Evaluation of Products to Alleviate Irrigation Salinity Stress on Bermudagrass Turf

2016 Progress Report

Salinity alleviation study area in Riverside, CA. Commercial and experimental products were applied from May to October 2016 on hybrid bermudagrass 'Tifway II' turf irrigated with saline water (electrical conductivity = EC ≈ 4.2 dS/m) from adjacent storage tanks. Photo taken on 6 Oct 2016.

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The Bottom Line: Seven commercial and experimental products were tested against two gypsum treatments (5 and 10 lb/M/month) and an untreated control for their ability to alleviate salinity stress on bermudagrass turf irrigated with saline water (electrical conductivity = EC ≈ 4.2 dS/m). Product applications were made from May to October 2016. During the experiment, bermudagrass was never significantly stressed from irrigation with saline water. The Ocean Organics program showed improved turf quality and color measured by reflectance (Normalized Difference Vegetation Index, NDVI) in comparison to the untreated control and lowest electrical conductivity of the saturated soil paste extract (EC_e) by the end of the bermudagrass growing season. The experimental treatment UCR001 applied on two-wk intervals had the highest visual quality, Dark Green Color Index (DGCI) and % green cover through the summer and until the fall, but its effects on soil chemistry were negligible.

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. Modification of soil physicochemical properties that result from salinity is one means of alleviating plant salinity stress. Moreover, there is a growing movement toward use of "organic", microbial, or other products for purposes of improving plant health under salinity stress. Overall, turf managers are inundated with a plethora of salinity alleviation products, many of which have not been tested under non-biased, replicated experiments on turf. The objective of this study was to evaluate nine commercial and experimental products for alleviating soil salinity and stress on bermudagrass turf irrigated with saline water.

Materials and Methods:

The plot area was sodded with 'Tifway II' bermudagrass in August 2012 on a Hanford fine sandy loam with no pre-existing salinity issues. 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. Saline water ion composition was based on Colorado River water (personal communication, D.L. Suarez, USDA-ARS Salinity Laboratory) and contained elevated concentrations of salts including Na^+, Cl^-, and SO_4^{2-} but not HCO_3^- and CO_3^{2-} (Table 1). Total salinity of the water was chosen to simulate an extreme, but realistic irrigation salinity for turf in California (personal communication, M. Huck). For the past three years, the plot area was irrigated from approximately May until November with saline water. Nevertheless, the combination of natural rainfall and cessation of saline irrigation during the winter lowered soil salinity in the study area, ensuring that no differences in soil chemical properties were found at the beginning of each study year. Environmental data for the site are provided in Table 2. The turf was mowed three times per week at 0.5 inches during the growing season, verticut in May 2016 and received 0.5 lbs N/M/month during each growing season for a total of 5 lbs N/M/yr using either urea, ammonium sulfate, or a complete granular fertilizer.

All treatments were applied initially on 26 May 2016 using a calibrated CO_2 boom sprayer at 2 gal/M. Plots were irrigated with ca. 1/4 in of water following application. Treatments were arranged in a complete randomized block design with 6 replicates. Plot size was 24 ft^2. List of treatments is provided in Table 3. Every two weeks, plots were evaluated for turf quality on a scale from 1 = worst to 9 = best, leaf firing (0-100%), volumetric soil water content (VWC) using time domain reflectometry (TDR), and Naturalized Difference Vegetation Index (NDVI) and Dark Green Color Index (DGCI) using Digital Image Analysis (DIA). Leachate (3 replicates/treatment; Figure 1) was also collected and analyzed for electrical conductivity (EC_L) on the same day. During rating weeks, irrigation scheduling included the night before collection of leachate samples. Soil samples were collected at the end of bermudagrass growing season (November 4) separately for each combination of chemical treatment and replication to assess salinity (Ag Source Labs, Lincoln, NE) accumulation in the root zone.

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 effect was significant during one or more rating dates.

Results:

- Salinity symptoms during 2016 were not visible on bermudagrass; hence, visual ratings never dropped below an acceptable quality level of 6 even on untreated plots (Figure 2). Turf quality was increased by two treatments only: UCR001 applied at two-wk intervals and the Ocean Organics program.
- Visual quality results were corroborated by remote sensing data. Together with Go Isolates, UCR001 improved DGCI of the plots regardless of its application intervals (Figure 3), and increased green cover of the plots in comparison to control when applied every two weeks (Figure 4). The Ocean Organics program increased NDVI in comparison to control consistently through the study (Figure 5).
- No differences were found in EC_L among treatments throughout the study.
- The Ocean Organics program decreased EC_e by the end of the study (Table 4). Although no statistical differences were found in soil SAR and Na^+ content by the end of the study, the Ocean Organics program showed the lowest numerical values, followed by the Lidochem program and gypsum applied at 10 lb/M.

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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 Vap Pres (mBars)	Avg Max Air Temp (F)	Avg Min Air Temp (F)	Avg Air Temp (F)	Avg Max Rel Hum (%)	Avg Min Rel Hum (%)	Avg Rel Hum (%)	Avg Wind Speed (mph)	Avg Soil Temp (F)
May 16	6.14	0.02	12	71.2	55.5	62.6	80	40	62	4	67.8
June 16	7.21	0	13.6	89.4	61.5	74.5	74	30	49	4.4	73
July 16	7.75	0	14.3	93.5	64.2	77.5	73	25	45	4.2	75.9
Aug 16	6.88	0	14.4	92.6	63.6	76.5	74	25	47	4	75.4
Sep 16	5.3	0	12.6	87.9	60.8	72.9	71	27	47	4	71.5
Oct 2016	3.86	0.87	11.2	80.7	56.6	67.7	70	31	51	3.5	66.4

Table 2. Properties of potable and saline (salts mixed with potable water) irrigation water used in the salinity alleviation study in Riverside, CA.

Properties	**Potable**	**Saline**
pH	7.8	7.6
EC, dS m^{-1}	0.6	4.4
TSS, mg L^{-1}	390	2835
SAR	3.2	18.3
Na^{+}, mg L^{-1}	53	524
K^{+}, mg L^{-1}	4	130
Ca^{2+}, mg L^{-1}	66	126
Mg^{2+}, mg L^{-1}	12	152
Cl^{-}, mg L^{-1}	31	996
NO_3^{-}-N, mg L^{-1}	5.2	5.1
HCO_3^{-}, mg L^{-1}	215	210
CO_3^{2-}, mg L^{-1}	0.01	0.01
SO_4^{2-}, mg L^{-1}	78	708
B, mg L^{-1}	0.08	0.11

Table 3. Commercial and experimental products and their frequency of application in the salinity alleviation study. 2016. Riverside, CA.

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

Table 4. Soil EC_e (dS/m), sodium absorption ratio (SAR), acidity (pH), and sodium (Na) content (meq/L) in October 2016 following application of treatments since May 2015. Riverside, CA. Means followed by the same letter in a column are not significantly different ($P = 0.05$).

No.	Treatment	EC_e (dS/m)	SAR	Na (ppm)	Ca (ppm)
1	Untreated Control	3.8 AB	5.9 AB	346 ABC	1137 AB
2	ATGS1	3.6 ABC	5.9 AB	352 ABC	1102 AB
3	Go Isolates	2.8 BC	5.3 AB	312 BC	1499 A
4	TurfRx Saltex TurfRx PeneCal TurfRx C-85 TurfRx Ca Si	3.6 ABC	6.4 A	407 A	1150 AB
5	KaPre Exalt Pennamin Perfect=K KaPre KelpPlus	2.6 BC	4.8 B	296 BC	940 AB
6	Gypsum	3.0 BC	5.5 AB	311 BC	1086 AB
7	DeSal StressRx XP Micro	2.4 C	4.6 B	293 C	899 B
8	UCR001a UCR001b UCR001c UCR001d	4.5 A	5.2 AB	388 AB	1456 AB
9	UCR002a UCR002b UCR002c UCR002d	3.6 ABC	5.3 AB	370 ABC	1146 AB
10	Gypsum	2.9 BC	4.8 B	306 BC	997 AB

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 in 3 out of 6 replicate plots for each treatment.

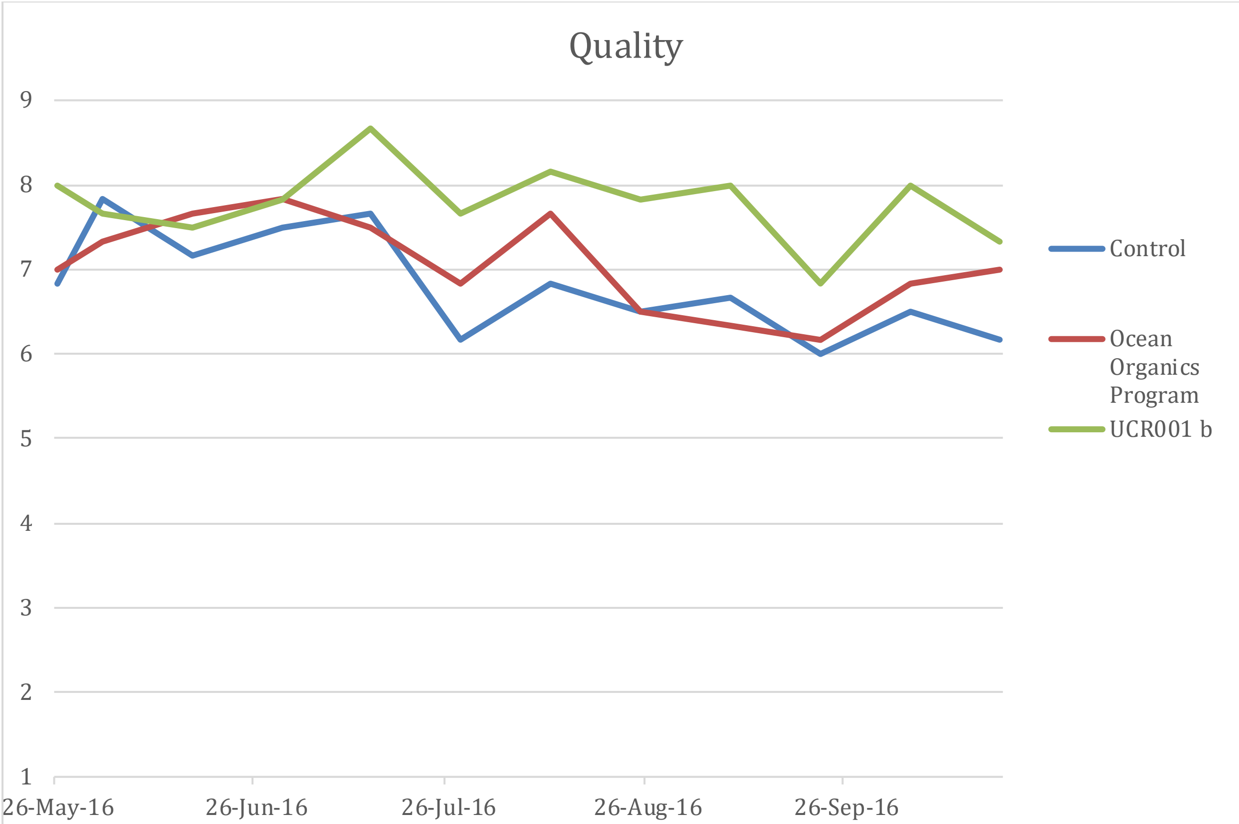

Figure 2. Turf quality (1 to 9 scale, 9 = best) in response to treatments in the salinity alleviation study in 2016. Riverside, CA. Treatments not shown were not significantly different from the control during the rating period.

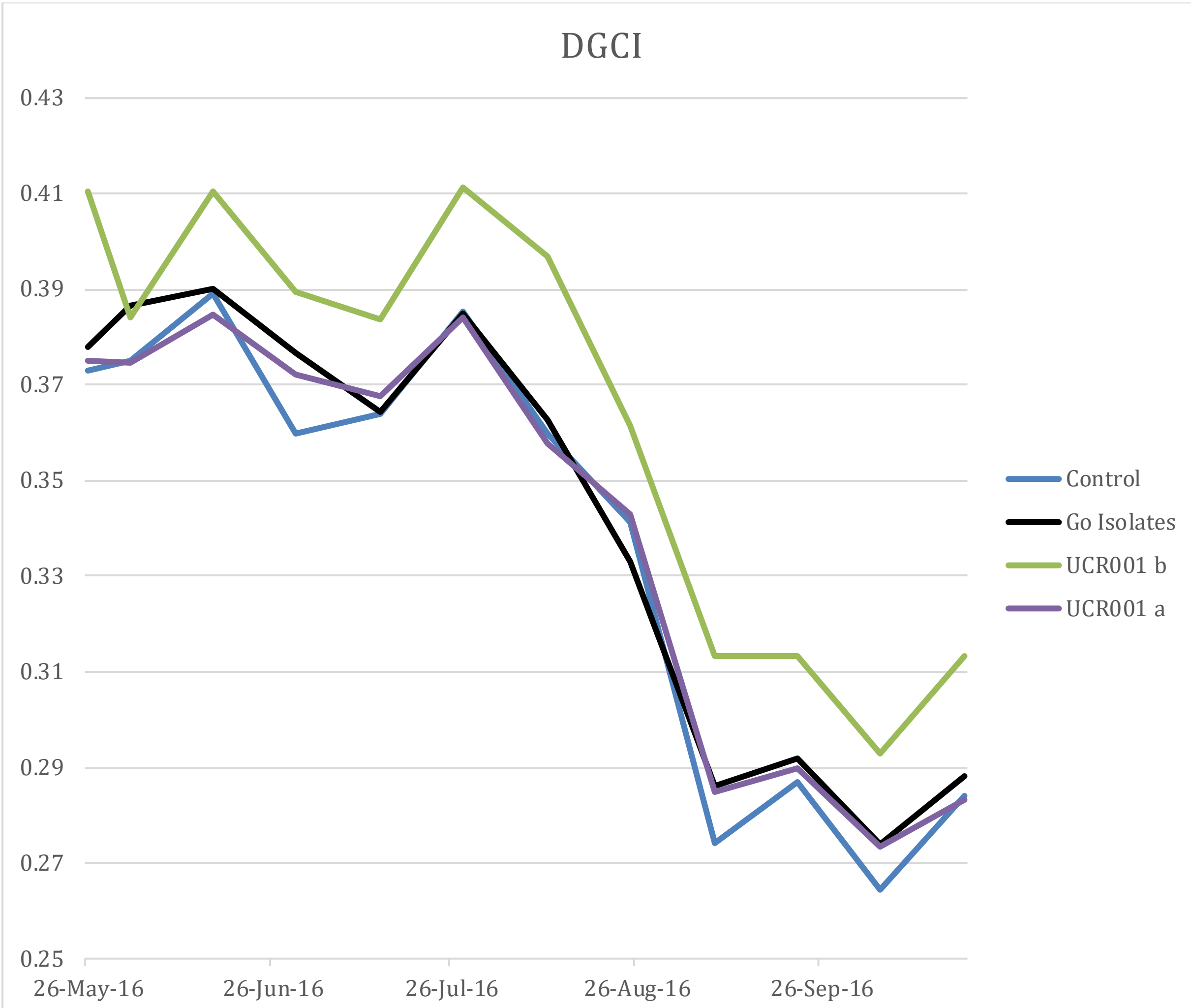

Figure 3. Dark Green Color Index (DGCI) in response to treatments in the salinity alleviation study in 2016. Riverside, CA. Treatments not shown were not significantly different from the control during the rating period.

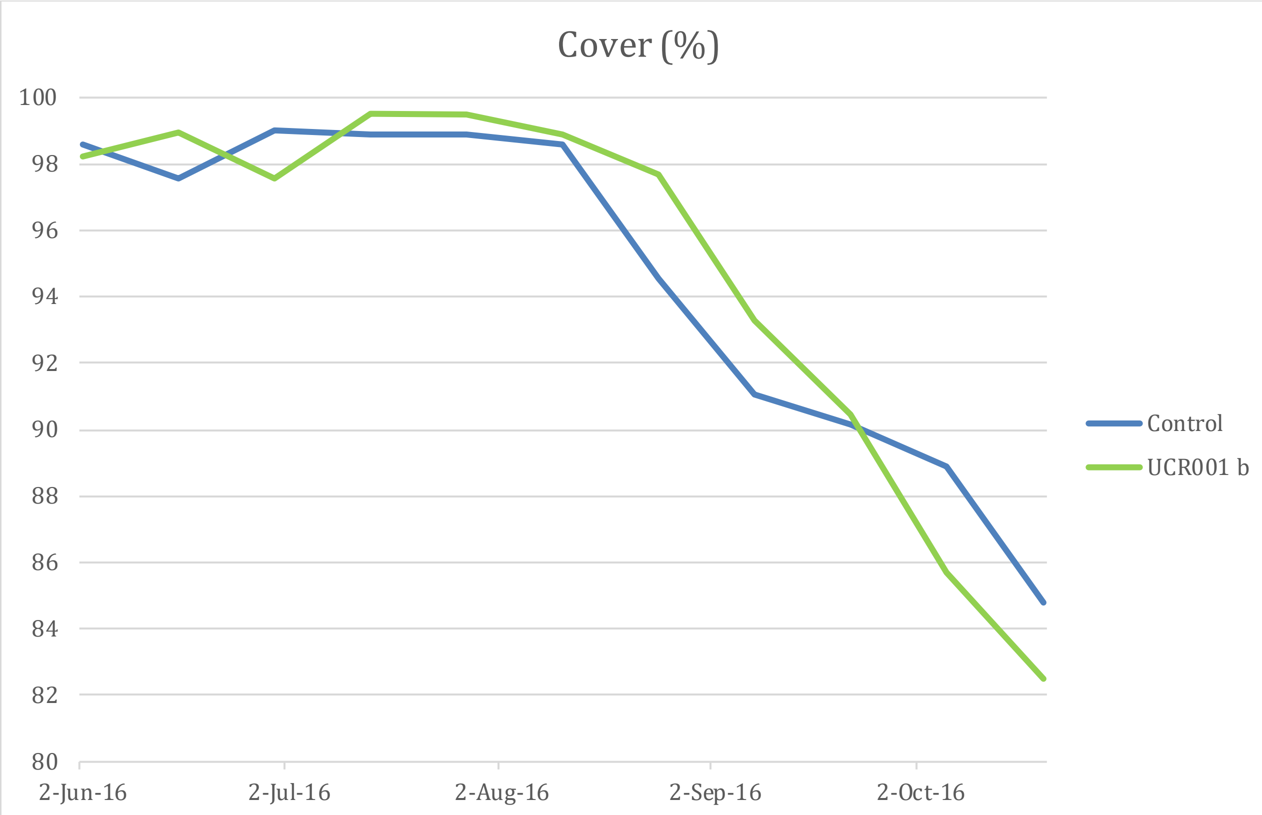

Figure 4. Percent green cover in response to treatments in the salinity alleviation study in 2016. Riverside, CA. Treatments not shown were not significantly different from the control during the rating period.

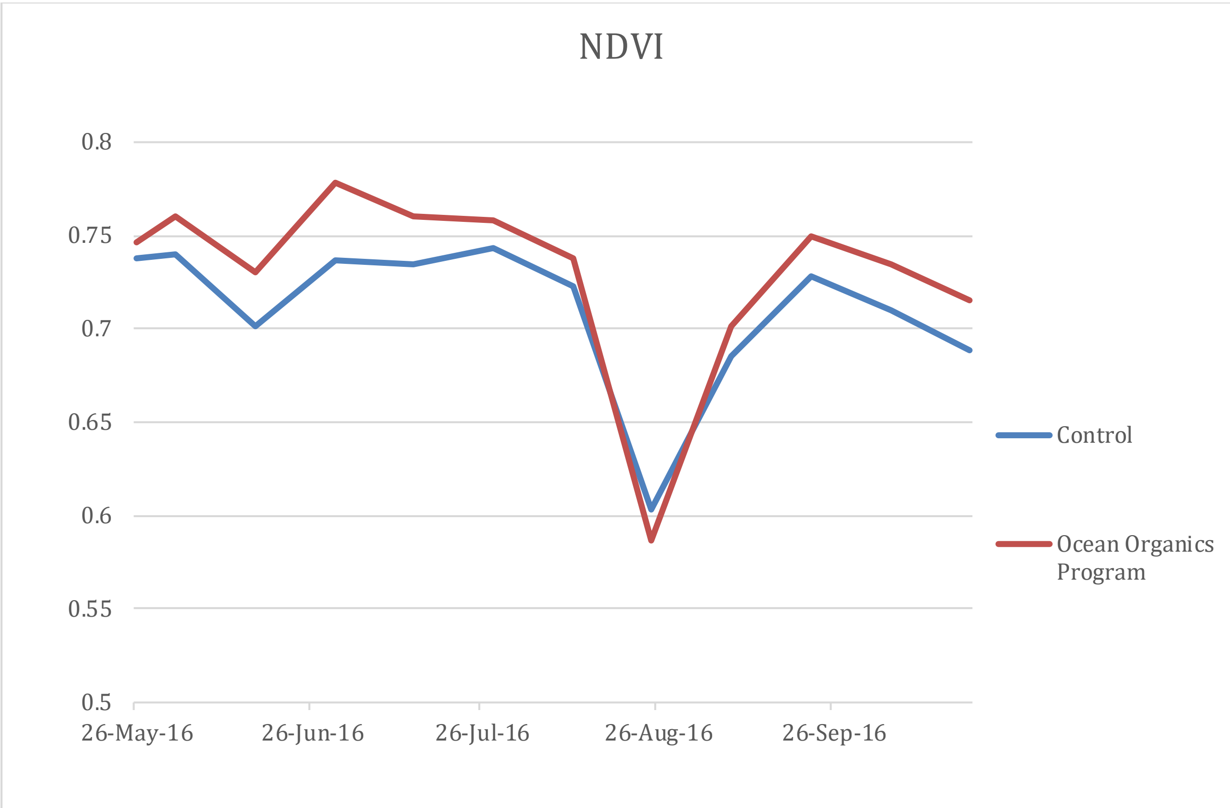

Figure 5. Normalized Difference Vegetation Index (NDVI) collected from the plots during the salinity alleviation study in 2016. Riverside, CA. Only treatments significantly different from control are shown in the graph.