Evaluation of Fertilizer Products for Turf Quality and Drought Tolerance
2014 Final Report

Fertilizer study area at UC Riverside, CA. Since August 8, 2014, turf was hand-watered at 70% and 40% replacement ET_0. Fertilizer products were applied at monthly intervals beginning August 9 to October. Photo taken on 2/21/2015.

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The Bottom Line: Eight commercial and experimental fertilizers were tested for their ability to promote and sustain quality on 'Princess-77' bermudagrass turf under deficit irrigation. Treatments were applied monthly at 1 lb N/M from August to October 2014 and final ratings were collected in April 2015. Turf was irrigated at either 70% or 40% replacement ET_0 from August to November 2014. Bermudagrass quality was acceptable (6 or higher) until October 16, after which quality declined steeply. Gro-Power was consistently rated with the highest quality during the study period, and also improved turf quality and green cover during spring green-up. Granular Amidas caused consistent increase in quality, but was only significantly greater than other products (excluding Gro-Power) on five rating dates. Similar differences were observed in cover as assessed via digital image analysis (DIA). Lowest quality during 2014 and spring green-up in 2015 was observed on plots treated with HGLF and PALB + HGLF. Similar results were detected for Dark Green Color Index, where HGLF and PALB + HGLF showed the lowest color indices. Differences in visual quality were not detected between ET_0 replacement levels, but detrimental effects on water reduction were detected for DGCI and percent green cover. Overall, results of this study substantiated our hypothesis that sufficient N fertilization can help prolong turf quality under drought or deficit irrigation. Furthermore, Gro-Power provided the best improvement to turf quality in this study.

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Introduction:

Water availability, or the lack thereof, outweighs all other biotic and abiotic factors in limiting crop yields. As water resources inevitably decline due to population growth and resultant irrigation requirements, water use must necessarily be reduced, especially during drought. In turf, drought stress will result in discoloration, weed invasion, and reduction of turf benefits such as reduced erosion, protection of surface water quality, reduction of urban heating and fire hazards. These negative effects can be partially mitigated through the use of warm-season grasses that, due to their specialized photosynthetic process, can tolerate greater degrees of drought stress than other grasses. Sufficient fertilization may help to maintain turf quality under multiple stressors, including reduced water availability. The objective of this study was to evaluate commercial and experimental fertilizers for their ability to maintain acceptable turf quality under deficit irrigation.

Materials and Methods:

The study was conducted in 2014-15 at the UC Riverside turfgrass research facility in Riverside, CA on mature bermudagrass 'Princess 77' turf. Environmental data for the site are provided in Table 1. Prior to application of fertilizer treatments, the entire field received a total of 3 lb N/M in 2014. The 60' x 90' field was divided into six 30' x 30' plots. From August 11 until November 10, 2014 plots were hand watered at 40% or 70% of previous week ET_0, as determined by an on-site CIMIS station. Each ET_0 replacement treatment was replicated three times. Plots did not receive any irrigation during the winter when bermudagrass went into dormancy. Fertilizer products (see Table 2) were randomized inside the ET_0 replacement plots and applied monthly beginning August 9, 2014. Each treatment was applied at a rate resulting in 1 lb N/M. All materials were directly applied as granular except the 'Amidas (spray)' treatment. Granular treatments were applied with shaker jars, while spray treatments were applied using a CO_2-powered hand boom sprayer equipped with TeeJet 8004VS nozzles and output of 2 gal/M. Every two weeks, plots were evaluated for turf quality on a scale from 1 = worst to 9 = best, volumetric soil water content (VWC) using time domain reflectometry (TDR), and dark green color index (DGCI) as well as percent cover using Digital Image Analysis (DIA). Visual turf quality and % green cover using DIA were taken to measure the effect of fertilizer products on bermudagrass green-up in spring 2015.

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 if treatment effect (fertilizer), ET_0 replacement effect, or their interaction was significant during one or more rating dates.

Results:

- Quality: Only fertilizer treatment significantly affected quality on all rating days following the first application. No differences were detected between different watering regimes. Bermudagrass quality was acceptable until October 16, after which quality declined steeply. Gro-Power was consistently rated with the highest quality during the study period. Granular Amidas also caused an increase in quality, but was only significantly greater than other products (excluding Gro-power) on September 4 and 18, October 16, December 4 and December 31. The lowest quality was observed on plots treated with

HGLF and PALB + HGLF. Overall, the treatment containing Gro-Power provided the best improvement to turf quality during the study (Figure 1).

- DGCI: Except for the first rating date prior to fertilizer application, fertilizer application always resulted in significant differences among treatments. Gro-Power, Granular Amidas, and Turf Royale achieved the highest DGCI at the beginning of the study, though by the conclusion no significant differences were detected among treatments. As with quality, HGLF and PALB + HGLF showed the lowest color indices (Figure 2). The effect of ET replacement was observed from October 2 until the end of the study, with treatments receiving 70% replacement achieving a darker green color (data not shown).

- Cover: Fertilization treatment effect was significant on all rating dates. Cover closely mirrored quality results, with Gro-Power consistently resulting in higher turf coverage. Beginning in September, Gro-Power achieved the highest green cover. Turf Royale and Sprayable Amidas reached the same percentage of green cover during five rating dates (Figure 3). Lowest green cover was consistently detected in plots fertilized with HGLF and PALB + HGLF. The effect of differential irrigation was significant beginning November 1 through the end of the study (data not shown).

- Soil Water Content: Significant differences in soil water content were detected between irrigation treatments beginning in November and continuing through the end of the study. Significant interaction between fertilizer treatment and irrigation regime was detected beginning in December, near the completion of the study. Plots receiving higher rates of irrigation were shown to result in increased soil water content, and those receiving the previously mentioned effective fertilizers with sufficient irrigation resulted in the highest soil water content. Turf Royale irrigated at 70% resulted in the highest soil water content (Figure 4).

- Green-up Quality: Green-up results closely resembled the results discussed above. Fertilization treatment had a significant effect on bermudagrass quality on all rating dates (Photo 1). Summer applications of Gro-Power resulted in the highest quality on all rating dates. Granular Amidas led to a significant increase in quality on March 19 and 27, 2015 in comparison to other fertilizers. The lowest quality was found in plots that had received PALB and HGLF (Figure 5).

- Green-up % green cover: Green cover was found to significantly differ based on fertilization treatment, with similar results to green-up quality. Gro-Power, granular Amidas, Calcinit and Turf Royale led to the highest green cover on all rating dates, whereas PALB and HGLF consistently demonstrated significantly lower cover (Figure 6).

- Green-up Soil Water Content: No differences were found in TDR results as all plots received the same irrigation rates during spring green-up (data not shown).

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

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

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 Max Rel Hum (%)	Avg Min Rel Hum (%)	Avg Rel Hum (%)	Avg Dew Point (°F)	Avg Wind Speed (mph)	Avg Soil Temp (°F)
Aug 2014	7.29 K	0.28 K	605 K	14.9	91.0	63.6 L	76.1	75	27	49	54.9	4.1 K	73.4
Sep 2014	6.19 K	1.45	538 K	14.7	91.6 K	64.6 L	76.7 K	72	27	48 K	54.6 K	3.8	73.4
Oct 2014	4.40 K	0.00 K	419 K	11.6 K	84.9	57.7	69.8 K	71 K	27 K	49 K	47.5 K	3.3 K	67.4 K
Nov 2014	3.21	0.20 K	297 K	7.5 K	75.0 K	49.7 K	62.2 K	61 K	25 K	41 K	34.4 K	3.6 K	59.4 K
Dec 2014	2.01 K	2.81 K	212	8.9 K	64.8 K	46.5 K	55.0 K	75	41	59 K	39.5 K	3.8 K	55.2
Tots/Avgs	23.10	4.7	414	11.5	81.5	56.4	68.0	71	29	49	46.2	3.7	65.8

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

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 Max Rel Hum (%)	Avg Min Rel Hum (%)	Avg Rel Hum (%)	Avg Dew Point (°F)	Avg Wind Speed (mph)	Avg Soil Temp (°F)
Jan 2015	2.83	0.53 K	262	7.1 K	70.5	46.1 K	57.5 K	66	27	45 K	34.3 K	3.8 K	52.1
Feb 2015	3.32	0.73 K	376 K	8.7 K	74.6 K	48.1	60.1 K	73	28	50 K	39.9 K	3.5 K	57.3 K
Mar 2015	5.85	0.24 K	509 K	8.0	79.3 K	51.6 K	65.0 K	64	22	40 K	37.6 K	4.2 K	60.1
Tots/Avgs	12.00	1.5	382	7.9	74.8	48.6	60.9	68	26	45	37.3	3.8	56.5

Flag Legend		
M - All Daily Values Missing	K - One or More Daily Values Flagged	
J - One or More Daily Values Missing	L - Missing and Flagged Daily Values	
Conversion Factors		
W/sq.m = Ly/day/2.065	inches * 25.4 = mm	(F-32) * 5/9 = c
	mBars * 0.1 = kPa	--

Table 2. Properties of fertilizer products used in the fertilizer study in Riverside, CA. 2014.

No.	Treatment	Company	Analysis/Application Rate	Nitrogen Source
1	Amidas (Granular)	Yara	40-0-0/1 lb N/M	35% Urea 5% Ammonium
2	Amidas (Spray)	Yara	40-0-0/1 lb N/M	35% Urea 5% Ammonium
3	Turf Royale	Yara	21-7-14/1 lb N/M	11.1% Ammoniacal 9.9% Nitrate
4	Calcinit	Yara	15.5-0-0/1 lb N/M	1.1% Ammoniacal 14.5% Nitrate
5	PALB + HGLF	AgriPower	½ qt/A + ½ qt/A	-
6	HGLF	AgriPower	½ qt/A	-
7	Best Super Turf	Simplot	25-5-5/1 lb N/M	10.6% Ammoniacal 14.4% Polymer-coated Urea
8	Gro-Power	Gro-Power	5-3-1/1 lb N/M	1% Ammoniacal 4% Urea

Table 3. Application record for commercial and experimental products in the fertilizer study. 2014. Riverside, CA.

Timing (months)	Initial	1	2
Date	9 August 2014	6 September 2014	11 October 2014
Average Temperature	74F	81F	70F
Average Wind Speed	4.2 mph	3.7 mph	3.2 mph
Conditions	Sunny, Clear	Sunny, Clear	Slightly Overcast

Phone 1. Image of 40% ET_0 replacement plot showing residual effects of fertilizer treatments. Photo taken on 2/21/2015.

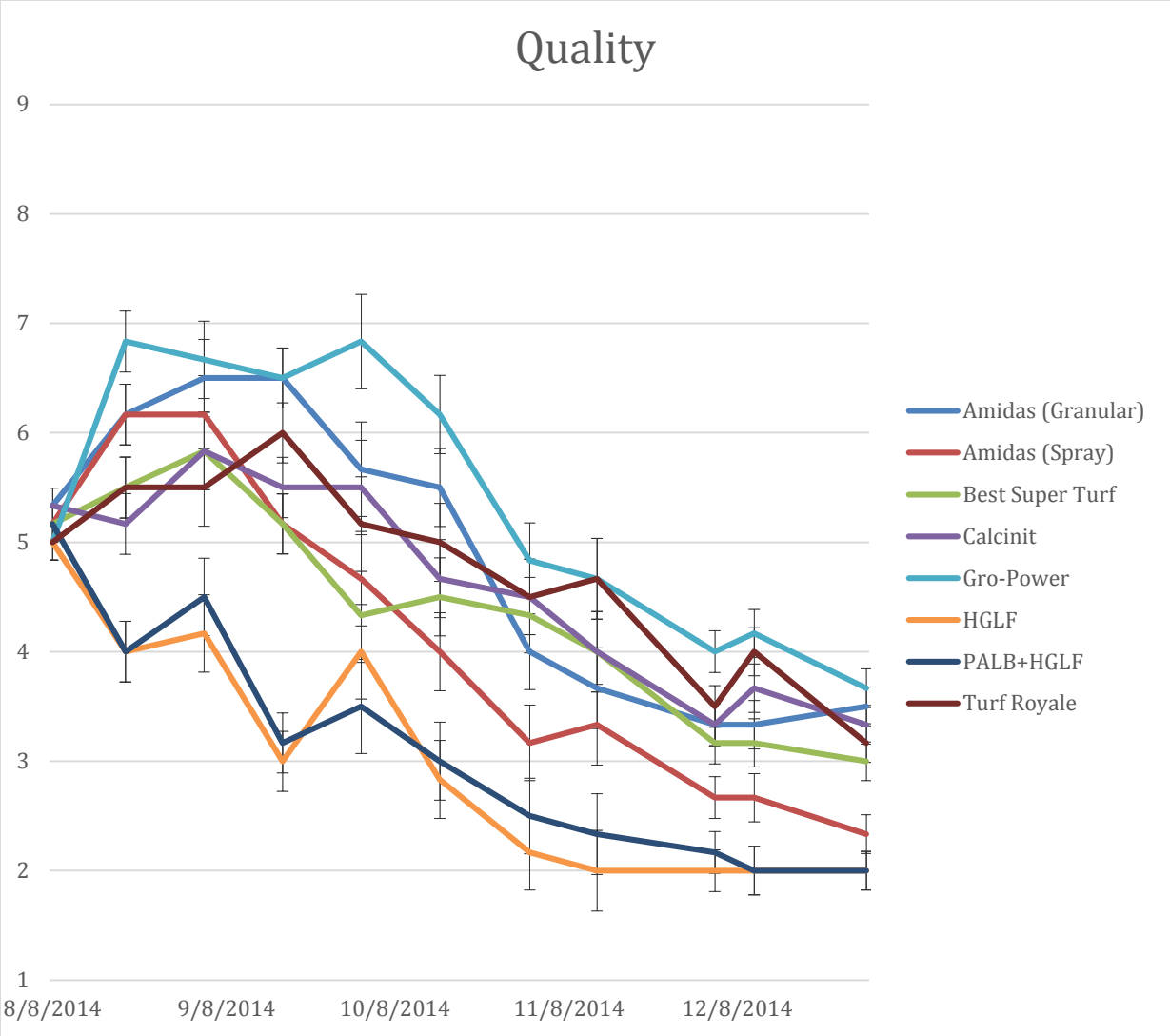

Figure 1. Average turf quality (1 to 9 scale, 9 = best) of plots across irrigation regimes in response to treatments in the fertilizer study in 2014. Riverside, CA.

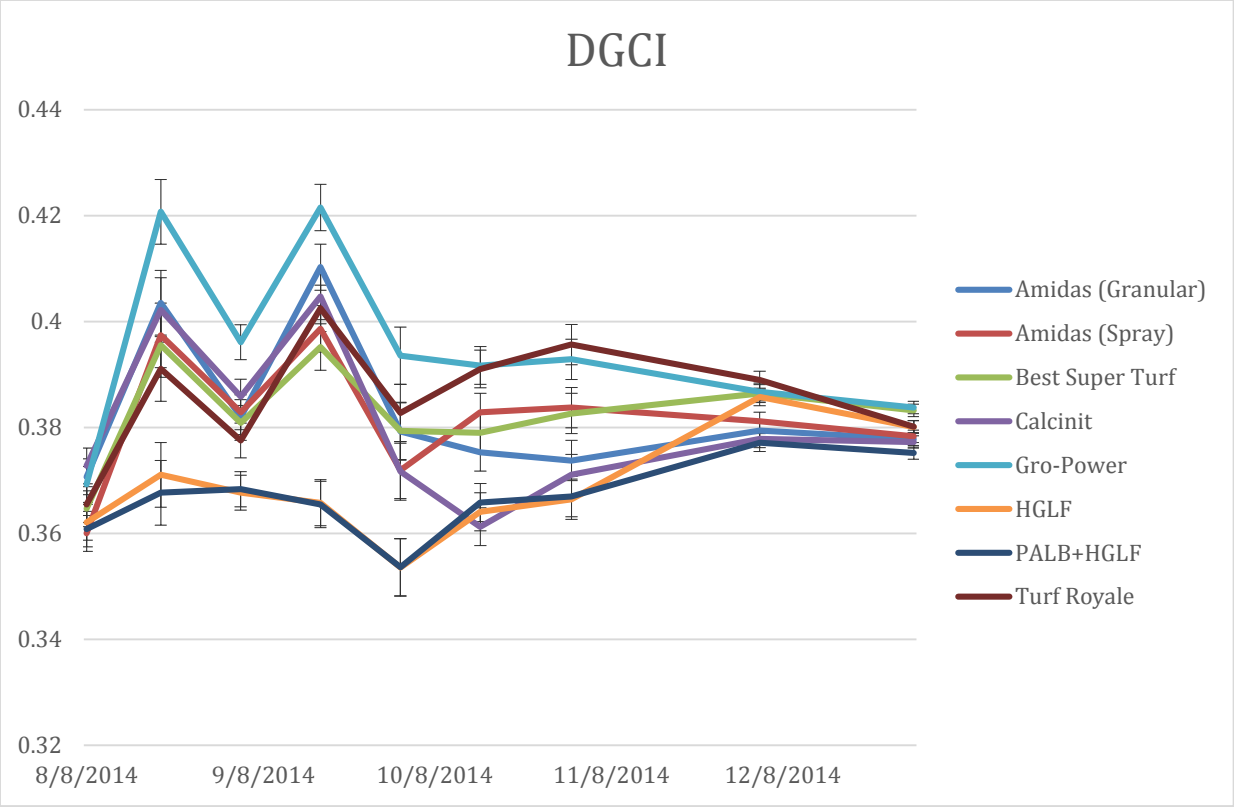

Figure 2. Average Dark Green Color Index (DGCI) of plots across irrigation regimes in response to treatments in the fertilizer study in 2014. Riverside, CA. Ratings for November 13 and December 11 are not included due to computer failure resulting in lost data.

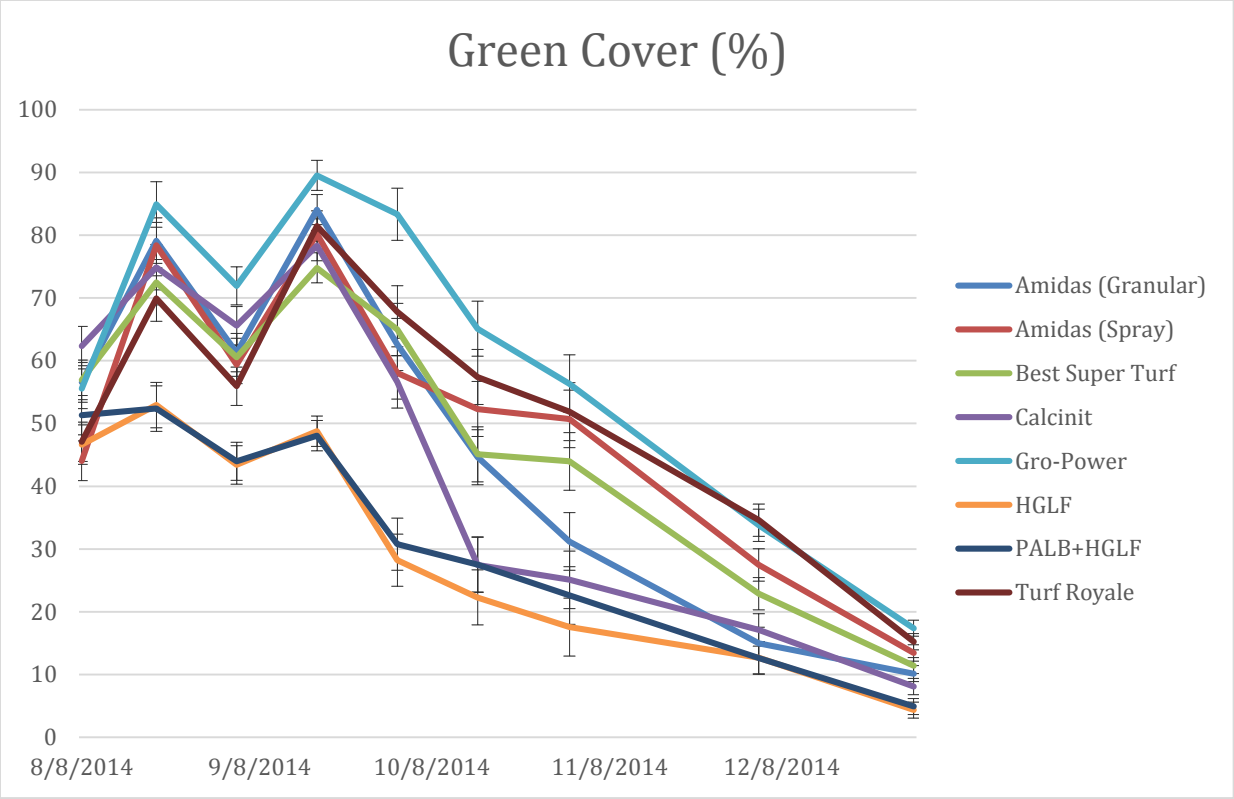

Figure 3. Average percent coverage of plots across irrigation regimes in response to treatments in the fertilizer study in 2014. Percent coverage is measured by DIA and represents green turf coverage. Riverside, CA. Ratings for November 13 and December 11 are not included due to computer failure resulting in lost data.

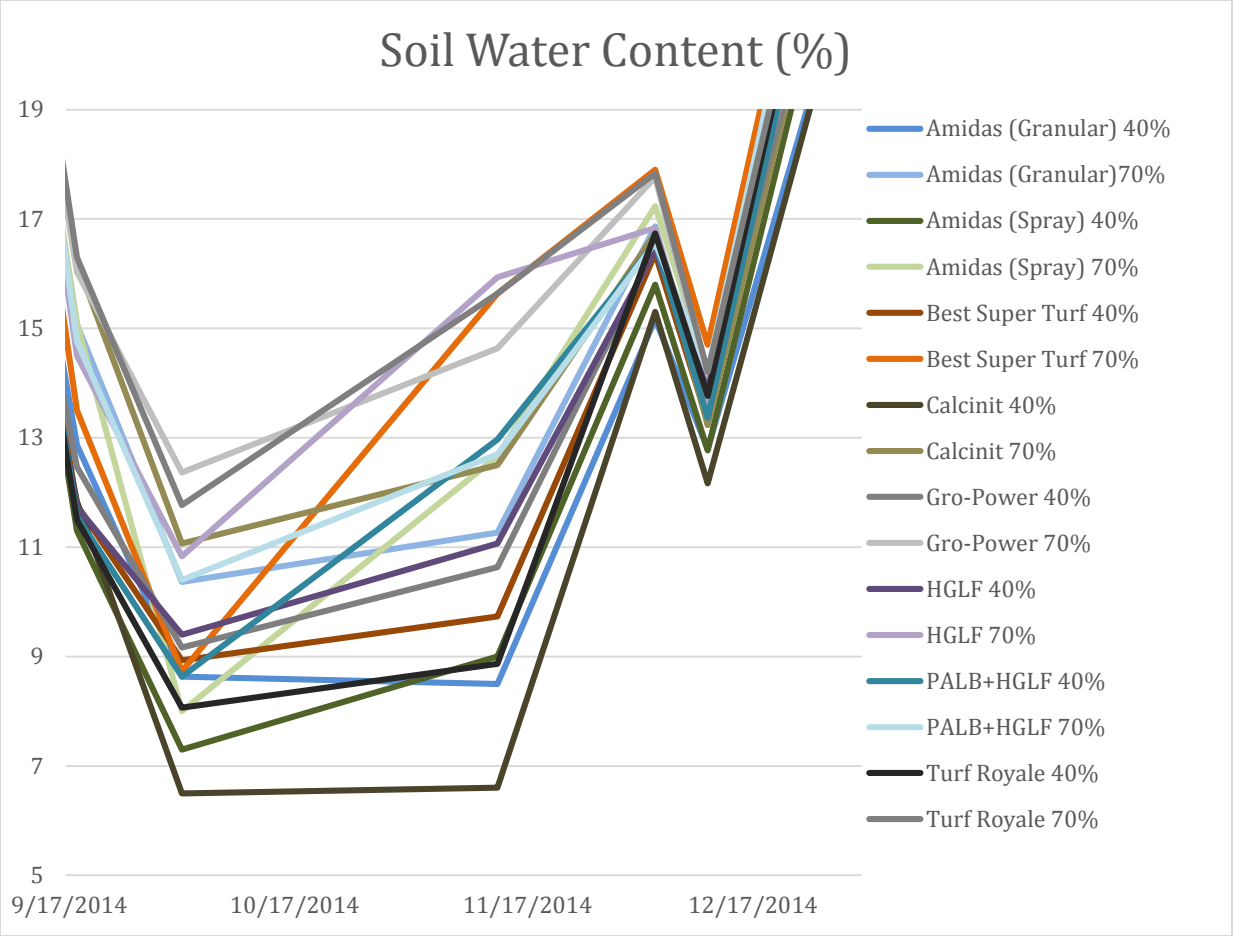

Figure 4. Soil water content as determined by TDR for each plot. Ratings are missing for September 4, October 16, and November 1 due to issues with TDR probe. No significant differences were detected until November between watering regimes, and interaction between treatment and irrigation was not detected until December. Therefore, only this range is included in the graph. Riverside, CA.

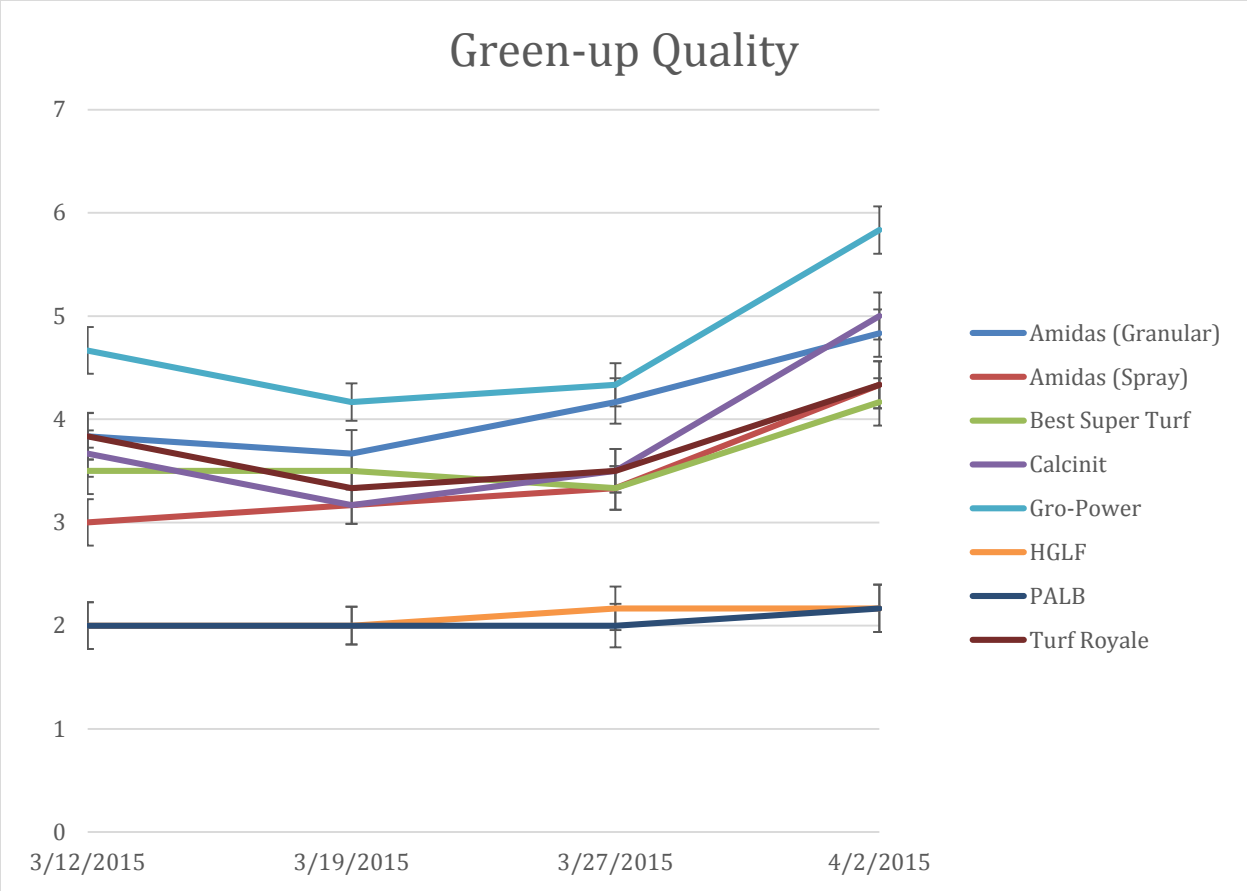

Figure 5. Average turf quality (1 to 9 scale, 9 = best) of plots across irrigation regimes in response to treatments in the fertilizer study during green-up in 2015. Riverside, CA.

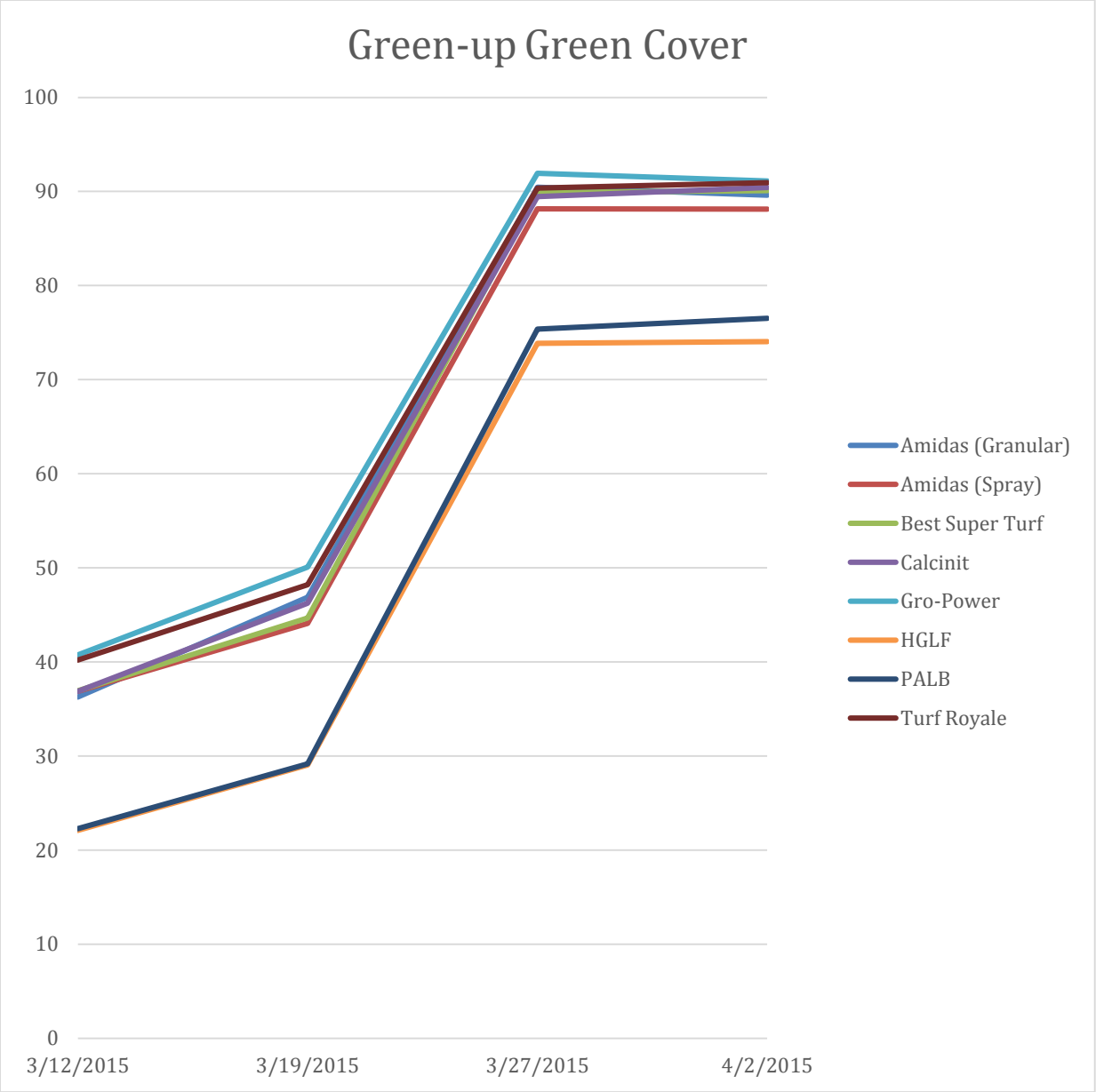

Figure 6. Average percent coverage of plots across irrigation regimes in response to treatments in the fertilizer study during green-up in 2015. Percent coverage is measured by DIA and represents green turf coverage. Riverside, CA.