

# MARK M. MAHADY & ASSOCIATES, INC.

*Consultant To The Turfgrass Industry*

## 2020 Product Evaluation for Enhanced Performance of a 328 Bermudagrass Fairway Subject to 40% ET Deficit Irrigation

Prepared For

AquaSmart

Ecologel

Exacto

Intelligro

Ocean Organics

Simplot

The Hi-Lo Golf Course Superintendents Association

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Prepared By

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## **Introduction**

During the summer of 2019, results from a replicated 60% ET (evapotranspiration) deficit irrigation trial on a *Poa annua* fairway at The Links at Spanish Bay golf course in the moderate Mediterranean climate of Pebble Beach, California, revealed the following:

- Untreated *Poa annua* check plots declined rapidly from a very good turfgrass quality rating (7.8) on July 30, 2019, to an unacceptable turfgrass quality rating (5.8) on August 13, 2019, only three weeks after the initiation of the 60% ET deficit irrigation regime.
- In comparison, Treatment 6, the Ocean Organics Program (XP 6 oz/1000 ft<sup>2</sup> or M, Stress Rx 6 oz/1000 ft<sup>2</sup>, Nautilus 6 oz/1000 ft<sup>2</sup> followed by 3.0 oz/1000 ft<sup>2</sup>, and DeSal 0.375 oz/1000 ft<sup>2</sup>), and Treatment 7, the Exacto Program (AquiMax 4 oz/1000 ft<sup>2</sup> followed by Turf Lateral 4 oz/1000 ft<sup>2</sup>) exhibited very good turfgrass quality ratings (7.5 and 7.8, respectively) on July 30, 2019, and were able to maintain acceptable levels of turfgrass quality (6.0) until September 10, 2019, a full seven weeks after the initiation of the 60% ET irrigation regime. Differences were statistically significant.

The results of the 2019 replicated trial on a *Poa annua* fairway at The Links at Spanish Bay, demonstrated that new technological developments in the areas of surfactants, abiotic stress inhibitors, pigments, and polyacrylamide irrigation injection can contribute to the enhanced performance of turfgrasses subject to deficit irrigation.

If real water savings could be verified through replicated field research on warm season grasses, such as bermudagrass, these technologies could represent new agronomic tools to enhance the efficient use of water in golf course settings located in the low desert region of the Coachella Valley.

The objective of this replicated field trial was to evaluate products for enhanced turf quality and rooting when applied as multiple sequential applications at two and four-week intervals from May through September 2020 to a perennial ryegrass overseeded 328 bermudagrass fairway maintained at 80% ET and then transitioned to 40% ET, with the following key question to be answered:

- Will multiple applications of the described products result in dynamic improvement in turf quality and rooting when compared to untreated in-plot checks throughout the deficit irrigation scheduling.

## **Material & Methods**

During March of 2020, Golf Course Superintendent, Tim Putnam selected a flat, fairway area with very good irrigation uniformity on hole #17 at La Quinta Country Club located in La Quinta, California as the site for the 2020 40% ET deficit irrigation field trial (cover page photographs, top right and top left).

This area is characterized as a true inland desert climate with extremely hot summers and warm to moderate winters. Summer temperatures may range from 95-120° F during the day to 70-90° F at night. Winter temperatures range from 65-90° F during the day to 30-50° F at night.

The 328 bermudagrass fairway site had been overseeded with a blend of Pangea and Black Bear perennial ryegrass at a rate of 750 pounds per acre on October 7, 2019 and was in excellent condition. New RainBird Model 700 sprinklers with yellow-black nozzles were installed in April of 2020 at 60-foot spacing and operated at 70 psi. The site was mowed three times per week at a cutting height of 0.400-inches.

The deficit irrigation field plot measured 46' x 65' and was oriented among fairway sprinklers to ensure uniform irrigation across the field trial site (Photograph 1). Treatment plots measured 10' x 10' with 5' x 10' application plots directly adjacent to 5' x 10' in-plot checks (Photograph 2). Side-by-side in-plot checks allow for direct comparison of treated versus untreated areas. This is of critical importance when attempting to identify subtle treatment effects.

**Photographs 1 & 2.** The 40% ET deficit irrigation field plot on the 17<sup>th</sup> fairway at La Quinta Country Club (left) and a 5' x 10' treatment plot (left) adjacent to a 5' x 10' untreated, in-plot check (right). Mark M. Mahady & Associates, Inc. 2020.



A composite soil sample was collected across the deficit irrigation field plot and a soil physical analysis as conducted by Turf and Soil Diagnostics (Linwood, Kansas) revealed a loamy sand textural classification (Photograph 3) consisting of 79.2% sand, 15.2% silt, and 5.6% clay with a corresponding infiltration rate of 0.9 inches per hour.

**Photograph 3.** A soil profile view from the deficit irrigation field plot on the 17<sup>th</sup> fairway at La Quinta Country Club on May 19, 2020. Mark M. Mahady & Associates, Inc.



Table 1 presents the laboratory analysis (AgSource Laboratories, Lincoln, NE) of the water source used to irrigate the deficit irrigation field trial at La Quinta Country Club. The water source utilized throughout the trial consisted of 100% canal water.

**Table 1.** Analysis of the irrigation water applied to the deficit irrigation field trial. La Quinta Country Club, La Quinta, CA. AgSource Laboratories. September 22, 2020. Mark M. Mahady & Associates, Inc.

<b>Analysis</b>	<b>Result</b>	<b>Unit</b>	<b>Lb/Acre Foot</b>
<b>Nitrate Nitrogen, NO3-N</b>	0.84	mg/L	2.30
<b>Chloride, Cl</b>	112.00	mg/L	304.64
<b>Sulfate, SO4</b>	249.09	mg/L	224.18
<b>Bicarbonate, HCO3</b>	138.59	mg/L	376.96
<b>Carbonate, CO3</b>	0.00	mg/L	0.00
<b>Hardness (CaCO3)</b>	277.15	*	*
<b>Total Calcium, Ca</b>	63.02	mg/L	171.41
<b>Total Magnesium, Mg</b>	29.17	mg/L	131.26
<b>Total Potassium, K</b>	4.8	mg/L	15.55
<b>Total Sodium, Na</b>	115.91	mg/L	315.28
<b>Sodium Adsorption Ratio, SAR</b>	5.8	ratio	*
<b>Total Boron, B</b>	0.16	mg/L	0.44
<b>Total Iron, Fe</b>	0.03	mg/L	0.08
<b>Total Manganese, Mn</b>	0.01	mg/L	0.03
<b>Electrical Conductivity, EC</b>	1.04	mmhos/cm	*
<b>Total Soluble Salts</b>	668.16	mg/L	1817.40
<b>pH</b>	8.0	*	*

The canal water is classified as fair quality irrigation water with a medium salinity hazard and medium permeability hazard. Extended use of this water is considered satisfactory for the growth of many plants. Successful bermudagrass growth, as well as successful perennial ryegrass germination and growth, have been achieved with the use of this irrigation source at La Quinta Country Club.

Treatments were replicated four times and positioned in the randomization based on the results of the percent soil volumetric moisture (SVM) ratings generated across all treatments on the day of application one (May 5, 2020). In this way, the average SVM present across all treatments was approximately equal on the day the trial was initiated. On the day of application one, the average SVM across all treatment plots was 30.1%. Following treatment positioning in the randomization, the average SVM in treatment plots ranged from 29.2% to 30.6%. This very small 1.4% difference in soil moisture further verified the uniformity of applied irrigation across the entire field plot.

The perennial ryegrass overseeded bermudagrass was irrigated at 80% ET from May 5 to June 4, 2020. On June 4, 2020, the 40% ET deficit irrigation regime was implemented and continued through bermudagrass transition until September 22, 2020.

A daily deficit irrigation treatment of 40% ET was calculated utilizing the California Irrigation Management Information System (CIMIS) weather station located in La Quinta, California (La Quinta II. A., Station 208). The weather station unit is a Campbell Scientific CR10X that generates hourly ET values and is located 3.1 miles from the field trial site on #17 fairway at La Quinta Country Club. A daily ET replacement schedule was utilized by the La Quinta Country Club maintenance staff. The fairways at La Quinta Country Club are normally irrigated at 80% ET during summer months, so the 40% ET deficit irrigation regime selected for this replicated field trial represented a 50% reduction in normal water use.

The trial was initiated and treatments, as presented in Table 2, were first deployed on perennial ryegrass overseeded bermudagrass on May 5, 2020, with applications and evaluations continuing through the summer and ending on September 22, 2020, a duration of 140 days.

Following standard best management practices for bermudagrass fairways, a 0.75" hollow-tine aeration was conducted across the entire field plot on June 4, 2020, and the field plot received 0.25 pounds of actual nitrogen in the form of granular ammonium sulfate (21-0-0) every two weeks from June 16 to September 8, 2020, to promote speed to cover for the 328 bermudagrass.

**Table 2:** Treatment protocol for the deficit irrigation field trial deployed on #17 fairway at La Quinta Country Club. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc. 2020.

<u>Treatments</u>	<u>Rate</u>	<u>Application Schedule</u>
1) Fertilized Check	Program <sup>1</sup>	*
2) Ocean Organics	Program	Every 2 weeks: May 5 to September 8, 2020
3) AquaSmart	Program	Every 2 weeks: May 5 to September 8, 2020
4) Aquimax	Program	Every 2 weeks: May 5 to September 8, 2020
5) Simplot	Program	Every 2 weeks: May 5 to September 8, 2020
6) Hydretain	9.0 oz fb 3.0 oz/M	Every 4 weeks: May 5 to September 8, 2020
7) Civitas + Zipline	8.5 oz + 3.0 oz/M	Every 2 weeks: May 5 to September 8, 2020
8) Industry Standard Soil Surfactant	6.0 oz fb 3.0 oz/M	Every 2 weeks: May 5 to September 8, 2020

<sup>1</sup> La Quinta Country Club fertility program: no wetting agents or plant growth regulators were applied.

A detailed description of the treatment application process is presented as follows. With the exception of Treatment 6, Hydretain, which was deployed at a 4-week interval, every treatment program was deployed at a 2-week interval from May 5 to September 8, 2020, representing 10 application events over the 140-day field trial.

### **Treatment Description**

**Treatment 1, Untreated Check.** One statistical check plot per replication. One in-plot, non-statistical check adjacent to every treatment plot to further decipher and identify subtle treatment effects.

**Treatment 2, Ocean Organics Program** deployed every 2-weeks. The program deployment consisted of a two-application process. The first application consisted of a tank mixture containing an Ocean Organics soil surfactant (6 oz/1000 ft<sup>2</sup> for the first application and 3.0 oz/1000 ft<sup>2</sup> for the remaining applications) plus DeSal (0.375 oz/1000 ft<sup>2</sup>) immediately followed by an irrigation event. Once the irrigation event was completed another tank mix application was deployed to the Ocean Organic plots consisting of XP 6 oz/1000 ft<sup>2</sup> and Stress Rx 6 oz/1000 ft<sup>2</sup>.

**Treatment 3, AquaSmart Program** deployed every 2-weeks. AquaSmart granular (50 lb/1000 ft<sup>2</sup>) was applied once only on the first application date of May 5, 2020 and was followed immediately by an irrigation event. Future program applications consisted of a 2-week rotation of Tens-O-Max wetting agent 1.0 oz/300 ft<sup>2</sup> (followed by immediate irrigation) and then two weeks later FullMax at 1.0 oz/340 ft<sup>2</sup>.

**Treatment 4, AquiMax Program** deployed every 2-weeks. The program consisted of a 2-week rotation of AquiMax 3 oz/1000 ft<sup>2</sup> (immediate post-application irrigation) followed two weeks later by Turf Lateral 4 oz/1000 ft<sup>2</sup> (immediate post-application irrigation).

**Treatment 5, Simplot Program** deployed every 2-weeks. The program deployment consisted of a two-application process. The first application consisted of a tank mixture containing Forte 0.37 oz/1000 ft<sup>2</sup> plus Brilliance 1.5 oz/1000 ft<sup>2</sup> immediately followed by an irrigation event. Once the irrigation event was completed OneUp at 0.74 oz/1000 ft<sup>2</sup> was deployed.

**Treatment 6, Hydretain** was deployed every 4-weeks. The initial application was deployed at 9.0 oz/1000 ft<sup>2</sup> with subsequent applications deployed at 3.0 oz/1000 ft<sup>2</sup>. All deployments received immediate post-application irrigation.

**Treatment 7, Civitas plus Zipline** tank mixture deployed every 2-weeks. The tank mixture consisted of Civitas at 8.5 oz/1000 ft<sup>2</sup> and Zipline at 3.0 oz/1000 ft<sup>2</sup>.

**Treatment 8, Industry Standard Surfactant** deployed every 2-weeks. The initial application was deployed at 6.0 oz/1000 ft<sup>2</sup> with subsequent applications deployed at 3.0 oz/1000 ft<sup>2</sup>.

All treatments, except for the AquiMax product in Treatment 4, were deployed with a CO<sub>2</sub> propelled small plot spray system pressurized to 28 psi and equipped with four TeeJet 11004 LP nozzles calibrated to deploy treatments at a spray volume of 1.5 gallons/1000 ft<sup>2</sup>. AquiMax was deployed at a spray volume of 24 gallons/1000 ft<sup>2</sup> to simulate an injection treatment. A pacing watch was used for all applications to maintain proper walking speed and ensure accurate applications.

Every daily ET replacement irrigation event was deployed at night and the SVM data collection was conducted at the same time (6:30 am) the following morning through the course of the entire field trial period. In addition, since ET replacement was based on a daily schedule all treatments received irrigation the evening following the morning product application (approximately 18 hours later). When application days occurred and post-application irrigation was required based on product requirements the quantity of water applied for post-application irrigation was subtracted from the nighttime ET replacement event, so that very accurate water application parameters could be maintained.

Evaluations were conducted every two weeks throughout the trial period extending from May 5, 2020, to September 22, 2020. Turfgrass color was rated on a 0-10 scale with 0 representing no green color, 6 minimally acceptable green color, and 10 very dark green color. Turfgrass quality was rated on a 0-10 scale with 0 representing no quality, 6 minimally acceptable quality, and 10 a maximum level of quality. Percent perennial ryegrass and percent bermudagrass cover was visually estimated on a 0-100 scale.

Total turf quality was calculated for each treatment at the end of the trial on September 22, 2020. Total turf quality represents the degree of quality at or above an acceptable standard of 6 on a 0-10 scale as evaluated over the entire length of the trial period. This method identifies the number of times over a specific rating period that turf quality ratings equal or exceed an established standard, in this case, an acceptable base quality rating of 6 on a turf quality scale of 0 to 10. Multiplying this number by the mean turf quality score of those ratings equal to or greater than 6 provides the total turf quality value.

The FieldScout TDR 350 Soil Moisture Meter was used to determine percent soil volumetric moisture (SVM) in each treatment plot. Three readings per plot were collected and averaged to generate SVM data. The W.E.T. Sensor (Dynamax Corporation) was used to determine electrical conductivity (EC) in each treatment plot. Three readings per plot (decisiemens/meter or dS/m) were collected and averaged to generate EC data. The Spectrum Technologies Field Scout TCM 500 NDVI Turf Color Meter generated NDVI (Normalized Difference Vegetative Index) data. Three readings per plot were generated and an average reading was calculated.

Quantitative root analysis via the WinRhizo method was conducted by Dr. William Crow at the University of Florida. Two ¾” diameter turf and soil profile core samples were collected to a depth of six inches from each treatment plot. Each core sample consisting of grass, roots, and soil was placed in a one-quart Ziploc bag. A total of 32 plot samples (8 treatments x 4 replications) were generated on each of the two sampling dates. Bermudagrass root sampling was conducted on June 16, 2020, and at the end of the trial on September 22, 2020. All samples were sent to Dr. William Crow at the University of Florida for analysis via overnight express.

Data were summarized and statistically analyzed. Differences between means were determined via LSD (P=.05 Duncan’s New Mean Separation).

Photographs of key treatment effects were generated during each evaluation.

## Results

### ◆ Treatments Effects: Perennial Ryegrass Quality, Percent Cover and SVM (Table 3)

Table 3 presents data for perennial ryegrass quality, perennial ryegrass percent cover, and percent soil volumetric moisture for the overseeded perennial ryegrass from day of application one on May 5, 2020, to day of application three on June 2, 2020, when subject to an 80% ET irrigation regime.

**Table 3.** The influence of treatment effects on perennial ryegrass quality, percent perennial ryegrass cover, and percent soil volumetric moisture when subject to 80% evapotranspiration irrigation and entering a spring/summer transition on an overseeded 328 bermudagrass fairway over three evaluation dates. Mark M. Mahady & Associates, Inc. 2020.

Treatments	Quality <sup>1</sup>	%Cover <sup>2</sup>	%SVM <sup>3</sup>	Quality	%Cover	%SVM	Quality	%Cover	%SVM
	80% ET DOA1 5/5/20	80% ET DOA2 5/5/20	80% ET DOA3 5/5/20	80% ET DOA1 5/19/20	80% ET DOA2 5/19/20	80% ET DOA3 5/19/20	80% ET DOA1 6/2/20	80% ET DOA2 6/2/20	80% ET DOA3 6/2/20
1) Untreated Check	8.0 a <sup>4</sup>	50.0 a	29.2 a	8.0 a	45.8 a	27.1 a	7.3 ab	26.8 a	27.0 a
2) Ocean Organics	8.0 a	50.0 a	29.8 a	8.0 a	45.5 a	26.8 a	6.8 b	18.5 a	27.6 a
3) AquaSmart	8.0 a	48.8 a	30.2 a	8.0 a	45.0 a	29.2 a	8.0 a	21.8 a	28.2 a
4) Aquimax	8.0 a	50.0 a	30.1 a	8.0 a	47.0 a	27.2 a	7.8 a	18.8 a	29.5 a
5) Simplot	8.0 a	53.8 a	30.8 a	8.0 a	45.8 a	29.2 a	8.0 a	28.3 a	28.9 a
6) Hydretain	8.0 a	46.3 a	30.3 a	8.0 a	43.8 a	28.0 a	7.3 ab	21.0 a	26.7 a
7) Civitas + Zipline	8.0 a	45.0 a	29.6 a	8.0 a	38.5 a	26.9 a	7.5 ab	18.5 a	29.0 a
8) Standard Surfactant	8.0 a	53.8 a	30.5 a	8.0 a	48.3 a	29.1 a	7.3 ab	22.8 a	28.3 a
LSD (P=.05)	0.00	6.19	2.64	0.00	7.26	3.98	0.78	14.98	3.69
Standard Deviation	0.00	4.21	1.75	0.00	4.94	2.71	0.53	10.18	2.51
CV	0.00	8.47	5.97	0.00	10.99	9.69	7.10	45.71	8.92

<sup>1</sup> Turfgrass quality: 0-10 scale with 0 representing no quality, 6 a minimum level of acceptable quality, and 10 the best quality.

<sup>2</sup> Percent perennial ryegrass cover visually estimated 0-100%.

<sup>3</sup> Percent soil volumetric moisture: an average of three readings per plot as measured with the FieldScout TDR 350 Soil Moisture Meter.

<sup>4</sup> Means followed by the same letter do not differ significantly (P=.05, Duncan’s New Mean Separation).

During this natural perennial ryegrass transition period, no visually dramatic or statistically significant effects were observed associated with turfgrass quality, percent cover, or percent soil volumetric moisture.

The perennial ryegrass in the untreated check plots transitioned naturally from 50% cover on May 5 to 26.8% cover on June 2, 2020, representing a reduction of 46.4% in perennial ryegrass cover. The remaining treatments (shown below) exhibited similar and statistically non-significant trends in the reduction of percent perennial ryegrass cover during this time frame.

- Treatment 1, Untreated Check: 46.4% reduction in perennial ryegrass cover
- Treatment 2, Ocean Organics: 63.0% reduction in perennial ryegrass cover
- Treatment 3, AquaSmart: 55.3% reduction in perennial ryegrass cover
- Treatment 4, Aquimax: 62.4% reduction in perennial ryegrass cover
- Treatment 5, Simplot: 47.4% reduction in perennial ryegrass cover
- Treatment 6, Hydretain: 54.6% reduction in perennial ryegrass cover
- Treatment 7, Civitas plus Zipline: 58.9% reduction in perennial ryegrass cover
- Treatment 8, Standard Surfactant: 57.6% reduction in perennial ryegrass cover

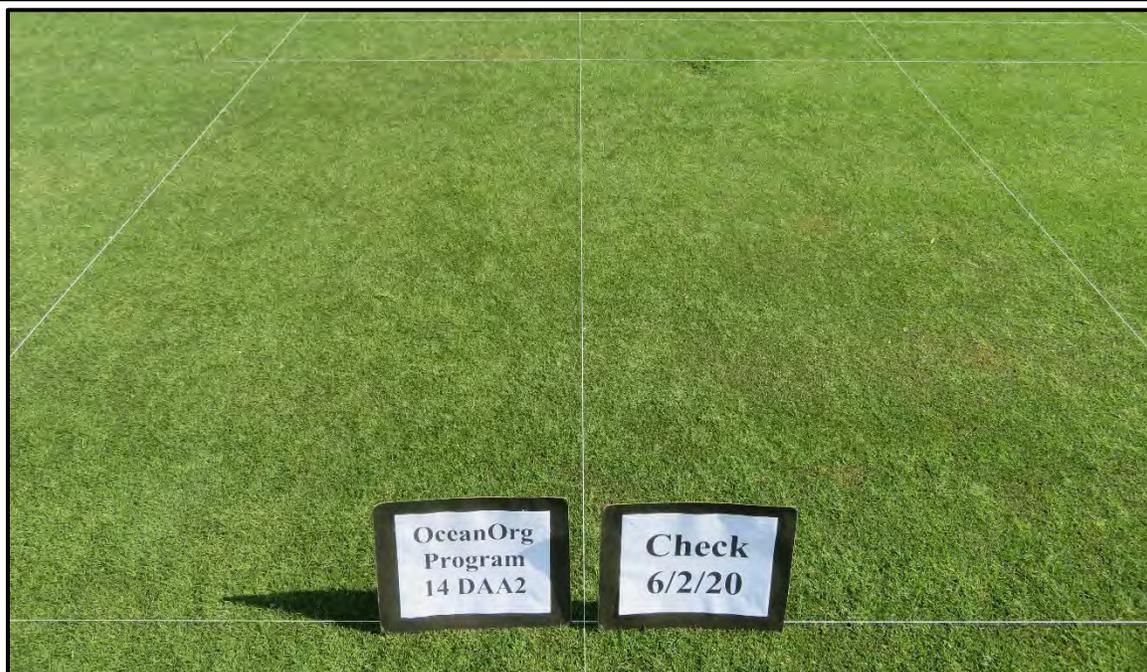
The take-home message is that none of the treatments evaluated during this time frame slowed or increased the natural speed of perennial ryegrass transition. Nor did specific treatments dynamically influence perennial ryegrass quality when compared to the untreated check.

In addition, very uniform percent soil volumetric moisture readings were generated across all treatments during the three evaluation events with small differences in maximum and minimum soil moisture levels.

- 5/5/20: maximum SVM 30.8%, minimum SVM 29.2%, SVM range 1.6%
- 5/19/20: maximum SVM 29.2%, minimum SVM 27.1%, SVM range 2.1%
- 6/2/20: maximum SVM 29.0%, minimum SVM 26.7%, SVM range 2.3%

These small ranges in maximum and minimum levels of percent soil volumetric moisture across three evaluation dates further verified the uniformity of applied irrigation across the entire field plot.

**Photograph 4.** Treatment 2, Ocean Organics Program (left) versus an Untreated Check (right) 14 days after application two (DAA2) on June 2, 2020. La Quinta Country Club. Mark M. Mahady & Associates, Inc.



**Photograph 5.** Treatment 3, AquaSmart Program (left) versus an Untreated Check (right) 14 DAA2 on June 2, 2020. La Quinta Country Club. Mark M. Mahady & Associates, Inc.



**Photograph 6.** Treatment 4, AquiMax Program (left) versus an Untreated Check (right) 14 DAA2 on June 2, 2020. La Quinta Country Club. Mark M. Mahady & Associates, Inc.



**Photograph 7.** Treatment 5, Simplot Program (left) versus an Untreated Check (right) 14 days DAA2 on June 2, 2020. La Quinta Country Club. Mark M. Mahady & Associates, Inc.



**Photograph 8.** Treatment 6, Hydretain (left) versus an Untreated Check (right) 28 DAA1 on June 2, 2020. La Quinta Country Club. Mark M. Mahady & Associates, Inc.



**Photograph 9.** Treatment 7, Civitas plus Zipline (left) versus an Untreated Check (right) 14 days DAA2 on June 2, 2020. La Quinta Country Club. Mark M. Mahady & Associates, Inc.



**Photograph 10.** Treatment 8, Industry Standard Surfactant (right) versus an Untreated Check (left) 14 days DAA2 on June 2, 2020. La Quinta Country Club. Mark M. Mahady & Associates, Inc.



◆ **Treatments Effects and Bermudagrass Color at 40% ET (Table 4)**

The 40% deficit irrigation regime was initiated on June 4, 2020, and a daily irrigation replacement schedule was implemented. Table 4 presents 328 bermudagrass color data for all treatments extending from June 16 to September 22, 2020.

Treatment 7, Civitas plus Zipline exhibited extended and enhanced turfgrass color when compared to the untreated check (**blue highlights**) on 8 of 8 evaluation dates. Differences were statistically significant when compared to the untreated check on July 28, 2020, 14 DAA6, and August 8, 2020, 14 DAA7.

Treatment 6, Hydretain exhibited extended and enhanced turfgrass color when compared to the untreated check (**blue highlights**) on 8 of 8 evaluation dates. Differences were not statistically significant when compared to the untreated check.

Treatment 7, Civitas plus Zipline, and Treatment 6, Hydretain ranked #1 and #2 respectively, for average turf color from June 16 to September 22, 2020 (**red highlights**) when compared to all treatments.

**Table 4.** Treatment effects and bermudagrass color from June 16 to September 22, 2020. La Quinta Country Club. La Quinta, CA. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.

Treatments	Deficit Irrigation Initiated on 6/4/20									Ave. Color 6/16 to 9/22/20	Color Ranking 1-8 1 is Best
	Bermuda Color <sup>1</sup> 14DAA3 6/16/20	Bermuda Color 14DAA4 6/30/20	Bermuda Color 14DAA5 7/14/20	Bermuda Color 14DAA6 7/28/20	Bermuda Color 14DAA7 8/11/20	Bermuda Color 14DAA8 8/25/20	Bermuda Color 14DAA9 9/8/20	Bermuda Color 14DAA10 9/22/20			
1) Check	4.3 a <sup>4</sup>	4.0 a	4.8 a	5.0 b	5.5 bc	5.8 a	5.8 a	6.0 a	5.15	8	
2) Ocean Organics	4.8 a	4.5 a	4.3 a	5.0 b	5.5 bc	6.0 a	6.0 a	6.3 a	5.30	5 (tie)	
3) AquaSmart	4.5 a	4.3 a	5.3 a	5.0 b	5.5 bc	6.0 a	6.0 a	6.3 a	5.37	4	
4) AquilMax	4.8 a	4.3 a	4.5 a	5.0 b	5.5 bc	6.0 a	6.0 a	6.3 a	5.30	5 (tie)	
5) Simplot	4.5 a	4.3 a	5.0 a	5.0 b	5.3 c	6.0 a	6.0 a	6.0 a	5.26	7	
6) Hydretain	<b>5.3 a<sup>2</sup></b>	4.8 a	5.5 a	6.0 ab	6.5 ab	<b>7.0 a</b>	<b>6.8 a</b>	<b>7.0 a</b>	6.11	<b>2</b>	
7) Civitas + Zipline	<b>5.3 a</b>	<b>5.0 a</b>	<b>5.8 a</b>	<b>6.8 a</b>	<b>7.0 a</b>	<b>7.0 a</b>	<b>6.8 a</b>	6.8 a	6.31	<b>1<sup>3</sup></b>	
8) Standard Surfactant	4.0 a	4.0 a	5.0 a	5.5 ab	5.5 bc	6.5 a	6.3 a	6.3 a	5.39	3	
LSD (P=.05)	0.89	1.25	1.27	1.20	1.08	0.96	1.08	1.05			
Standard Deviation	0.60	0.85	0.87	0.81	0.74	0.65	0.74	0.71			
CV	12.97	19.48	17.32	15.05	12.75	10.37	11.89	11.23			

<sup>1</sup> Bermudagrass color: 0-10 scale with 0 representing no green color, 6 a minimum level of acceptable color, and 10 very dark green color.  
<sup>2</sup> **Blue highlights** represent the highest color ratings per evaluation event.  
<sup>3</sup> **Red highlights** represent the highest average color rankings over the period from June 16 to September 22, 2020.  
<sup>4</sup> Means followed by the same letter do not differ significantly (P=0.05, Duncan's New Mean Separation).

◆ **Treatments Effects and Bermudagrass Quality at 40% ET (Table 5, Figure 1)**

Table 5 presents 328 bermudagrass quality data for all treatments extending from June 16 to September 22, 2020.

No statistically significant effects were observed between treatments and the untreated check relative to 328 bermudagrass quality from June 16 to September 22, 2020, although strong positive trends for enhancement in bermudagrass quality (**blue highlights** in Table 5) were observed.

Treatment 7, Civitas plus Zipline exhibited higher levels of 328 bermudagrass quality when compared to the untreated check (**blue highlights**) on 8 of 8 evaluation dates. Acceptable levels of turfgrass quality (≥ 6.0) were observed on 3 of 8 evaluation dates 14 DAA8, 14 DAA9, and 14 DAA10.

Treatment 6, Hydretain exhibited higher levels of 328 bermudagrass quality when compared to the untreated check (**blue highlights**) on 8 of 8 evaluation dates. Acceptable levels of turfgrass quality ( $\geq 6.0$ ) were observed on 3 of 8 evaluation dates 14 DAA8, 14 DAA9, and 14 DAA10. Treatment 7, Civitas plus Zipline (5.69), and Treatment 6, Hydretain (5.59) ranked #1 and #2 respectively, for average turf quality from June 16 to September 22, 2020, (**red highlights**) when compared to all treatments.

**Table 5.** Treatment effects and bermudagrass quality from June 16 to September 22, 2020. La Quinta Country Club. La Quinta, CA. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.

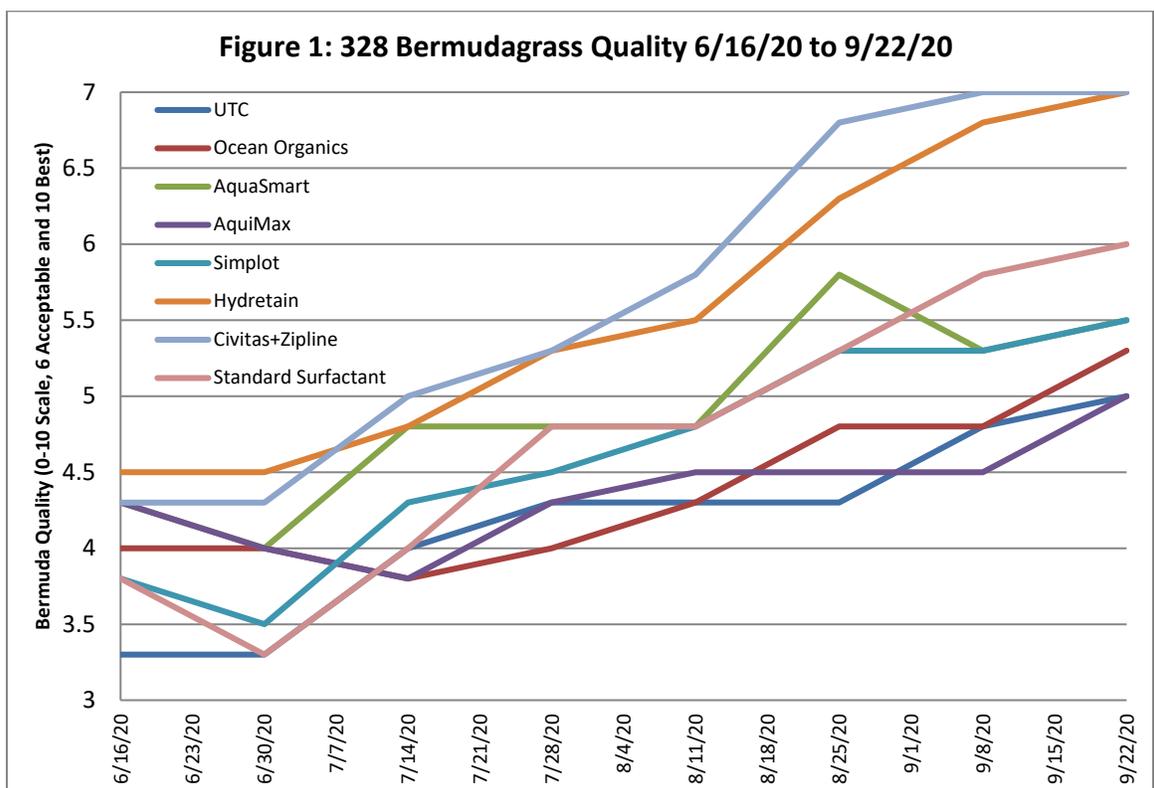
Deficit Irrigation Initiated on 6/4/20										
Treatments	Bermuda Quality <sup>1</sup> 14DAA3 6/16/20	Bermuda Quality 14DAA4 6/30/20	Bermuda Quality 14DAA5 7/14/20	Bermuda Quality 14DAA6 7/28/20	Bermuda Quality 14DAA7 8/11/20	Bermuda Quality 14DAA8 8/25/20	Bermuda Quality 14DAA9 9/8/20	Bermuda Quality 14DAA10 9/22/20	Ave. Quality 6/16 to 9/22/20	Quality Ranking 1-8 1 is Best
1) Check	3.3 a <sup>4</sup>	3.3 a	4.0 a	4.3 a	4.3 a	4.3 a	4.8 a	5.0 a	4.16	8
2) Ocean Organics	4.0 a	4.0 a	3.8 a	4.0 a	4.3 a	4.8 a	4.8 a	5.3 a	4.38	6
3) AquaSmart	4.3 a	4.0 a	4.8 a	4.8 a	4.8 a	5.8 a	5.3 a	5.5 a	4.91	3
4) Aquimax	4.3 a	4.0 a	3.8 a	4.3 a	4.5 a	4.5 a	4.5 a	5.0 a	4.36	7
5) Simplot	3.8 a	3.5 a	4.3 a	4.5 a	4.8 a	5.3 a	5.3 a	5.5 a	4.63	5
6) Hydretain	<b>4.5 a<sup>2</sup></b>	<b>4.5 a</b>	4.8 a	<b>5.3 a</b>	5.5 a	6.3 a	6.8 a	<b>7.0 a</b>	5.59	<b>2</b>
7) Civitas + Zipline	4.3 a	4.3 a	<b>5.0 a</b>	<b>5.3 a</b>	<b>5.8 a</b>	<b>6.8 a</b>	<b>7.0 a</b>	<b>7.0 a</b>	5.69	<b>1<sup>3</sup></b>
8) Standard Surfactant	3.8 a	3.3 a	4.0 a	4.8 a	4.8 a	5.3 a	5.8 a	6.0 a	4.73	4
LSD (P=.05)	1.27	0.98	1.27	1.33	1.60	2.32	2.47	2.79		
Standard Deviation	0.87	0.67	0.86	0.91	1.09	1.58	1.68	1.89		
CV	21.65	17.41	20.17	19.60	22.62	29.49	30.54	32.78		

<sup>1</sup> Bermudagrass quality: 0-10 scale with 0 representing no quality, 6 a minimum level of acceptable quality, and 10 the best quality.

<sup>2</sup> **Blue highlights** represent the highest quality ratings per evaluation event.

<sup>3</sup> **Red highlights** represent the highest average quality rankings over the period from June 16 to September 22, 2020.

<sup>4</sup> Means followed by the same letter do not differ significantly (P=0.05, Duncan's New Mean Separation).



**Photograph 11.** The deficit irrigation field plot located on #17 fairway at La Quinta Country Club on May 5, 2020 minutes after the first application of described treatments. This site consisted of 328 bermudagrass overseeded with perennial ryegrass. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



**Photograph 12.** The deficit irrigation field plot located on #17 fairway at La Quinta Country Club on June 30, 2020, 14 DAA4 and 26 days after the initiation of the 40% ET deficit irrigation regime. The perennial ryegrass has transitioned completely from the turf stand and only 328 bermudagrass remains. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



**Photograph 13.** The Ocean Organics Program 14 DAA4 (left) versus an untreated check (right) 26 days after the initiation of the 40% ET deficit irrigation regime on June 30, 2020. The perennial ryegrass has transitioned completely from the stand and only 328 bermudagrass remains. Note slight enhancement in color and quality with the Ocean Organics Program versus the untreated check. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



**Photograph 14.** The AquaSmart Program 14 DAA4 (left) versus an untreated check (right) on June 30, 2020, 26 days after the initiation of the 40% ET deficit irrigation regime on June 30, 2020. The perennial ryegrass has transitioned completely from the stand and only 328 bermudagrass remains. No difference in color and quality when comparing the AquaSmart Program to the untreated check. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



**Photograph 15.** The Aquimax Program 14 DAA4 (left) versus an untreated check (right) on June 30, 2020, 26 days after the initiation of the 40% ET deficit irrigation regime. The perennial ryegrass has transitioned completely from the stand and only 328 bermudagrass remains. No difference in color and quality when comparing the Aquimax Program to the untreated check. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



**Photograph 16.** The Hydretain treatment 28 DAA2 (left) versus an untreated check (right) on June 30, 2020, 26 days after the initiation of the 40% ET deficit irrigation regime. The perennial ryegrass has transitioned completely from the stand and only 328 bermudagrass remains. Note enhancement in color and quality with the Hydretain treatment versus the untreated check. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



**Photograph 17.** The Civitas plus Zipline treatment 14 DAA4 (left) versus an untreated check (right) on June 30, 2020, 26 days after the initiation of the 40% ET deficit irrigation regime. The perennial ryegrass has transitioned completely from the stand and only 328 bermudagrass remains. Note the enhancement in color and quality with the Civitas plus Zipline treatment versus the untreated check. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



**Photograph 18.** The Industry Standard Surfactant 14 DAA4 (left) versus an untreated check (right) on June 30, 2020, 26 days after the initiation of the 40% ET deficit irrigation regime. The perennial ryegrass has transitioned completely from the stand and only 328 bermudagrass remains. No difference in color and quality when comparing the Industry Standard Surfactant to the untreated check. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



◆ **Treatments Effects and Total Turf Quality at 40%ET (Table 6)**

Table 6 presents 328 bermudagrass quality data as generated from the period from June 16, 2020, (12 days after the initiation of the 40% ET irrigation regime) to September 22, 2020 (110 days after the initiation of the 40% ET irrigation regime).

Total Turf Quality presented in the last column in Table 6, represents the degree of quality at or above an acceptable standard of 6 on a 0-10 scale as evaluated over the length of the trial period.

This method identifies the number of times over a specific rating period that turf quality ratings equal or exceed an established standard, in this case, an acceptable base quality rating ≥ 6 on a turf quality scale of 0 to 10. Multiplying this number by the mean turf quality score of those ratings greater than or equal to 6 provides the Total Turf Quality value.

**Table 6.** The influence of treatment effects on 328 bermudagrass Total Turf Quality from June 16 to September 22, 2020. La Quinta Country Club. La Quinta, CA. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.

Deficit Irrigation Initiated on 6/4/19										
Treatments	Bermuda Quality <sup>1</sup> 14DAA3 6/16/20	Bermuda Quality 14DAA4 6/30/20	Bermuda Quality 14DAA5 7/14/20	Bermuda Quality 14DAA6 7/28/20	Bermuda Quality 14DAA7 8/11/20	Bermuda Quality 14DAA8 8/25/20	Bermuda Quality 14DAA9 9/8/20	Bermuda Quality 14DAA10 9/22/20	Total Turf Quality <sup>3</sup> 6/16 to 9/22/20	Total Turf Quality Ranking 1-8 1 is Best
1) Check	3.3 a <sup>4</sup>	3.3 a	4.0 a	4.3 a	4.3 a	4.3 a	4.8 a	5.0 a	0.00	4 (tie)
2) Ocean Organics	4.0 a	4.0 a	3.8 a	4.0 a	4.3 a	4.8 a	4.8 a	5.3 a	0.00	4 (tie)
3) AquaSmart	4.3 a	4.0 a	4.8 a	4.8 a	4.8 a	5.8 a	5.3 a	5.5 a	0.00	4 (tie)
4) AquilMax	4.3 a	4.0 a	3.8 a	4.3 a	4.5 a	4.5 a	4.5 a	5.0 a	0.00	4 (tie)
5) Simplot	3.8 a	3.5 a	4.3 a	4.5 a	4.8 a	5.3 a	5.3 a	5.5 a	0.00	4 (tie)
6) Hydretain	4.5 a	4.5 a	4.8 a	5.3 a	5.5 a	6.3 a <sup>2</sup>	6.8 a	7.0 a	20.1	2
7) Civitas + Zipline	4.3 a	4.3 a	5.0 a	5.3 a	5.8 a	6.8 a	7.0 a	7.0 a	20.8	1 <sup>3</sup>
8) Standard Surfactant	3.8 a	3.3 a	4.0 a	4.8 b	4.8 a	5.3 a	5.8 a	6.0 a	6.0	3
LSD (P=.05)	1.27	0.98	1.27	1.33	1.60	2.32	2.47	2.79		
Standard Deviation	0.87	0.67	0.86	0.91	1.09	1.58	1.68	1.89		
CV	21.65	17.41	20.17	19.60	22.62	29.49	30.54	32.78		

<sup>1</sup> Bermudagrass quality: 0-10 scale with 0 representing no quality, 6 a minimum level of acceptable quality, and 10 the best quality.  
<sup>2</sup> Blue highlights represent the quality ratings ≥ 6.0 per evaluation event.  
<sup>3</sup> Red highlights represent the three highest Total Turf Quality rankings over the period from June 16 to September 22, 2020, which identifies the best-performing treatments over the entire trial period. Total Turf Quality represents the degree of quality over time. This method identifies the number of times over a specific rating period that turf quality ratings equal or exceed an established standard, in this case, an acceptable base quality rating of 6 on a turf quality scale of 0 to 10. Multiplying this number by the mean turf quality score of those ratings greater than or equal to 6 provides the Total Turf Quality value.  
<sup>4</sup> Means followed by the same letter do not differ significantly (P=0.05, Duncan's New Mean Separation).

**Table 6: Key Data Perspectives of Total Turf Quality**

1. Treatment 7, Civitas plus Zipline generated a Total Turf Quality rating of 20.8 and ranked #1 of 8 treatments.
2. Treatment 6, Hydretain generated a Total Turf Quality rating of 20.1 and ranked #2 of 8 treatments.
3. Treatment 8, Standard Surfactant generated a Total Turf Quality rating of 6.0 and ranked #3 of 8 treatments.
4. These data show that multiple applications of Treatment 7, Civitas plus Zipline, and Treatment 6, Hydretain resulted in acceptable levels of turf quality on 328 bermudagrass maintained in a fairway setting as soon as 82 days after perennial ryegrass transition and the initiation of a 40% ET deficit irrigation regime.

◆ **Treatments Effects and Bermudagrass Percent Cover at 40% ET (Figure 2 and Table 7)**

Figure 2 and Table 7 present the percent cover of 328 bermudagrass for all treatments extending from the beginning of spring bermudagrass transition on June 16, 2020, to September 22, 2020.

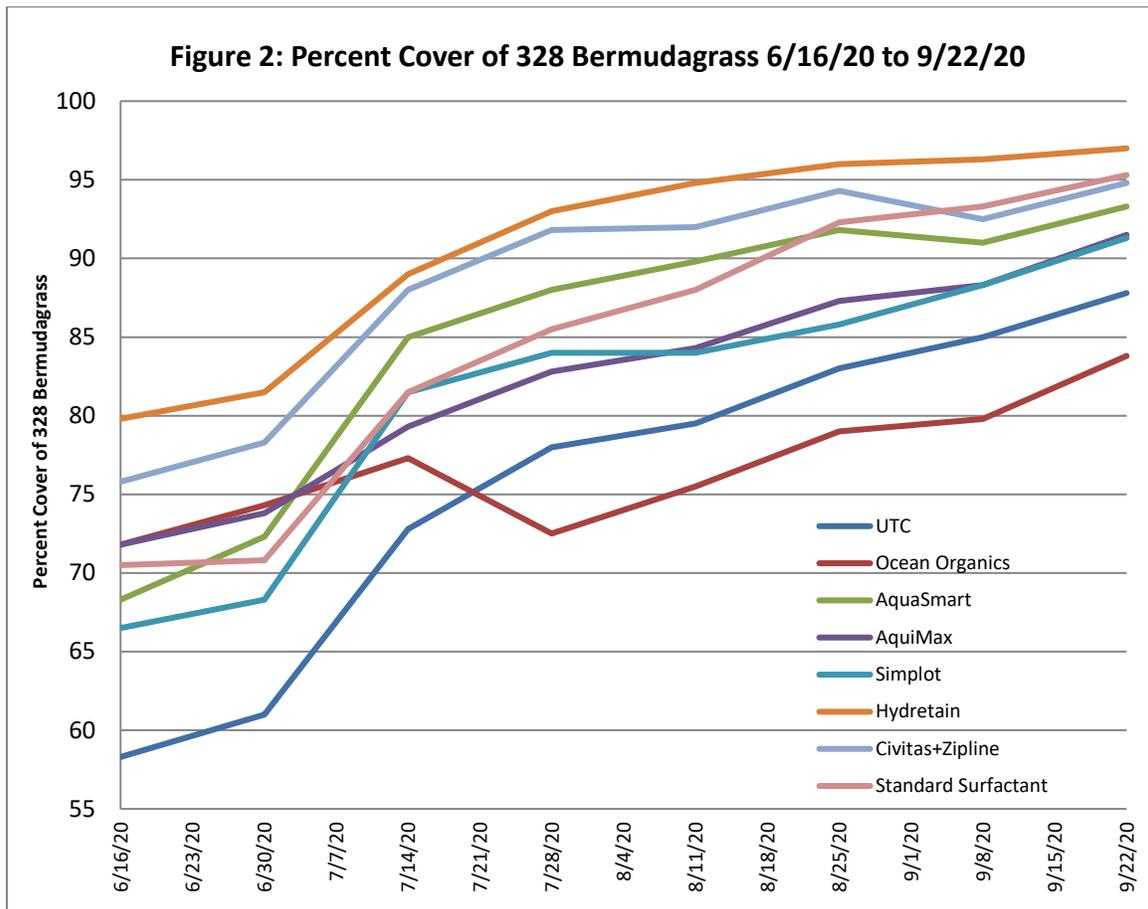
The 40% ET deficit irrigation regime was initiated on June 4, 2020, and all of the overseeded perennial ryegrass had dissipated in the turfgrass stand by June 16, 2020, so only 328 bermudagrass remained in the field plot.

No statistically significant effects were observed between treatments and the untreated check relative to the percent cover of 328 bermudagrass from June 16 to September 22, 2020, although positive treatment trends for enhancement in bermudagrass percent cover (blue highlights in Table 7) were observed.

Treatment 6, Hydretain exhibited the most consistent positive trend and the highest levels of 328 bermudagrass cover of all treatments during all eight evaluation dates when compared to the untreated check (blue highlights in Table 7 and Figure 2).

Treatment 7, Civitas plus Zipline exhibited higher levels of 328 bermudagrass cover when compared to the untreated check (blue highlights in Table 7 and Figure 2) on 8 of 8 evaluation dates.

Treatment 6, Hydretain and Treatment 7, Civitas plus Zipline ranked #1 and #2 respectively, for enhancement in speed to cover of transitioning 328 bermudagrass from June 16 to September 22, 2020, when compared to all treatments.



**Table 7.** The influence of treatments on percent cover of 328 bermudagrass from June 16 to September 22, 2020. La Quinta Country Club. La Quinta, CA. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.

Deficit Irrigation Initiated on 6/4/20								
Treatments	Bermuda %Cover <sup>1</sup>	Bermuda %Cover						
	14DAA3 6/16/20	14DAA4 6/30/20	14DAA5 7/14/20	14DAA6 7/28/20	14DAA7 8/11/20	14DAA8 8/25/20	14DAA9 9/8/20	14DAA10 9/22/20
1) Check	58.3 a <sup>3</sup>	61.0 a	72.8 a	78.0 a	79.5 a	83.0 a	85.0 a	87.8 a
2) Ocean Organics	71.8 a	74.3 a	77.3 a	72.5 a	75.5 a	79.0 a	79.8 a	83.8 a
3) AquaSmart	68.3 a	72.3 a	85.0 a	88.0 a	89.8 a	91.8 a	91.0 a	93.3 a
4) Aquimax	71.8 a	73.8 a	79.3 a	82.8 a	84.3 a	87.3 a	88.3 a	91.5 a
5) Simplot	66.5 a	68.3 a	81.5 a	84.0 a	84.0 a	85.8 a	88.3 a	91.3 a
6) Hydretain	79.8 a <sup>2</sup>	81.5 a	89.0 a	93.0 a	94.8 a	96.0 a	96.3 a	97.0 a
7) Civitas + Zipline	75.8 a	78.3 a	88.0 a	91.8 a	92.0 a	94.3 a	92.5 a	94.8 a
8) Standard Surfactant	70.5 a	70.8 a	81.5 a	85.5 a	88.0 a	92.3 a	93.3 a	95.3 a
LSD (P=.05)	20.86	19.60	16.97	16.63	16.23	14.82	14.91	13.29
Standard Deviation	14.18	13.33	11.54	11.31	11.03	10.07	10.14	9.04
CV	20.17	18.39	14.11	13.39	12.83	11.36	11.35	9.84

<sup>1</sup> Bermudagrass percent cover: visually estimated 0-100% scale.  
<sup>2</sup> **Blue highlights** represent the two highest percent cover ratings per evaluation event.  
<sup>3</sup> Means followed by the same letter do not differ significantly (P=0.05, Duncan's New Mean Separation).

#### ◆ **Treatments Effects and Bermudagrass Root Length and Surface Area at 40% ET (Table 8)**

Table 8 presents root length (cm) and root surface area (cm<sup>2</sup>) data for all treatments as generated through WinRhizo root analysis on June 16, 2020, and September 22, 2020.

No statistically significant treatment effects were observed during the designated sampling dates, although trends for enhancement in 328 bermudagrass root length and root surface area (**blue highlights** Table 8) were observed.

Treatment 4, Aquimax exhibited an 18% increase in root length when compared to the untreated check during the September 22, 2020 sampling date. In addition, Aquimax showed a 16.8% increase in root length from the June 16, 2020, to the September 22, 2020 sampling events while the untreated check revealed a 23.1% reduction in root length during the same time period.

Treatment 4, Aquimax also exhibited a 27.6% increase in root surface area when compared to the untreated check during the September 22, 2020 sampling date. In addition, Aquimax showed a 45.9% increase in root surface area from the June 16, 2020, to the September 22, 2020 sampling events while the untreated check revealed a 13.4% reduction in root surface area during the same time period.

Treatment 8, Standard Surfactant showed a 26.8% increase in root surface area from the June 16, 2020 to the September 22, 2020 sampling while the untreated check revealed a 13.4% reduction in root surface area during the same time period.

Treatment 6, Hydretain showed a 16.9% increase in root surface area from the June 16, 2020, to the September 22, 2020 sampling events while the untreated check revealed a 13.4% reduction in root surface area during the same time period.

Although Treatment 8, Civitas plus Zipline showed a 25.2% reduction in root length and a 16.0% reduction in root surface area from the June 16, 2020, to the September 22, 2020 sampling events, it is hypothesized that the Civitas plus Zipline treatment which showed the highest turf quality ratings of all treatments throughout the evaluation period, may have produced enhanced color and quality foliage at the expense of root length and root surface area during periods of induced stress from the 40% ET deficit irrigation regime.

**Table 8.** The influence of treatment effects on 328 bermudagrass root length (cm) and root surface area (cm<sup>2</sup>) on June 16, 2020, and September 22, 2020. La Quinta Country Club. La Quinta, CA. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.

Treatments	Root Length (cm) <sup>1</sup>	Root Length (cm)	% Δ in Root Length (cm)	Root Surf Area (cm <sup>2</sup> ) <sup>2</sup>	Root Surf Area (cm <sup>2</sup> )	% Δ in Root Surf Area (cm <sup>2</sup> )
	14DAA3 6/16/20	14DAA10 9/22/20	6/16/20 to 9/22/20	14DAA3 9/10/19	14DAA10 9/10/19	6/16/20 to 9/22/20
1) Check	170.9 a <sup>4</sup> ***	131.4 a (100.0%) <sup>3</sup>	-23.1% ***	11.2 a ***	9.7 a (100.0%) <sup>3</sup>	-13.4% ***
2) Ocean Organics	130.2 a ***	112.3 a (85.4%)	-13.7% ***	8.0 a ***	7.5 a (77.1%)	-6.3% ***
3) AquaSmart	169.3 a ***	150.7 a (114.7%)	-11.0% ***	10.1 a ***	11.1 a (114.2%)	+9.9% ***
4) AquilMax	132.7 a ***	155.0 a (118.0%)	+16.8% ***	8.5 a ***	12.4 a (127.6%)	+45.9% ***
5) Simplot	165.0 a ***	97.8 a (74.4%)	-40.7% ***	9.6 a ***	7.4 a (76.5%)	-22.9% ***
6) Hydretain	143.9 a ***	137.6 a (104.7%)	-4.4% ***	8.9 a ***	10.4 a (107.2%)	+16.9% ***
7) Civitas + Zipline	182.6 a ***	136.5 a (103.9%)	-25.2% ***	11.9 a ***	10.0 a (103.1%)	-16.0% ***
8) Standard Surfactant	114.6 a ***	116.8 a (88.9%)	+1.9% ***	7.1 a ***	9.0 a (93.0%)	+26.8% ***
LSD (P=.05)	52.80	45.13	***	3.43	3.67	***
Standard Deviation	35.90	30.68	***	2.33	2.49	***
CV	23.76	23.65	***	24.81	25.74	***

<sup>1</sup> Root length (cm) as determined through the WinRhizo root analysis.

<sup>2</sup> Root surface area (cm<sup>2</sup>) as determined through the WinRhizo root analysis.

<sup>3</sup> Control represents 100% in comparison to treatment effects.

<sup>4</sup> Means followed by the same letter do not differ significantly (P=0.05, Duncan's New Mean Separation).

**◆ Treatments Effects and Percent Soil Volumetric Moisture at 40% ET (Table 9)**

Table 9 presents percent soil volumetric moisture (SVM) data for all treatments extending from June 2, 2020, to September 8, 2020. The 40% ET deficit irrigation regime was initiated on June 4, 2020.

**Table 9.** The influence of treatment effects on percent soil volumetric moisture or %SVM at a 40% ET deficit irrigation regime from June 16 to September 8, 2020. La Quinta Country Club. La Quinta, CA. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.

Treatments	Deficit Irrigation Initiated on 6/4/20							
	Bermuda %SVM <sup>1</sup> 14DAA2 6/2/20	Bermuda %SVM 14DAA3 6/16/20	Bermuda %SVM 14DAA4 6/30/20	Bermuda %SVM 14DAA5 7/14/20	Bermuda %SVM 14DAA6 7/28/20	Bermuda %SVM 14DAA7 8/11/20	Bermuda %SVM 14DAA8 8/25/20	Bermuda %SVM 14DAA9 9/8/20
1) Check	27.0 a <sup>2</sup>	9.7 a	8.9 a	11.9 a	8.7 a	7.5 a	10.3 a	11.3 a
2) Ocean Organics	27.6 a	9.2 a	9.3 a	10.1 a	8.3 a	6.9 a	11.3 a	13.0 a
3) AquaSmart	28.2 a	8.9 a	9.4 a	11.5 a	10.4 a	7.0 a	11.0 a	11.9 a
4) AquilMax	29.5 a	8.1 a	8.4 a	9.9 a	9.0 a	6.7 a	9.9 a	11.9 a
5) Simplot	28.9 a	9.2 a	8.4 a	11.0 a	8.6 a	6.5 a	10.8 a	11.4 a
6) Hydretain	26.7 a	9.1 a	8.5 a	10.6 a	9.1 a	6.8 a	10.6 a	12.9 a
7) Civitas + Zipline	29.0 a	9.6 a	9.1 a	11.7 a	10.1 a	7.3 a	11.6 a	12.8 a
8) Standard Surfactant	28.3 a	10.0 a	10.3 a	11.9 a	10.4 a	7.4 a	10.3 a	11.5 a
LSD (P=.05)	3.69	2.27	1.93	2.71	2.20	1.36	2.14	2.38
Standard Deviation	2.51	1.55	1.31	1.84	1.49	0.92	1.45	1.62
CV	8.92	16.77	14.53	16.64	16.07	13.21	13.59	13.39

<sup>1</sup> Percent soil volumetric moisture: an average of three readings per plot as measured with the FieldScout TDR 350 Soil Moisture Meter.

<sup>2</sup> Means followed by the same letter do not differ significantly (P=0.05, Duncan's New Mean Separation).

From these data, it appears that there were few dynamic interactions or interpretive trends between treatments and percent soil volumetric moisture. In addition, very uniform percent soil volumetric moisture readings were generated across all treatments during the eight evaluation events with small differences in maximum and minimum soil moisture levels. These small ranges in maximum and minimum levels of percent volumetric soil moisture across eight evaluation dates further verified the uniformity of applied irrigation across the entire field plot.

◆ **Possible Factors Contributing to Poor 328 Bermudagrass Performance (Table 10)**

During the 140-day field trial there were some treatments that exhibited very acceptable bermudagrass percent cover and turf quality when compared to the adjacent in-plot check in two or three of four replications, but very poor performance in the remaining replication or small areas of specific plots. To better determine the potential cause of this effect, further evaluations comparing variables in good turf areas and poor turf areas were conducted. The results presented are non-replicated but are averages for good and poor turf areas across all treatment plots. The goal was to attempt to identify the cause for very slow bermudagrass speed to cover and poor quality in certain areas throughout the field plot. The variables evaluated included turf color, turf quality, NDVI, percent soil volumetric moisture, percent bermudagrass cover, and electrical conductivity.

Table 10 presents averages of turf color, turf quality, NDVI, percent soil volumetric moisture, percent cover, and electrical conductivity (EC) as generated in good turf areas and poor turf areas for all treatments on a single evaluation date of September 8, 2020. As a comparison, the #17 Fairway LQCC 80% ET, Good Turf designation (Line 1 in Table 10) represents turf and soil conditions in a portion of the 17<sup>th</sup> fairway adjacent to the research plot area that received the standard 80% ET irrigation regime during the summer months.

**Table 10.** The influence of electrical conductivity and percent soil volumetric moisture on turf color, turf quality, NDVI, and percent cover of a 328 bermudagrass fairway subject to a 40% ET deficit irrigation regime. September 8, 2020. La Quinta Country Club. La Quinta, CA. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.

Treatments	Bermuda Color <sup>1</sup>	Bermuda Quality <sup>2</sup>	Bermuda NDVI <sup>3</sup>	Bermuda % SVM <sup>4</sup>	Bermuda %Cover <sup>5</sup>	Bermuda EC: dS/m
	14DAA9 9/8/20	14DAA9 9/8/20	14DAA9 9/8/20	14DAA9 9/8/20	14DAA9 9/8/20	14DAA9 9/8/20
#17 Fairway LQCC: 80% ET, Good Turf	7.5	9.0	0.791	31.4	100.0	1.84
1) Check: Good Turf Areas	7.0	7.0	0.733	14.7	99.0	2.53
1) Check: Poor Turf Areas	5.0	3.0	0.584	13.2	60.0	3.57
2) Ocean Organics: Good Turf Areas	7.0	8.0	0.753	10.9	100.0	1.86
2) Ocean Organics: Poor Turf Areas	6.0	4.0	0.665	12.5	73.0	2.92
3) AquaSmart: Good Turf Areas	7.0	7.0	0.759	10.3	99.0	1.80
3) AquaSmart: Poor Turf Areas	5.0	4.0	0.586	13.6	86.0	3.41
4) AquilMax: Good Turf Areas	7.0	6.0	0.738	9.3	96.0	1.80
4) AquilMax: Poor Turf Areas	5.0	3.0	0.585	14.5	68.0	2.69
5) Simplot: Good Turf Areas	7.0	8.0	0.736	11.6	100.0	1.84
5) Simplot: Poor Turf Areas	5.0	3.0	0.585	14.5	68.0	2.69
6) Hydretain: Good Turf Areas	7.0	8.0	0.736	11.7	99.0	1.82
6) Hydretain: Poor Turf Areas	6.0	5.0	0.654	15.1	89.0	3.72
7) Civitas + Zipline: Good Turf Areas	7.0	9.0	0.747	13.6	100.0	2.42
7) Civitas + Zipline: Poor Turf Areas	6.0	4.0	0.658	10.9	76.0	3.13
8) Standard Surfactant: Good Turf Areas	7.0	6.0	0.753	13.4	97.0	2.32
8) Standard Surfactant: Poor Turf Areas	5.0	5.0	0.603	11.3	86.0	2.84
Treatment Average Across All Good Turf Areas	7.0	7.4	0.744	11.9	98.8	2.05
Treatment Average Across All Poor Turf Areas	5.4	3.9	0.616	13.4	76.4	3.15

<sup>1</sup> Bermudagrass color: 0-10 scale with 0 representing no green color, 6 a minimum level of acceptable color, and 10 very dark green color.  
<sup>2</sup> Bermudagrass quality: 0-10 scale with 0 representing no quality, 6 a minimum level of acceptable quality, and 10 the best quality.  
<sup>3</sup> NDVI (Normalized Difference Vegetative Index): an average of three readings per plot as measured with the Spectrum Technologies Field Scout TCM 500.  
<sup>4</sup> Percent soil volumetric moisture: an average of three readings per plot as measured with the FieldScout TDR 350 Soil Moisture Meter.  
<sup>5</sup> Bermudagrass percent cover: visually estimated 0-100% scale.  
<sup>6</sup> Electrical conductivity (EC: dS/m): an average of three readings per area as measured with the W.E.T. Sensor (Dynamax Corporation).

**Table 10: Key Points of Discussion on September 8, 2020, 14 DAA9**

1. Good turf areas across all treatments averaged 98.8% 328 bermudagrass cover, including 99.0% bermudagrass cover in the untreated check plot. In comparison, the poor turf areas averaged 76.4% 328 bermudagrass cover, a 22.7% reduction in percent bermudagrass cover when compared to good turf areas.
2. Percent soil volumetric moisture levels were very similar throughout the entire field plot with an average of 11.9% in good turf areas and 13.4% in poor turf areas. From these results, it would appear that percent soil volumetric moisture was not a critical factor contributing to the poor performance of 328 bermudagrass in certain areas.
3. The 328 bermudagrass in the middle of #17 fairway adjacent to the field plot, subject to 80% ET throughout the summer and exhibited excellent turf quality showed low EC levels of 1.84 dS/m (line one Table 10).
4. Electrical conductivity levels in good turf areas across all treatments in the 40% ET deficit irrigation trial averaged 2.05 dS/m. Electrical conductivity levels in poor turf areas across all treatments in the 40% ET deficit irrigation trial averaged 3.15 dS/m with some locations generating readings greater than 5.0 dS/m.
5. From these data and corresponding field observations, it would appear that average EC levels above 2.69 dS/m may have contributed to slow speed to cover of 328 bermudagrass.

**Photograph 19.** 328 bermudagrass in good condition showing 16.3% soil volumetric moisture and a soil EC reading of 2.03 dS/m on September 8, 2020. Compare this good turf quality to the poor turf quality in Photograph 20. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



**Photograph 20.** 328 bermudagrass in poor condition showing 26.3% soil volumetric moisture and a soil EC reading of 5.05 dS/m on September 8, 2020. Compare this poor turf quality and poor tacking of bermudagrass stolons to the good turf quality in Photograph 19. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



**Photograph 21.** Minimal rooting at bermudagrass nodes results in poor tacking and very slow establishment of 328 bermudagrass stolons in high soil EC locations. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



**Photograph 22.** An area on the 17<sup>th</sup> fairway at La Quinta adjacent to the 40% ET deficit irrigation trial. This high quality 328 bermudagrass site was irrigated at 80% ET and on September 8, 2020, revealed 100% bermudagrass cover, 31.4% soil volumeter moisture, and an EC reading of 1.84 dS/m. Tim Putnam, Superintendent. Mark M. Mahady & Associates, Inc.



**Photograph 23.** The 40% ET deficit irrigation field trial plot located on the 17<sup>th</sup> fairway at La Quinta Country Club on September 8, 2020. Although much of the plot is in very good condition even after a summer of only 40% ET irrigation, EC hot spots with reduced bermudagrass cover can be observed in some areas. Mark M. Mahady & Associates, Inc.



**Photograph 24.** The Ocean Organics Program 14 DAA9 on September 8, 2020, in a low EC area (untreated check plots are located to the left and right of the Ocean Organics plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 100% bermudagrass cover, 10.9% soil volumetric moisture, and an EC reading of 1.86 dS/m.



**Photograph 25.** The Ocean Organics Program 14 DAA9 on September 8, 2020, in a high EC area (untreated check plots are located to the left and right of the Ocean Organics plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 73% bermudagrass cover, 12.5% soil volumetric moisture, and an EC reading of 2.93 dS/m.



**Photograph 26.** The AquaSmart Program 14 DAA9 on September 8, 2020, in a low EC area (untreated check plots are located to the left and right of the AquaSmart plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 99% bermudagrass cover, 10.3% soil volumetric moisture, and an EC reading of 1.80 dS/m.



**Photograph 27.** The AquaSmart Program 14 DAA9 on September 8, 2020, in a high EC area (untreated check plots are located to the left and right of the AquaSmart plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 86% bermudagrass cover, 13.6% soil volumetric moisture, and an EC reading of 3.41 dS/m.



**Photograph 28.** The AquiMax Program 14 DAA9 on September 8, 2020, in a low EC area (untreated check plots are located to the left and right of the AquiMax plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 96% bermudagrass cover, 9.3% soil volumetric moisture, and an EC reading of 1.80 dS/m.



**Photograph 29.** The AquiMax Program 14 DAA9 on September 8, 2020, in a high EC area (untreated check plots are located to the left and right of the AquiMax plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 68% bermudagrass cover, 16.1% soil volumetric moisture, and an EC reading of 2.92 dS/m.



**Photograph 30.** The Simplot Program 14 DAA9 on September 8, 2020, in a low EC area (untreated check plots are located to the left and right of the Simplot plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 100% bermudagrass cover, 11.6% soil volumetric moisture, and an EC reading of 1.83 dS/m.



**Photograph 31.** The Simplot Program 14 DAA9 on September 8, 2020, in a high EC area (untreated check plots are located to the left and right of the Simplot plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 68% bermudagrass cover, 14.5% soil volumetric moisture, and an EC reading of 2.73 dS/m.



**Photograph 32.** Hydretain 14 DAA5 on September 8, 2020, in a low EC area (untreated check plots are located to the left and right of the Hydretain plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 99% bermudagrass cover, 11.7% soil volumetric moisture, and an EC reading of 1.82 dS/m.



**Photograph 33.** Hydretain 14 DAA5 on September 8, 2020, in a high EC area (untreated check plots are located to the left and right of the Hydretain plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 89% bermudagrass cover, 15.1% soil volumetric moisture, and an EC reading of 3.46 dS/m.



**Photograph 34.** Civitas plus Zipline 14 DAA9 on September 8, 2020, in a low EC area (untreated check plots are located to the left and right of the Civitas plus Zipline plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 100% bermudagrass cover, 13.6% soil volumetric moisture, and an EC reading of 2.42 dS/m.



**Photograph 35.** Civitas plus Zipline 14 DAA9 on September 8, 2020, in a high EC area (untreated check plots are located to the left and right of the Civitas plus Zipline plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 65% bermudagrass cover, 10.9% soil volumetric moisture, and an EC reading of 3.13 dS/m.



**Photograph 36.** Industry Standard Surfactant 14 DAA9 on September 8, 2020, in a low EC area (untreated check plots are located to the left and right of the Standard Surfactant plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 98% bermudagrass cover, 13.4% soil volumetric moisture, and an EC reading of 2.32 dS/m.



**Photograph 37.** Industry Standard Surfactant 14 DAA9 on September 8, 2020, in a high EC area (untreated check plots are located to the left and right of the Standard Surfactant plot). This 328 bermudagrass site was irrigated at 40% ET and on September 8, 2020, revealed 86% bermudagrass cover, 8.8% soil volumetric moisture, and an EC reading of 2.84 dS/m.



## **Summary and Practical Perspectives**

From these data generated on a 328 bermudagrass fairway subject to a 40% ET deficit irrigation regime at La Quinta Country in the low desert microclimate of La Quinta, California, the following key take-home messages and conclusions are presented.

### **Treatment Influence on Perennial Ryegrass Transition at 80% ET**

None of the treatments evaluated during the May 5, 2020, to June 2, 2020 time period slowed or increased the natural speed of perennial ryegrass transition. Nor did specific treatments dynamically influence perennial ryegrass quality when compared to the untreated check.

In addition, very uniform percent soil volumetric readings were generated across all treatments during the three evaluation events with small differences in maximum and minimum soil moisture levels. These small ranges in maximum and minimum levels of percent soil volumetric moisture across three evaluation dates further verified the uniformity of applied irrigation across the entire field plot.

### **Treatment Influence on 328 Bermudagrass Transition at 40% ET**

The 40% ET irrigation regime was initiated on June 4, 2020, and a daily irrigation replacement schedule implemented. Twelve days later on June 16, 2020, all of the perennial ryegrass had dissipated in the stand, leaving the 328 bermudagrass as the only live, viable turf cover component.

Tim Putnam, Superintendent at La Quinta Country Club maintains a standard summer irrigation regime of 80% ET for the 328 bermudagrass fairways. Thus, the 40% ET deficit irrigation regime evaluated in this replicated field research trial represents a 50% reduction in applied irrigation from the on-site industry standard.

### **Turfgrass Color**

- Treatment 7, Civitas plus Zipline exhibited extended and enhanced turfgrass color when compared to the untreated check on 8 of 8 evaluation dates. Differences were statistically significant when compared to the untreated check on July 28, 2020, 14 DAA6, and August 8, 2020, 14 DAA7.
- Treatment 6, Hydretain exhibited extended and enhanced turfgrass color when compared to the untreated check on 8 of 8 evaluation dates. Differences were not statistically significant when compared to the untreated check.
- Treatment 7, Civitas plus Zipline, and Treatment 6, Hydretain ranked #1 and #2 respectively, for average turfgrass color from June 16 to September 22, 2020, when compared to all treatments.

### **Turfgrass Quality**

- No statistically significant effects were observed between treatments and the untreated check relative to 328 bermudagrass quality from June 16 to September 22, 2020, although strong positive trends for enhancement in bermudagrass quality were observed.
- Treatment 7, Civitas plus Zipline exhibited higher levels of 328 bermudagrass quality when compared to the untreated check on 8 of 8 evaluation dates. Acceptable levels of turfgrass quality ( $\geq 6.0$ ) were observed on 3 of 8 evaluation dates 14 DAA8, 14 DAA9, and 14 DAA10.

- Treatment 6, Hydretain exhibited higher levels of 328 bermudagrass quality when compared to the untreated check on 8 of 8 evaluation dates. Acceptable levels of turfgrass quality ( $\geq 6.0$ ) were observed on 3 of 8 evaluation dates 14 DAA8, 14 DAA9, and 14 DAA10.
- Treatment 7, Civitas plus Zipline (5.69), and Treatment 6, Hydretain (5.59) ranked #1 and #2 respectively, for average turf quality from June 16 to September 22, 2020, when compared to all treatments.

#### Total Turf Quality

- Treatment 7, Civitas plus Zipline generated a Total Turf Quality rating of 20.8 and ranked #1 of 8 treatments.
- Treatment 6, Hydretain generated a Total Turf Quality rating of 20.1 and ranked #2 of 8 treatments.
- Treatment 8, Standard Surfactant generated a Total Turf Quality rating of 6.0 and ranked #3 of 8 treatments.
- These data show that multiple applications of Treatment 7, Civitas plus Zipline, and Treatment 6, Hydretain resulted in acceptable levels of turf quality on 328 bermudagrass maintained in a fairway setting as soon as 82 days after perennial ryegrass transition and the initiation of a 40% ET deficit irrigation regime.

#### Bermudagrass Percent Cover

- No statistically significant effects were observed between treatments and the untreated check relative to the percent cover of 328 bermudagrass from June 16 to September 22, 2020, although positive treatment trends for enhancement in bermudagrass percent cover were observed.
- Treatment 6, Hydretain exhibited the most consistent positive trend and the highest levels of 328 bermudagrass cover of all treatments during all eight evaluation dates when compared to the untreated check.
- Treatment 7, Civitas plus Zipline exhibited higher levels of 328 bermudagrass percent cover when compared to the untreated check on 8 of 8 evaluation dates.
- Treatment 7, Civitas plus Zipline and Treatment 6, Hydretain ranked #1 and #2 respectively, for enhancement in speed to cover of transitioning 328 bermudagrass from June 16 to September 22, 2020, when compared to all treatments.

#### Bermudagrass Root Length and Surface Area

- No statistically significant treatment effects were observed during the designated root sampling dates, although trends for enhancement in 328 bermudagrass root length and root surface area were observed.
- Treatment 4, AquiMax exhibited an 18% increase in root length when compared to the untreated check during the September 22, 2020 sampling date. In addition, AquiMax showed a 16.8% increase in root length from the June 16, 2020, to the September 22, 2020 sampling events while the untreated check revealed a 23.1% reduction in root length during the same time period.

- Treatment 4, Aquimax also exhibited a 27.6% increase in root surface area when compared to the untreated check during the September 22, 2020 sampling date. In addition, Aquimax showed a 45.9% increase in root surface area from the June 16, 2020, to the September 22, 2020 sampling events while the untreated check revealed a 13.4% reduction in root surface area during the same time period.
- Treatment 8, Standard Surfactant showed a 26.8% increase in root surface area from the June 16, 2020, to the September 22, 2020 sampling events while the untreated check revealed a 13.4% reduction in root surface area during the same time period.
- Treatment 6, Hydretain showed a 16.9% increase in root surface area from the June 16, 2020, to the September 22, 2020 sampling events while the untreated check revealed a 13.4% reduction in root surface area during the same time period.
- Although Treatment 8, Civitas plus Zipline showed a 25.2% reduction in root length and a 16.0% reduction in root surface area from the June 16, 2020, to the September 22, 2020 sampling events, it is hypothesized that the Civitas plus Zipline treatment which showed the highest turf quality ratings of all treatments throughout the evaluation period, may have produced enhanced color and quality foliage at the expense of root length and root surface area during periods of induced stress from the 40% ET deficit irrigation regime.

#### Percent Soil Volumetric Moisture and Treatment Effects

- There were few dynamic interactions or interpretive trends between treatments and percent soil volumetric moisture. In addition, very uniform percent soil volumetric readings were generated across all treatments during the eight evaluation events with small differences in percent maximum and minimum soil volumetric moisture levels.

#### Possible Factors Contributing to Poor 328 Bermudagrass Performance

During the 140-day field trial there were some treatments that exhibited very acceptable bermudagrass percent cover and turf quality when compared to the adjacent in-plot check in two or three of four replications, but very poor performance in the remaining replication or small areas of specific plots.

- Good turf areas across all treatments averaged 98.8% 328 bermudagrass cover, including 99.0% bermudagrass cover in the untreated check plot. In comparison, the poor turf areas averaged 76.4% 328 bermudagrass cover, a 22.7% reduction in percent bermudagrass cover when compared to good turf areas.
- Percent soil volumetric moisture levels were very similar throughout the entire field plot with an average of 11.9% in good turf areas and 13.4% in poor turf areas. From these results, it would appear that percent soil volumetric moisture was not a critical factor contributing to the poor performance of 328 bermudagrass in certain areas.
- The 328 bermudagrass in the middle of #17 fairway adjacent to the field plot, subject to 80% ET throughout the summer and exhibited excellent turf quality showed low EC levels of 1.84 dS/m.
- Electrical conductivity levels in good turf areas across all treatments in the 40% ET deficit irrigation trial averaged 2.05 dS/m. Electrical conductivity levels in poor turf areas across all treatments in the 40% ET deficit irrigation trial averaged 3.15 dS/m with some locations generating EC readings greater than 5.0 dS/m.
- From these data and corresponding field observations, it would appear that average EC levels above 2.69 dS/m may have contributed to slow speed to cover of 328 bermudagrass.

### **What Does the Data Tell Us?**

Due to the variability in soil EC levels across the field plot, which was expressed during the 40% ET deficit irrigation application period from June 4, 2020, to September 22, 2020, the treatment data generated can be interpreted within three different perspectives:

1. Including both high and low EC soil plots in a statistical analysis.
2. Averaging treatment performance in high EC soils (>2.69 dS/m).
3. Averaging treatment performance in low EC soils (<2.53 dS/m).

When including both high and low soil EC levels in a statistical analysis these were the key findings:

- Treatment 7, Civitas plus Zipline, and Treatment 6, Hydretain exhibited enhanced turfgrass color, turfgrass quality, Total Turf Quality, and speed to bermudagrass cover when compared to other treatments.
- Treatment 4, AquiMax exhibited the greatest increases in root length and root surface area when compared to other treatments.

When averaging treatment performance in high EC soils (>2.69 dS/m) these were the key take-home messages:

- Poor turf areas registered a soil EC average of 3.15 dS/m across all treatments with some locations generating EC readings greater than 5.0 dS/m.
- None of the treatments applied in high EC areas exhibited acceptable turf quality by September 8, 2020.
- The average percent bermudagrass cover in high EC areas across all treatments was 76.4% with the untreated check showing 60% bermudagrass cover.

When averaging treatment performance in low EC soils (<2.53 dS/m) these were the key take-home messages:

- Good turf areas registered a soil EC average of 2.05 dS/m. As a comparison, 328 bermudagrass in the middle of #17 fairway adjacent to the field plot and subject to 80% ET throughout the summer exhibited excellent turf quality with EC levels of 1.84 dS/m.
- All treatments, including the untreated check, exhibited acceptable turf quality by September 8, 2020.
- The average percent bermudagrass cover in low EC areas across all treatments was 98.8% with the untreated check showing 99% bermudagrass cover.

### **Why is this Information Important for Superintendents in the Coachella Valley?**

The data generated in this field trial relates to the performance of perennial ryegrass overseeded 328 bermudagrass in a fairway setting transitioning to a solid bermudagrass stand when subject to a 40% ET deficit irrigation regime with daily irrigation replacement and multiple applications of the described treatments.

***Question 1: If onsite irrigation water quantity and availability is restricted, can 328 bermudagrass maintained in a fairway setting survive a 40% ET irrigation regime through summer transition in the low desert and provide acceptable bermudagrass cover by September?***

Yes. However, there are several important factors and considerations. Salinity management is critical for success. In this 40% ET deficit irrigation trial soil electrical conductivity (salinity) was the greatest limiting factor associated with 328 bermudagrass quality and speed to cover. EC levels greater than 2.69 dS/m slowed speed to cover of bermudagrass by reducing the rooting at the nodes of spreading bermudagrass stolons and thus reducing the tacking capacity of advancing stolons. This slow growth and poor-quality phenomena associated with moderate EC levels (3.37 dS/m) were also observed during the summer of 2020 on a recently sodded Santa Ana bermudagrass fairway in Southern California.

Monitor water quality, follow a daily ET irrigation replacement schedule, address possible salinity issues prior to initiating the deficit irrigation program (soil tests, gypsum as required, DeSal).

Also, know that when subject to 40% deficit irrigation, speed to cover of bermudagrass is greatly reduced, and that surface quality may not be acceptable for 8-10 weeks.

***Question 2: Are there products and programs that can enhance turf color, turf quality, and speed to cover of 328 bermudagrass subject to 40% ET deficit irrigation regimes?***

Yes. In this trial Treatment 7, Civitas plus Zipline, and Treatment 6, Hydretain exhibited enhanced turfgrass color, turfgrass quality, Total Turf Quality, and speed to bermudagrass cover when compared to other treatments. Acceptable turf quality was achieved by August 25, 2020, 82 days after the initiation of the 40% ET deficit irrigation regime.

In addition, Treatment 4, AquiMax exhibited the greatest increases in root length and root surface area when compared to other treatments.

However, these data also point to the realistic perspective that during June, July, and August, bermudagrass growth and recovery from perennial ryegrass transition will be slow and surface quality will not be acceptable, although the bermudagrass will survive when subject to a 40% ET deficit irrigation regime. As previously mentioned, salinity management within the scope of these product program concepts is critically important.

***Question 3: This 40% deficit irrigation field trial was conducted on a 328 bermudagrass fairway that was transitioning from overseeded perennial ryegrass to solid stand bermudagrass during the summer months. Would the results have been similar if the bermudagrass stand had been allowed to achieve 100% cover prior to the initiation of the 40% deficit irrigation regime?***

It would be recommended to verify the performance of the successfully performing products and programs in a future trial with the initiation of the deficit irrigation regime following the completion of 100% bermudagrass cover. The salinity variable would be important to monitor.

It is hypothesized (a best guess with no viable data) that the top-performing products and programs in the 2020 field trial as conducted on #17 fairway at La Quinta Country Club would also perform well in a trial initiated on a bermudagrass stand that had achieved 100% cover prior to the initiation of treatments and the 40% deficit irrigation regime.

The reason for this hypothesis is that the protocol developed in the 2020 trial was chosen to create the most challenging environment possible to evaluate the potential benefits of specific products and programs for bermudagrass recovery and growth when subject to a 40% ET deficit irrigation regime during the bermudagrass transition. As to be expected in field research, some treatments performed better than others. None of the 328 bermudagrass turf in any treatments, even the untreated check plot, died or failed to recover even when subject to the 40% deficit irrigation regime initiated during 328 bermudagrass transition. However, the data showed a correlation between increasing salinity and slower bermudagrass recovery.

From these data generated in this replicated field trial, it would appear that these new technologies and program concepts may represent unique agronomic tools and options to assist golf course superintendents and turfgrass managers in their efforts to better manage turf irrigation when water quantity is limiting and/or when the economics of water use becomes compromised.

These program concepts also support the implementation of water use planning throughout turfgrass growing seasons. For example, if superintendents know early in the year that above normal water savings will be required throughout the growing months, they could initiate the successful deficit irrigation product programs described and then utilize a sequence of multiple two- to four-week irrigation periods at 40% ET followed by an 80% ET recovery period.

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