Species | Sapphire | GameOn | Surge | Speedzone Southern | Avenue South | Trimec Southern | Q4 Plus | Tenacity + Monument | Manuscript | Triplet + Celero + Velocity | Triplet + Velocity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Kikuyugrass** | - | - | + | + | + | + | + | +* | +* | + | + |
| **Crabgrass** | - | - | - | - | - | - | - | + | + | - | - |
| **Kyllinga** | 0 | 0 | NA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **English daisy** | +++ | ++ | +++ | ++ | +++ | + | +++ | + | - | ++ | ++ |
| **Slender Celery** | ++++ | ++++ | ++++ | +++ | ++++ | ++++ | ++++ | ++++ | - | +++ | ++++ |
| **Dandelion** | ++ | ++ | ++ | ++ | ++ | ++ | +++ | +++ | - | +++ | +++ |
| **Spurge** | + | +++ | ++ | +++ | ++ | ++ | +++ | ++ | - | +++ | +++ |
| **Yellow wood sorrel (Oxalis)**** | 0 | 0 | NA | NA | NA | 0 | 0 | NA | 0 | 0 | 0 |
| **Cudweed** | + | + | ++++ | +++ | ++++ | ++++ | ++++ | - | - | ++ | +++ |
| **Black medic**** | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ | NA | ++++ | ++++ |

*Historically, sequential applications of Manuscript (2 in fall) followed by Monument (fall, 2 in spring) have resulted in 100% control of Kikuyugrass.
**Sparse populations in study area.
NA = Weed not present in treated plots.
0 = Weed present in some plots, but initial cover is unknown.
– = No control.
+ = Some injury or suppression, mild or inconsistent effect.
++ = Good suppression, noticeable reduction but not absent.
+++ = Strong suppression, mostly injured or absent.
++++ = Excellent control. Weed absent.

# CIMIS data September. 2024 – Aug. 2025

| 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 2024 | 5.5 K | 0.25 K | 483 K | 15.9 K | 89.9 K | 62 K | 74.2 K | 81 K | 34 K | 58 K | 57 K | 3.5 K | 72.9 K |
| Oct 2024 | 4.5 | 0 K | 397 K | 12.5 K | 86 | 56.6 | 69.6 K | 77 K | 28 K | 51 | 49.5 | 3.4 K | 67.7 K |
| Nov 2024 | 3.1 K | 0.22 K | 307 K | 7.4 K | 71.6 | 45.8 | 58 K | 71 K | 25 K | 46 K | 35.2 K | 3.8 K | 56.8 K |
| Dec 2024 | 2.3 | 0.01 | 247 | 7.8 | 70.7 K | 44.7 | 55.9 K | 77 | 30 | 53 K | 36.9 K | 3 | 53.4 |
| Jan 2025 | 3.2 | 0.36 | 287 | 5.8 | 66.8 | 41.8 | 54 | 65 | 26 | 43 | 27.9 | 4.7 K | 50.3 |
| Feb 2025 | 3.1 | 1.65 | 346 | 9.3 K | 71.9 K | 48 K | 58.7 K | 81 | 36 | 57 K | 41.5 K | 3.7 | 54.9 |
| Mar 2025 | 3.9 | 1.73 | 420 K | 9.9 | 67.9 K | 46.3 | 56.1 | 88 | 43 | 65 | 44 | 3.8 K | 57.9 |
| Apr 2025 | 5 | 0.15 | 505 K | 10.4 | 72.8 | 49.8 | 60.3 | 83 | 38 | 59 | 45.2 | 4.1 | 61.8 |
| May 2025 | 6 | 0.87 | 562 | 13.7 | 79.8 K | 56.3 K | 66.6 K | 86 | 42 | 63 K | 52.9 K | 4.2 | 65.9 |
| Jun 2025 | 7 K | 0.13 | 661 K | 15.7 | 86.7 | 60.1 K | 71.7 K | 86 K | 37 K | 60 K | 56.5 K | 4.3 K | 72.3 |
| Jul 2025 | 7.6 | 0 K | 666 | 16.1 | 88.9 | 60.5 | 73.4 | 85 | 35 | 58 | 57.3 | 4.2 | 72.4 |
| Aug 2025 | 7.4 | 0 | 602 K | 16.8 | 94.4 | 64.8 | 78.2 | 79 | 31 | 51 | 58.4 | 3.9 K | 74.5 |
| Tots/Avgs | 58.5 | 5.4 | 456.9 | 11.8 | 79.0 | 53.1 | 64.7 | 79.9 | 33.8 | 55.3 | 46.9 | 3.88 | 63.4 |

| | |
|---|---|
| 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 17, 2026

See you then!

UC RIVERSIDE
Turfgrass Science