Evaluation of Irrigation Strategies and Products to Alleviate Irrigation Salinity Stress and Rapid Blight Disease on Annual Bluegrass Greens

2017 Progress Report

Salinity alleviation and rapid blight study area in Riverside, CA. Commercial and experimental products were applied from June to October 2017 on annual bluegrass turf irrigated with saline water (electrical conductivity = EC ≈ 2.0 dS/m) from adjacent storage tanks either 3 days/week (deep, infrequent) or every day (shallow, frequent). Photo taken on 22 Oct 2017.

Research Report Brought To You By:

UC RIVERSIDE — UNIVERSITY OF CALIFORNIA
Turfgrass Science

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

Evaluation of Irrigation Strategies and Products to Alleviate Irrigation Salinity Stress and Rapid Blight Disease on Annual Bluegrass Greens
2017 Progress Report

Marco Schiavon, Antonio Verzotto, Magdalena Poleska, Pawel Orlinski, Pawel Petelewicz, and Jim Baird
Department of Botany and Plant Sciences
University of California, Riverside
951-333-9052; jbaird@ucr.edu

The Bottom Line: Twenty-two commercial and experimental treatments were tested against untreated controls for their ability to alleviate salinity stress and potential rapid blight disease development on an annual bluegrass green irrigated using either shallow, frequent or deep, infrequent irrigation with saline water (electrical conductivity = EC ≈ 2.0 dS/m). Products and saline irrigation were applied from June to October 2017. Initial turf loss occurred due to drought stress from high temperatures and ET rates. Our results suggest that irrigation practices are more important than chemical amendments to prevent annual bluegrass loss, and leaching events may not be needed on annual bluegrass golf greens if adequate volumes of water are applied frequently. Differences in chemical treatments were visible near the end of the study only, when ET rates decreased. By the end of September, NutriMend (16 oz/M) + Komodo Pro (8 oz/M) applied every week was the only treatment that increased turf quality in comparison to the control. Although the causal agent of rapid blight disease could not be identified, Lexicon, Contend A (benzovinduiflupyr + difenoconazole), Velista, and Velista + Secure fungicides reduced disease cover during the latter stages of the experiment. These fungicides have demonstrated activity against rapid blight disease based on previous research in California.

Introduction:

Increasing salinity issues caused by insufficient precipitation, drought, and increasing use of alternative non-potable sources of irrigation water are inevitable for turf and landscape plants in the southwestern United States. Most golf course superintendents in California who manage annual bluegrass putting greens are faced with managing salinity stress resulting from use of reclaimed irrigation water and/or salt accumulation during extended drought. Leaching and modification of soil physicochemical properties can help alleviating salinity stress. Overall, numerous products are purported to aid in salinity management, many of which have not been tested under non-biased, replicated experiments on turf.

Rapid blight, caused by the terrestrial slime mold *Labyrinthula terrestris*, was first discovered as a disease of turfgrass in the early part of this century. Since then, it has been found in at least 11 states in the U.S. including California. As the name implies, rapid blight symptoms appear quickly as water-soaked patches, which soon coalesce into large dead areas. In California, the disease is most severe on *Poa annua* greens, but also can be troublesome on *Poa trivialis* and perennial ryegrass in overseeded turf particularly in Arizona. Almost always, rapid blight is associated with elevated sodium chloride caused by poor irrigation water and or extensive periods without rainfall or sufficient leaching of salts. Historically, only a few fungicides have provided effective control of rapid blight, including pyraclostrobin (Insignia), trifloxystrobin (Compass), and mancozeb (Fore).

The objectives of this research were to: 1) determine best irrigation/leaching practices when the sole source of water for irrigation is saline; 2) evaluate the efficacy of commercial products to reduce stress caused by salinity and improve soil chemistry/structure; and 3) evaluate fungicides for control of rapid blight, a disease associated with high salinity.

Materials and Methods:

A 5,400-ft^2 research putting green was constructed using 8 inches of sand/peat/soil with physical properties conforming to USGA recommendations, but simulating a mature putting green with minimum suggested infiltration rate. The rootzone mix was donated by P.W. Gillibrand Co. Annual bluegrass was established using aeration cores from Mesa Verde Country Club in Orange County. Turf was irrigated with Toro 300 series pop-up stream sprinklers (Toro Company, Bloomington, MN) on 30-ft spacing. Saline water was made by mixing salts in potable water within two 5000-gal storage tanks (Snyder Industries, Inc., Lincoln, NE) containing submersible pumps for mixing and agitation. Total salinity (EC ≈ 2.0 dS/m) of the water was chosen to simulate an extreme, but realistic irrigation salinity for turf in California. Environmental data for the site are provided in Table 1. Once established, turf was mowed at 0.110 inches 5 times/week, rolled weekly, topdressed monthly with sand, and received 0.125 lbs N/M and Primo Maxx at 0.125 oz/M every two weeks. The 60-ft x 90-ft area was subdivided into six 30-ft x 30-ft areas. Starting on June 23, plots were irrigated by hand with saline water (2.0 dS/m). Two irrigation methods were replicated three times inside the study area: 1) shallow, frequent irrigation: plots irrigated every day and slightly higher volume on Fridays to simulate a light flushing, with no 'traditional' flushing event expected; and 2) deep, infrequent irrigation: majority of irrigation applied on Mon-Wed-Fri with light syringing as needed on other days, and salinity was leached when soil electrical conductivity (EC_e) in the last treatment in one replication reached 2 dS/m. Both irrigation strategies resulted in a target replacement of 100% ET_0 based on the previous week.

Twelve salinity alleviation and 12 fungicide treatments including untreated controls were replicated inside each 30-ft x 30-ft area and applied every 1, 2, or 4 weeks from June thru October (Tables 2 and 3). All salinity and fungicide treatments were applied initially on 23 June and 28 June 2017, respectively using a calibrated CO_2 boom sprayer at 2 gal/M. Plots were irrigated with ca. 1/4 in of water following application of salinity treatments. Plot size was 24 ft^2. Every 2 weeks plots were evaluated for turf quality, volumetric soil water content (VWC) and EC_e using POGO, and Normalized Difference Vegetative Index (NDVI) and Dark Green Color Index (DGCI) using Digital Image Analysis. Leachate was also collected from suction lysimeters (Figure 1) and analyzed for EC_L. Furthermore, fungicide treated plots were evaluated for disease cover and turf quality, turf injury and turf cover at weekly basis. At the end of the study (November 4), soil samples were taken for complete nutrient and salinity analysis by Harris Labs.

Data were subjected to analysis of variance (ANOVA). When necessary, multiple comparisons of means were assessed using Fisher's protected least significant difference test at the 0.05 probability level. Each graphical output is presented and discussed only when the chemical amendment, irrigation regime, or sampling date effect or their interactions were significant.

Results:

- During the first month of the study a significant amount of turf loss occurred due to drought stress from high temperatures and ET rates, and before irrigation volumes were adjusted to 130% ET_0. Neither salinity nor rapid blight were not responsible for initial turf loss.
- Irrigation frequency had the highest impact on the results. In fact, shallow, frequent irrigation not only resulted in better turf performance (visual quality, cover, and NDVI) (Fig. 2), but also helped mitigate accumulation of salts in the rootzone in comparison to deep, infrequent irrigation, and also by increasing VWC (Fig. 3). Only one flushing event was needed throughout the entire study on the deep, infrequently irrigated plots, and it was necessary for all replications. Our results suggest that heavy leaching events may not be needed on annual bluegrass golf greens if adequate volumes of water are applied frequently.
- Differences in chemical treatments were visible near the end of the study only, when ET rates decreased. By the end of September, NutriMend (16 oz/M) + KomodoPro (8 oz/M) applied every week was the only treatment that increased turf quality in comparison to the control. Conversely, SafeZone (2.94 oz/M) + Aquapam (5.88 oz/M), Revolution (6oz/M) + UMAXX (46-0-0), UCR001+UCR002, and UCR001+UCR002+UCR003 performed worse than the control (Fig. 4).
- Soil analysis at the end of the study revealed that shallow, frequent irrigation reduced soil EC, and Ca, K, Mg and Na content (Fig. 5). Moreover, EC was lower in comparison to the control in a handful of treatments only, including Megalex, and both Ocean Organics programs. Regardless, lower soil salinity by the end of the study did not translate into better annual bluegrass quality.
- Although there was a significant amount of turf loss due to drought in plots treated with fungicides, treatments continued over time and by the end of September it became apparent that some fungicide treatments improved turf cover while others including the control had greater disease cover combined with elevated soil salinity not associated with initial effects of drought (Table 3). Although symptoms of water-soaked lesions were similar to rapid blight disease and soil salinity elevated to levels associated with this disease, we were unable to identify *Labyrinthula terrestris* in samples taken in early September. Samples taken again in early November were sent to Clemson University and revealed only anthracnose and summer patch pathogens present. Despite lack of positive rapid blight identification, Lexicon, Contend A (benzovinduiflupyr + difenoconazole), Velista, and Velista + Secure fungicides reduced disease cover as the experiment progressed. Lexicon contains pyraclostrobin, which has demonstrated efficacy against rapid blight. Previous research conducted by UCR in Northern California demonstrated similar efficacy of the other aforementioned fungicides when both rapid blight and anthracnose pathogens were present.

Acknowledgments: Thanks to the Golf Course Superintendents Association of Southern California, California Turfgrass & Landscape Foundation, P.W. Gillibrand Co., Mesa Verde CC, and companies that provided product and financial support for this research.

Table 1. Environmental data collected and reported by the California Irrigation Management System (CIMIS) for Station 44 (Riverside) during the salinity alleviation study. Riverside, CA. Weather station located ≈ 100 ft away from study area.

Month Year	Total ETo (in)	Total Precip (in)	Avg Sol Rad (Ly/day)	Avg Vap Pres (mBars)	Avg Max Air Temp (F)	Avg Min Air Temp (F)	Avg Air Temp (F)	Avg Rel Hum (%)	Avg Wind Speed (mph)	Avg Soil Temp (F)
Jun-17	6.98	0	613	16	88.8	60.5	73.5	59	4.3	74.5
Jul-17	7.11	0.03	569	18.7	93.8	65.7	78.5	57	4	78.6
Aug-17	6.4	0.39	523	19.8	93	65.7	77.5	61	4	78.1
Sep-17	4.92	0.06	421	16.6	87.1	62.2	73.4	60	4.1	74.3
Oct-17	4.54	0	354	10.8	85.5	57.8	70.6	47	3.9	67.4

Table 2. Commercial and experimental products, their frequency of application and soil electrical conductivity (EC) by the end of the study in the salinity alleviation study. 2017. Riverside, CA.

No.	Treatment	Company	Rate	Frequency (wks)	EC (dS/m)
1	Untreated Control	--	--	--	4.31 ab*
2a 2b	UMAXX Revolution	Simplot Aquatrols	0.02 lb/M 6 oz/M	2 4	4.37 ab
3	Megalex (3-0-0)	Grigg Brothers	7.3 oz/M	2	3.18 c
4a 4b	Safe Zone (0-0-13) Aqua Pam	Grigg Brothers Grigg Brothers	1 gal/A 2 gal/A	4 4	3.98 bc
5	Nutricor (5-4-4)	Solutions 4Earth	15 fl oz/M	1	3.63 bc
6a 6b	NutriMend (10-3-0) Komodo Pro (0-0-16)	Solutions 4Earth Solutions 4Earth	16 fl oz/M 8 fl oz/M	1 1	5.77 a
7a 7b	NutriMend (10-3-0) Komodo Pro (0-0-16)	Solutions 4Earth Solutions 4Earth	16 fl oz/M 8 fl oz/M	2 2	3.79 bc
8a 8b 8c	DeSal StressRx XP Micro	Ocean Organics Ocean Organics Ocean Organics	0.75 oz/M 6 oz/M 6 oz/M	2 2 2	3.26 c
9a 9b 9c 9d	DeSal StressRx XP Micro EXP SF1	Ocean Organics Ocean Organics Ocean Organics Ocean Organics	0.25 oz/M 6 oz/M 6 oz/M 6 oz/M	2 2 2 2	3.07 c
10a 10b	UCR001 UCR002	--	3.5 oz/M 6 oz/M	2 2	5.16 ab
11a 11b	UCR003 UCR002	--	1.2 oz/M 6 oz/M	2 2	4.04 bc
12a 12b 12c	UCR001 UCR002 UCR003	--	0.56 oz/M 6 oz/M 3.5 oz/M	2 2 2	4.02 bc

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

Table 3. Effect of fungicide treatments on disease cover (0-100%) and soil electrical conductivity EC (dS/m) on chosen dates. 2017. Riverside, CA.

No.	Treatment	Company	Rate (oz/M)	Freq. (wks)	Disease Cover (0-100%)				Soil EC (dS/m)	
					09/26	10/10	11/01	11/07	09/26	10/10
13	Untreated Control	-	-	-	33 a*	51 a	56 a	64 a	0.96 a	2.00 a
14	JR 1	-	3	2	24 abcd	34 abc	44 ab	44 abc	1.07 a	2.10 a
	JR 2	-	0.366	2						
15	JR 1	-	3	2	17 bcd	31 bc	45 ab	39 abc	1.13 a	2.08 a
	JR 2	-	0.366	2						
	Compass	Bayer	0.2	2						
16	JR 1	-	6	2	20 abcd	27 bc	48 a	53 ab	1.13 a	2.12 a
	JR 2	-	0.732	2						
17	JR 1	-	6	2	14 cd	23 c	49 a	53 ab	1.31 a	2.25 a
	JR 2	-	0.732	2						
	Compass	Bayer	0.2	2						
18	Lexicon	BASF	0.34	2	25 abcd	36 abc	20 bc	18 c	0.70 a	1.73 a
19	Affirm	NuFarm	0.88	2	28 abc	33 abc	33 abc	43 abc	0.86 a	1.90 a
20	NUP-15014	-	1.3	2	30 ab	41 abc	56 a	50 ab	1.24 a	2.37 a
21	Rotator	NuFarm	0.5	2	32 a	43 ab	53 a	48 ab	1.15 a	2.08 a
22	Velista	Syngenta	0.7	2	17 bcd	30 bc	31 abc	28 bc	1.09 a	2.10 a
23	Velista	Syngenta	0.5	2	32 a	34 abc	38 abc	28 bc	0.83 a	1.88 a
	Secure	Syngenta	0.5	2						
24	Contend A	Syngenta	1.0	2	12 d	23 c	15 c	17 c	0.88 a	1.90 a

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

Figure 1. Suction lysimeters (Irrometer, Riverside, CA) used to capture leachate for analysis of EC_L. Lysimeters were buried 4 inches below the turf surface all replicate plots for each treatment in the salinity alleviation study.

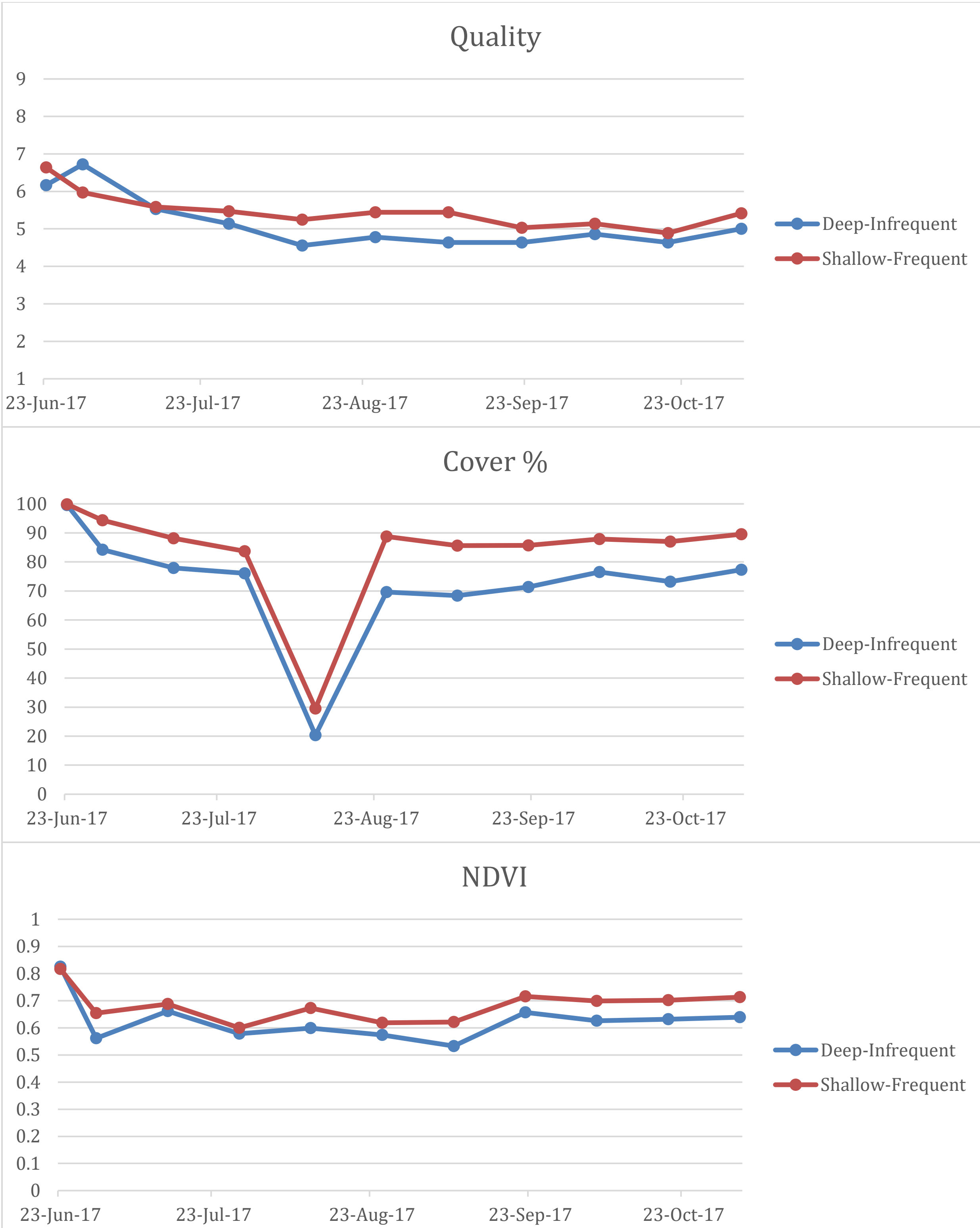

Figure 2. Turf quality (1 to 9 scale, 9 = best), percent green cover (%), and NDVI in response to irrigation strategies in the salinity alleviation study in 2017. Riverside, CA.

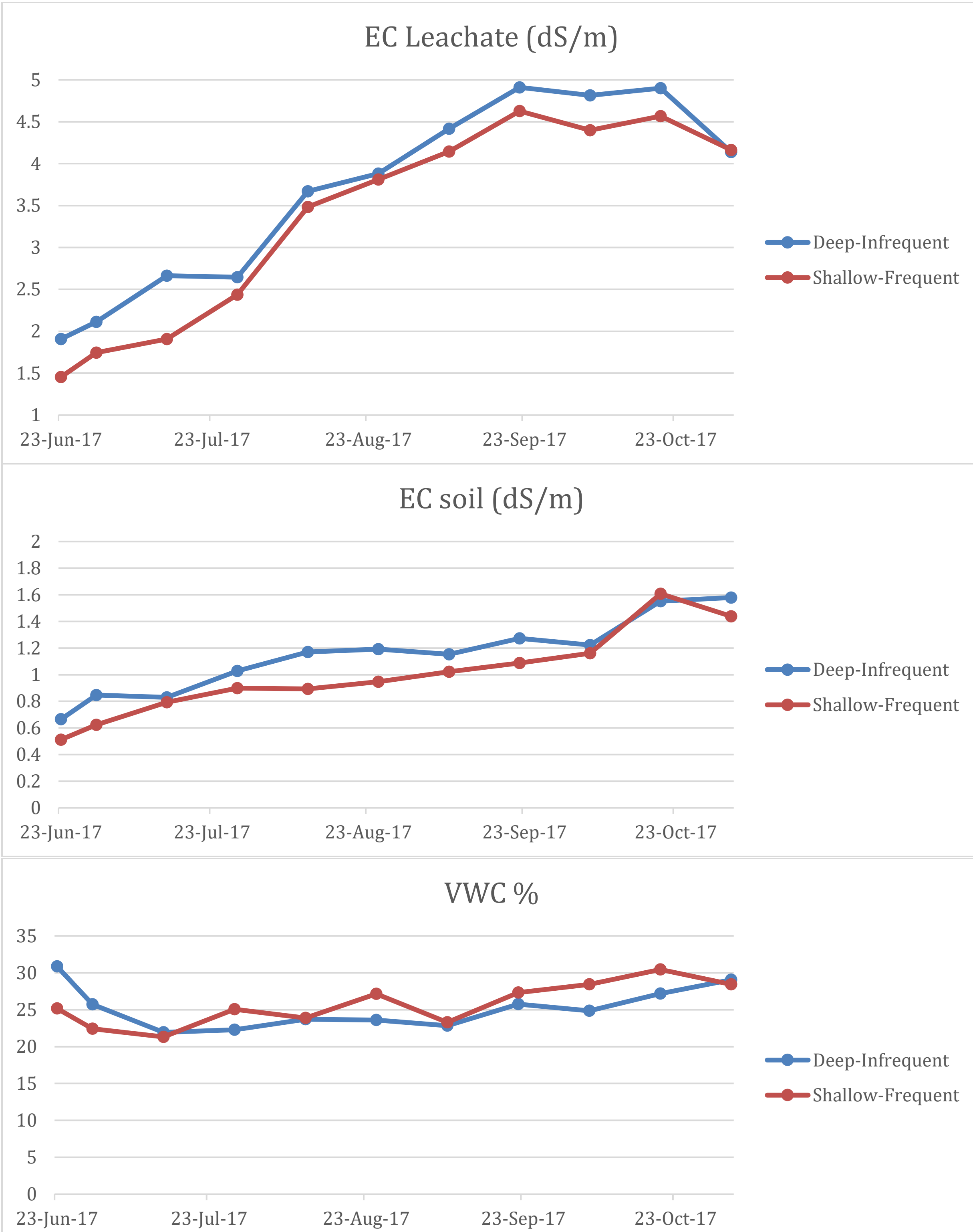

Figure 3. Electrical conductivity of leachate and soil (dS/m), and volumetric water content (VWC) in response to irrigation strategies in the salinity alleviation study in 2017. Riverside, CA.

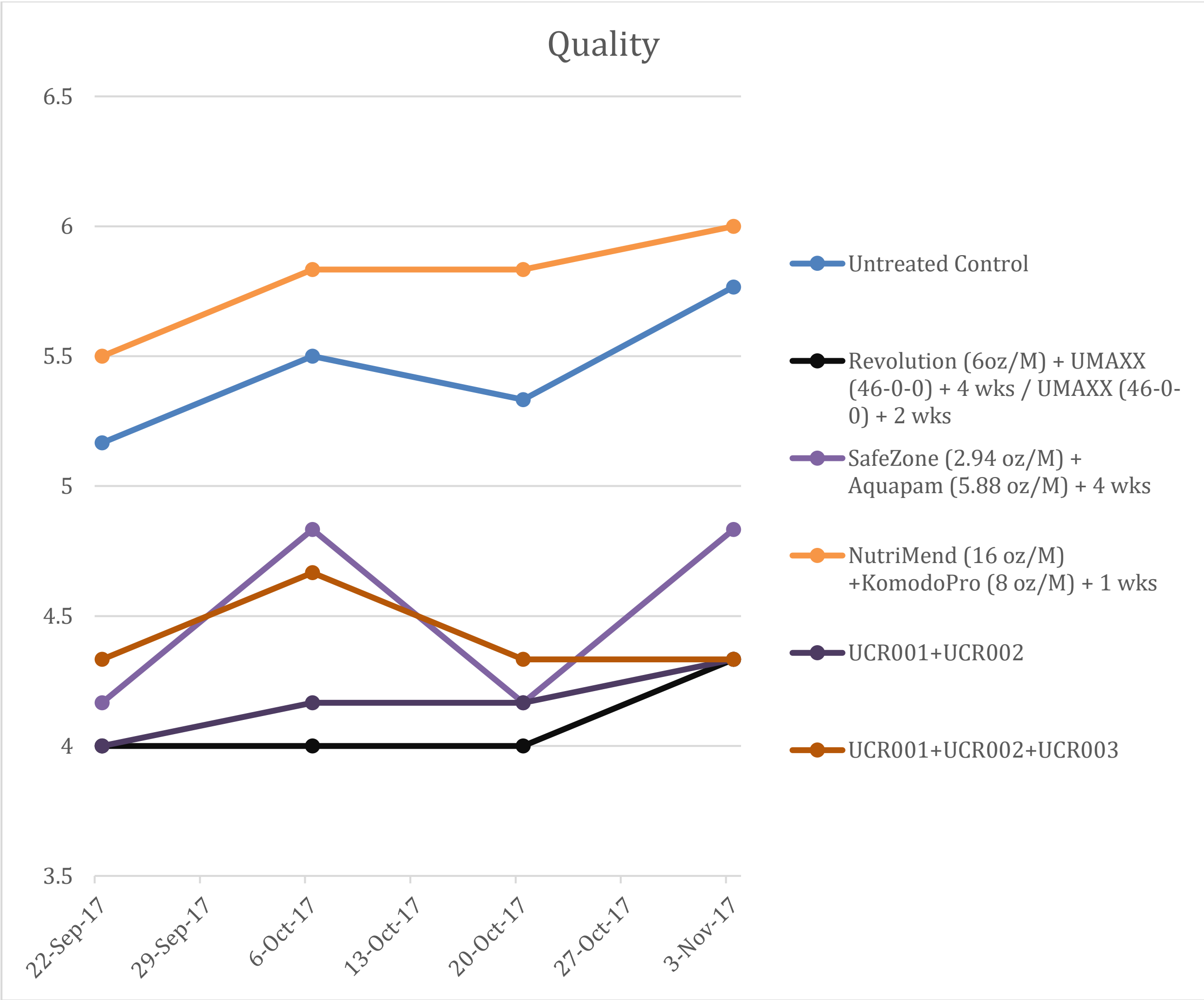

Figure 4. Turf quality (1 to 9 scale, 9 = best) in response to treatments in the salinity alleviation study in 2017. Riverside, CA. Treatments not shown were not significantly different from the control during the rating period.

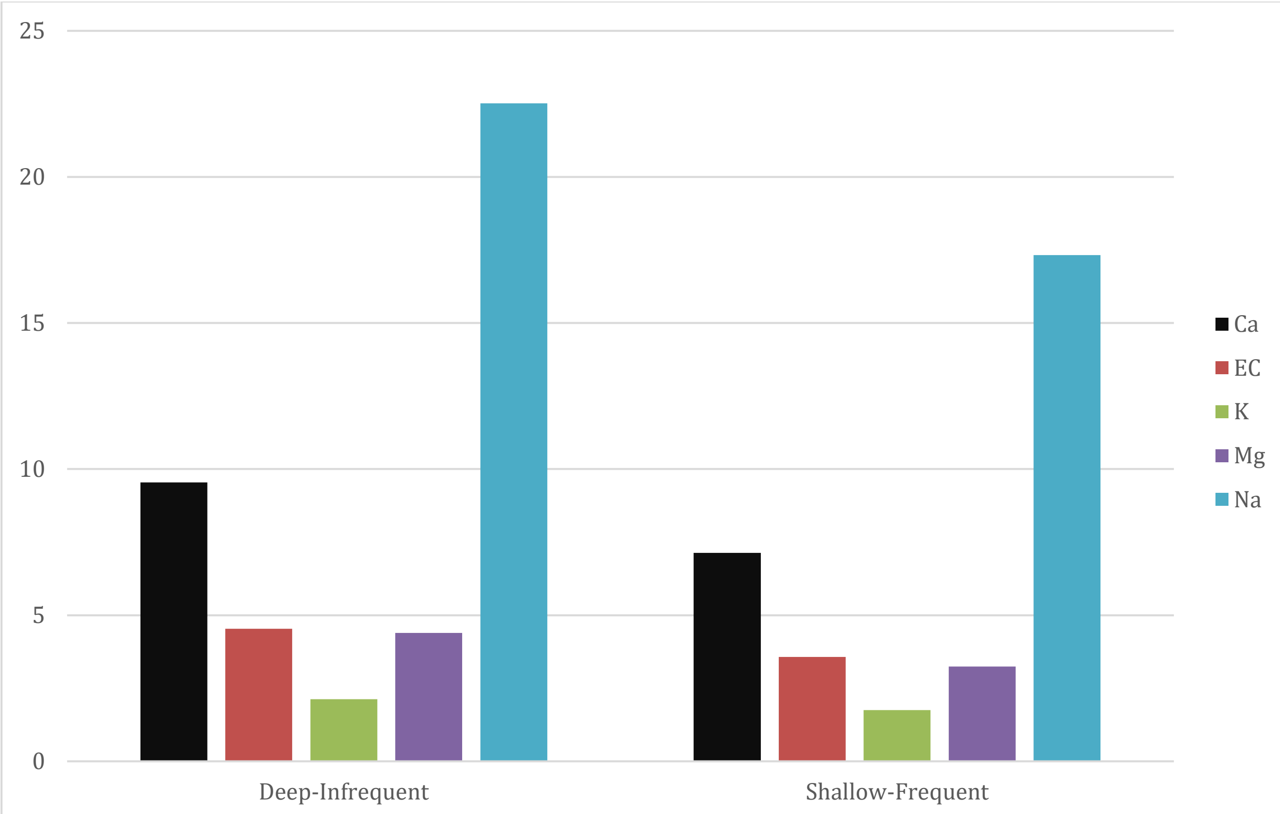

Figure 5. Effects of irrigation strategy on soil calcium (Ca; meq/L), potassium (K; meq/L), magnesium (Mg; meq/L), sodium (Na; meq/L), and electrical conductivity (dS/m) at the end of the salinity alleviation study in 2017. Riverside, CA.