Evaluation of Robust Fertilizer
Kentucky Bluegrass Trial

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EXECUTIVE SUMMARY

A fertilizer trial was conducted with Robust Kentucky Bluegrass Fertilizer. Robust is a fertilizer blended with various humic acid and possibly other additives thought to improve nutrient use and efficiency while producing growth stimulation effects.

Four treatments were applied in a Randomized Block Experimental Design at four locations:

- Control
- urea + traditional
- PCU + traditional
- Robust

Robust fertilizer (15-7-7) was analyzed to determine concentrations of all nutrients. The amount of each nutrient in the Robust Fertilizer was then matched with the other fertilized treatments.

Nitrogen was matched with urea or Polymer-Coated Urea (PCU). There was a significant fertilizer response, regardless of source, at all four locations.

Not surprisingly, application of urea resulted in rapid greening, but also excessive shoot growth early in the fall. Urea also resulted in greater shoot nitrogen (N) concentration at two locations just four weeks after application, with that trend reversed in the late season.

Both the Robust and PCU plots showed slow/control release properties with more steady growth throughout the fall season. In addition, the Robust produced additional improvement at the sandy soil location with a significant improvement in visual appearance over all other treatments. Robust also resulted in greater shoot phosphorus (P) concentrations more than all other treatments at the end of the season.

Furthermore, fertilization resulted in increased nutrient uptake in all treatments. There were no differences between fertilization treatments for nutrients except nitrogen (N) and phosphorus (P).

INTRODUCTION

Previous research results indicate that blending fertilizer with humic acid can result in increased plant health and nutrient uptake, especially with P uptake. Phosphorus is poorly soluble in soil thus, in some cases, blending humic acid with P can improve P's solubility. Robust fertilizer includes a blend of proprietary compounds, including but not limited to humic acid, with claims of improved nutrient solubility.

In addition, efficiency techniques with fertilizer can also improve various nutrient use. For example, one approach is to use fertilizers that have a controlled or slow release property. These strategies can minimize the amount of risk for volatilization, precipitation, leaching, and gas loss, thus making nutrients more available in a steady supply to the plant. Again, Robust fertilizer has claims of being a slow release fertilizer.

The objectives of this study was to evaluate the in-field impact of Robust fertilizer upon the growth and health of Kentucky bluegrass.

MATERIAL AND METHODS

Six replicates of four treatments (control, Urea + traditional, PCU + traditional, and Robust) were applied in a Randomized Block Experimental Design at four locations at Provo, Utah. 1-Each plot was approximately 1 by 3 yards.

Fertilization

Robust Fertilizer (15-7-7) was analyzed to determine concentrations of all nutrients (Table 1). The amount of each nutrient in the Robust Fertilizer was matched with the other fertilized treatments.

Table 1. Fertilizer analysis (averaged across two bags)

% N	% P	% K	% S	% Ca	% Mg	ppm Na	ppm Zn	ppm Fe	ppm Mn	ppm Cu	ppm B
15.4	4.5	7.9	19	2.1	0.85	1,548	64	987	474	33	43

Nitrogen was applied at a 2-lb/1000 ft^2 for all fertilized treatments. Robust (15-7-7), Urea (46-0-0), and Polymer-Coated Urea (46-0-0) were used to supply N. The amount of other nutrients was matched based on the amount applied in the Robust fertilizer.

Sources for the "traditional" applications used for the urea and PCU treatments were:

potassium phosphate	potassium sulfate
elemental S	copper sulfate
zinc sulfate	calcium chloride
manganese sulfate	magnesium chloride
ferrous sulfate	boric acid

Fertilizer was applied broadcast by hand to each plot at four locations:

- Established loam (turf at this site was established in approximately 2008),
- Established sand (turf at this site was established in approximately 2012),
- Newly Seeded loam (turf established late August 2015 with fertilizer applied just prior to seeding and raked in to a depth of 2 inches),
- Newly Sodded loam (turf established late August 2015 with fertilizer applied just prior to seeding and raked in to a depth of 2 inches.

Fertilizer application occurred on August 17 and 18, 2015. All sites had Kentucky bluegrass (*Poa pratensis* L.) as the predominate species with some inclusion of perennial ryegrass (*Lolium perenne* L.) and annual bluegrass (*Poa annua* L.) at the previously established sites.

Analysis

Beginning on August 24, 2015, readings were taken approximately every week. Weekly readings included:

- Visual ratings on a scale of 0 to 5, with 0 being bare soil and 5 being thick, vibrant green grass
- Normalized Difference Vegetative Index (NDVI)
- Plant height.

Biomass readings were also taken on September 21 and November 16, 2015, respectively. These biomass samples were taken by waiting one week after mowing at a height of two inches and then mowing at this same height to collect the new growth. These clippings were then analyzed for most essential nutrients by drying at 120°F to constant dry weight followed then by grinding with a Wiley Mill using a 60 mesh screen. Nitrogen (N) analysis was conducted via the Dumas combustion method using a LECO TruSpec CN Determinator (LECO Instruments, St. Joseph, MI, USA). The other nutrients were analyzed by digesting the tissue using nitric acid with microwave heating (Milestone Ethos EZ, Milestone Inc., Shelton, CT, USA) with analysis by ICP-OES (Thermo Scientific iCAP 7400, Thermo Fisher Scientific, Waltham, MA, USA). Note: No measurements were possible for the seeded site for approximately one month after seeding.

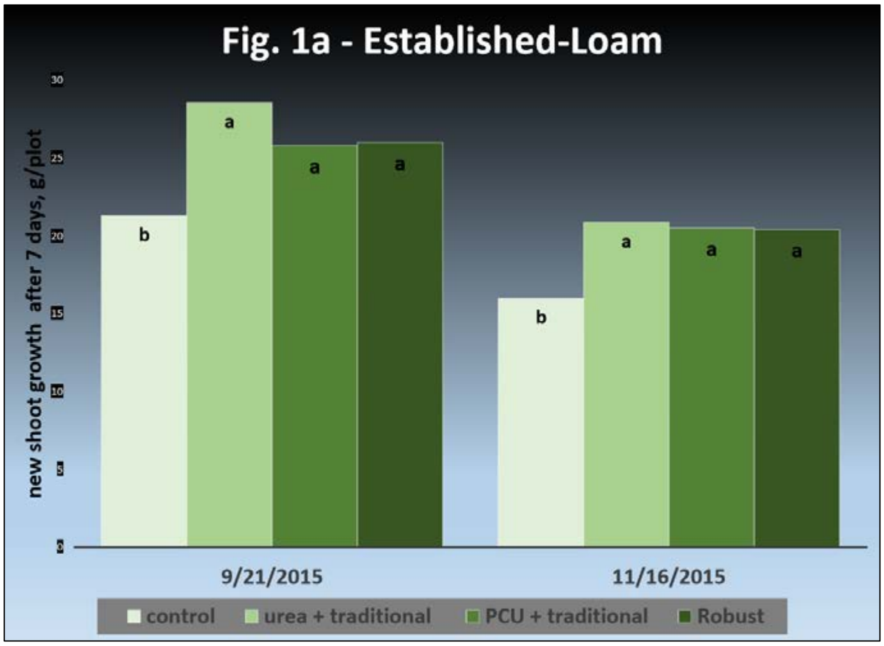
Statistical analysis was performed using SAS Software (SAS Inc., Cary, NC, USA) using ANOVA with mean separation by Tukey-Kramer method.

RESULTS AND DISCUSSION

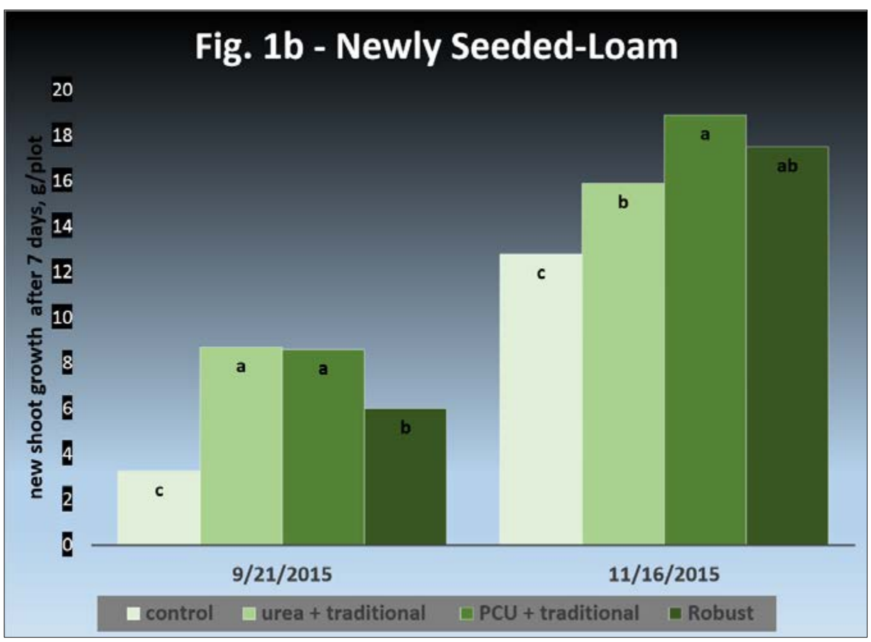
For turf grass, it is desirable to have a modest but not excessive amount of growth. Rapid growth results in excessive mowing and/or scalping when mowing is done infrequently.
In addition, clipping removal costs are related to the amount of biomass generated. Often, managers want to avoid clipping removal, but this is difficult and unwise in situations where there is a high level of growth.

In general, the fertilized treatments, regardless of source, gave a significant increase in growth over the unfertilized control. However, the source effect was not always consistent.

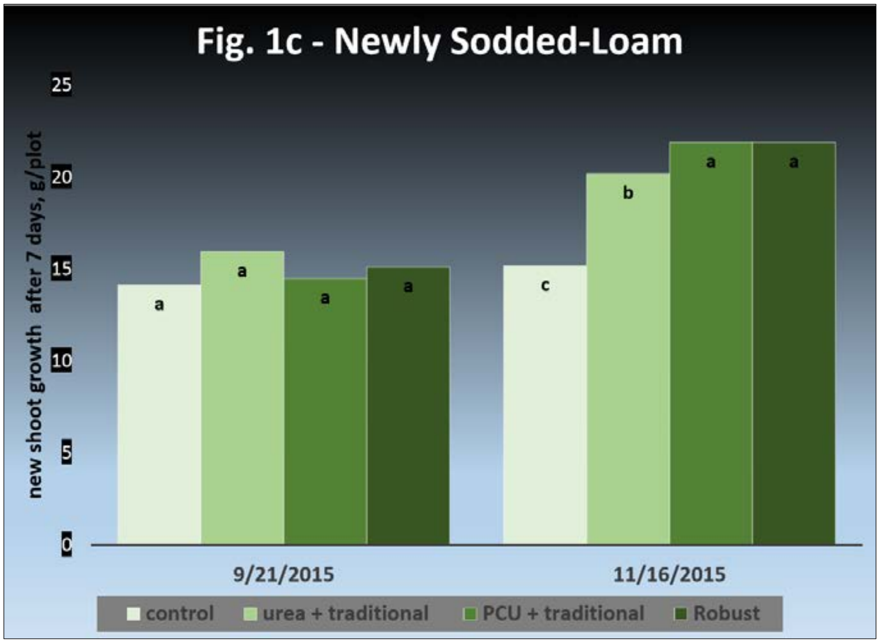
For the established loam site there were no statistical differences between fertilizer treatments when evaluating new shoot growth seven days after the last mowing (Fig. 1a).



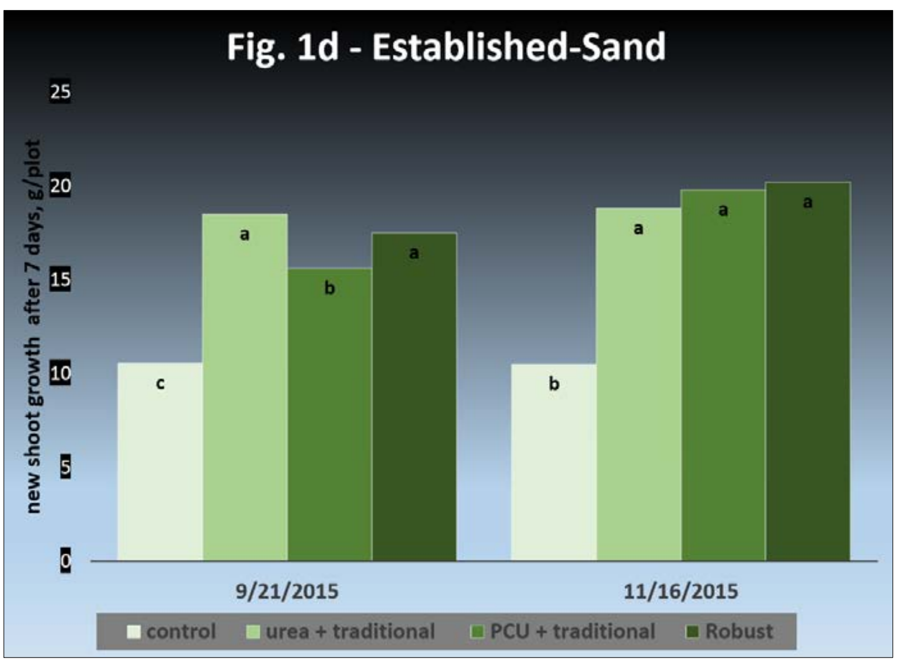
At the newly seeded loam site, the PCU and urea treatments had greater growth than Robust at the first sampling date on September 21, 2015, but the trend reversed at the end of the season on November 16, 2015. (Fig. 1b).



There were no differences in new shoot growth for the newly sodded site at the first sampling, likely due to the sod having few roots for nutrient uptake at that time. (Fig. 1c). However, the Robust and PCU had greater growth than the urea at the last sampling date.

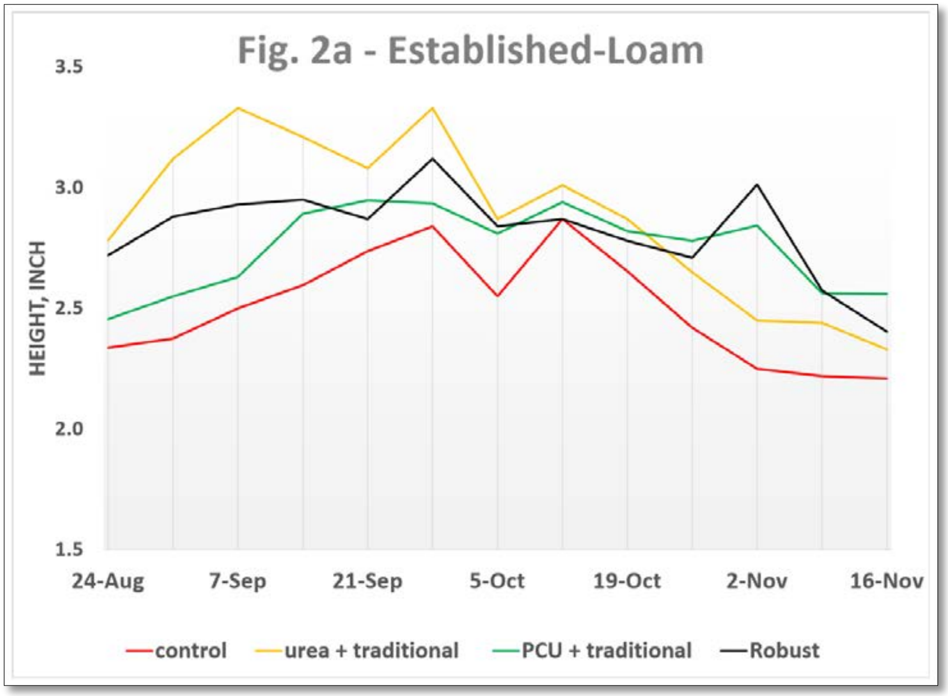


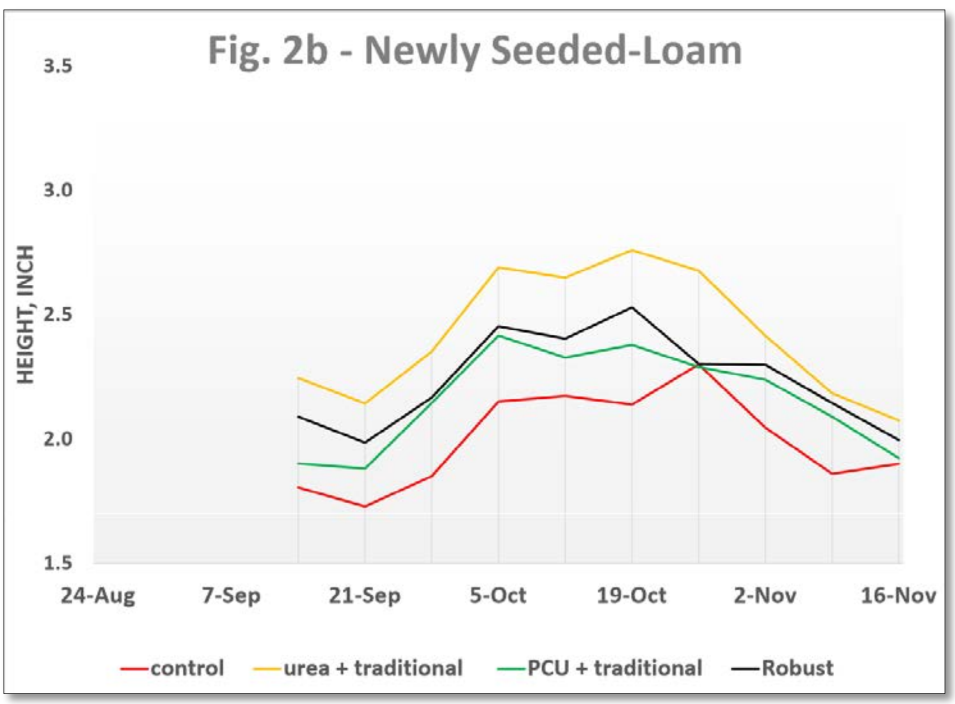
There were no differences in new shoot growth for the sand plot other than PCU having less growth at the early sample date (Fig. 1d).

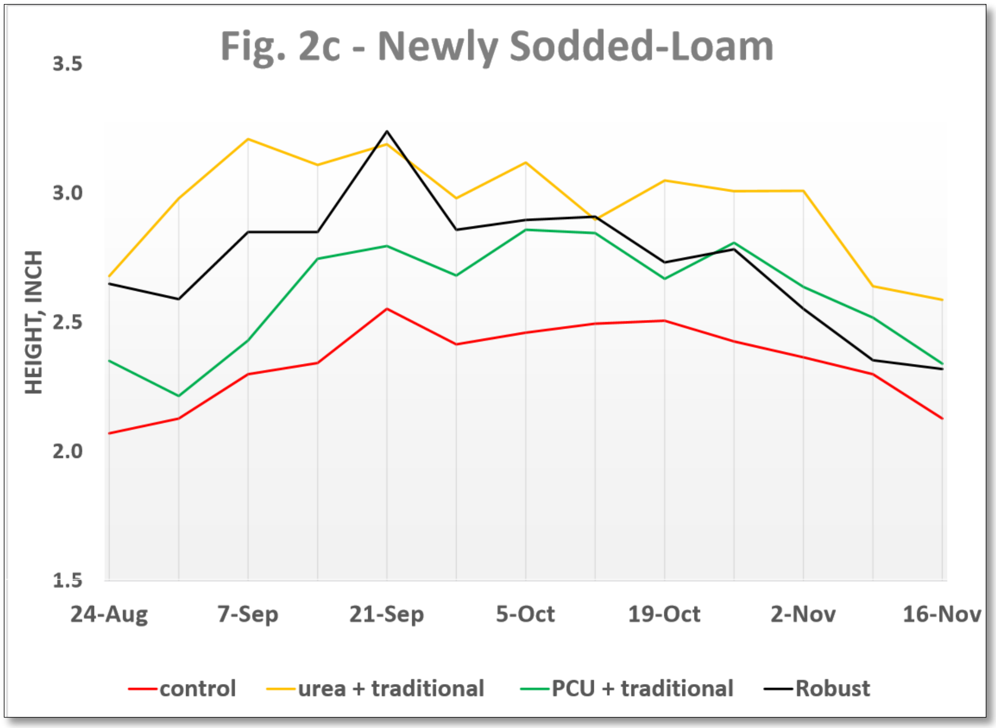


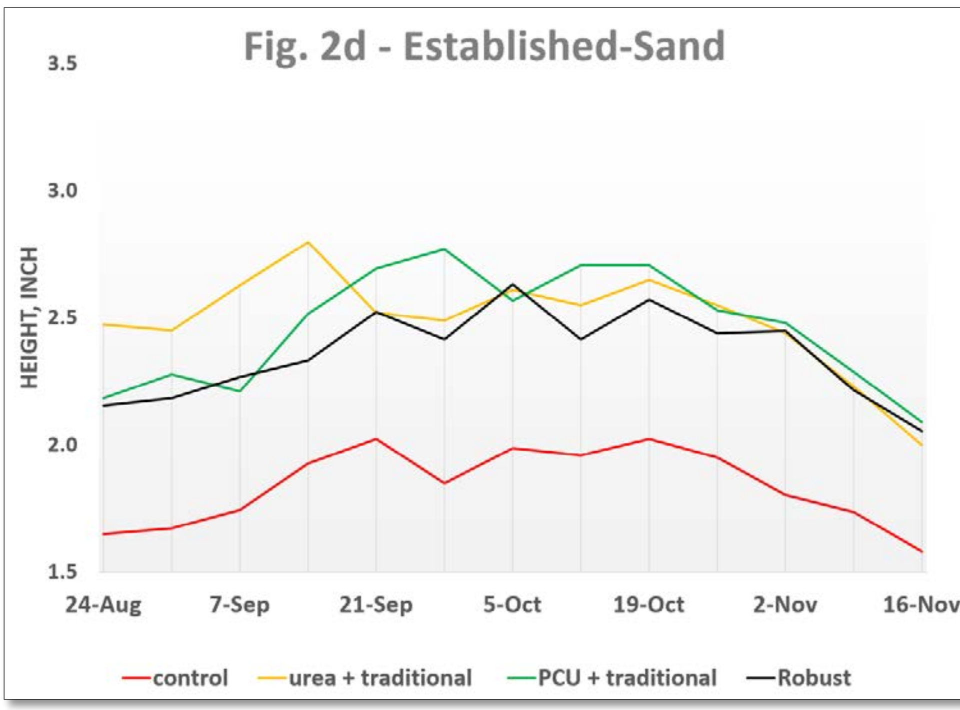
Biomass readings are time consuming and difficult to take and height readings have been shown to be highly correlated to the amount of new shoot growth. These readings were taken weekly

(Figs. 2a-d). Statistical analysis is not shown due to tremendous complexity, but the trends were very similar to those shown for the biomass readings.









Similarly, visual ratings (Figs. 3a-d) and NDVI readings (Figs. 4a-d) were conducted weekly. The trends for the visual ratings followed the height and biomass readings.

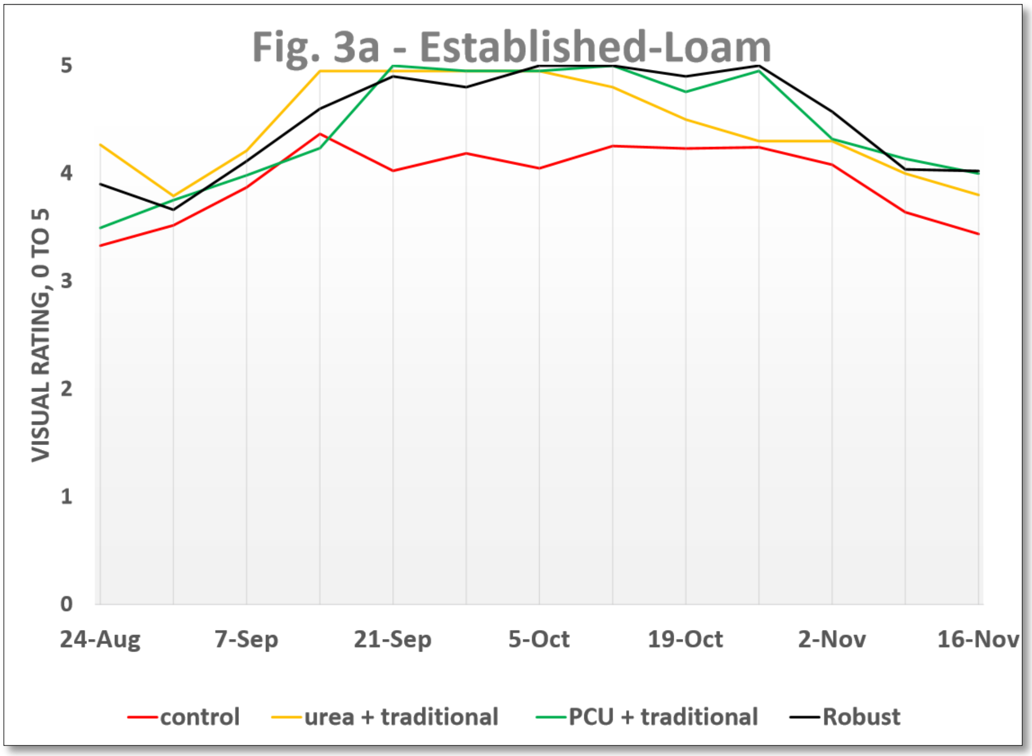


Fig. 3a - Established-Loam
VISUAL RATING, 0 TO 5
5
4
3
2
1
0
24-Aug
7-Sep
21-Sep
5-Oct
19-Oct
2-Nov
16-Nov
control
urea + traditional
PCU + traditional
Robust

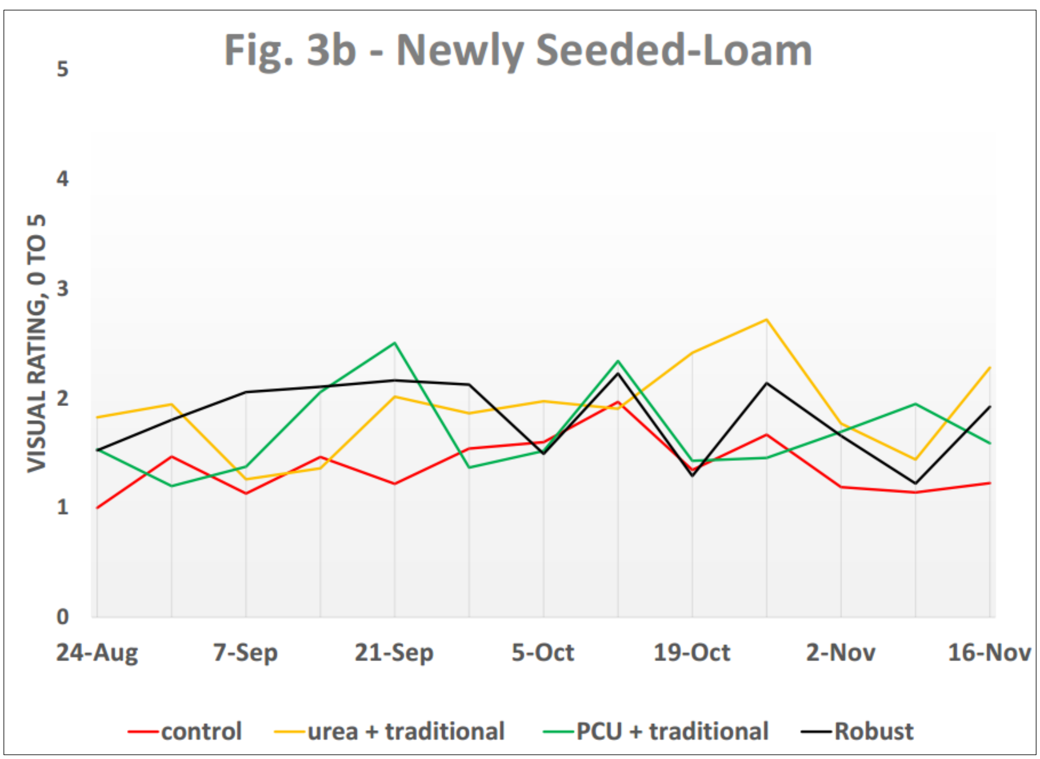
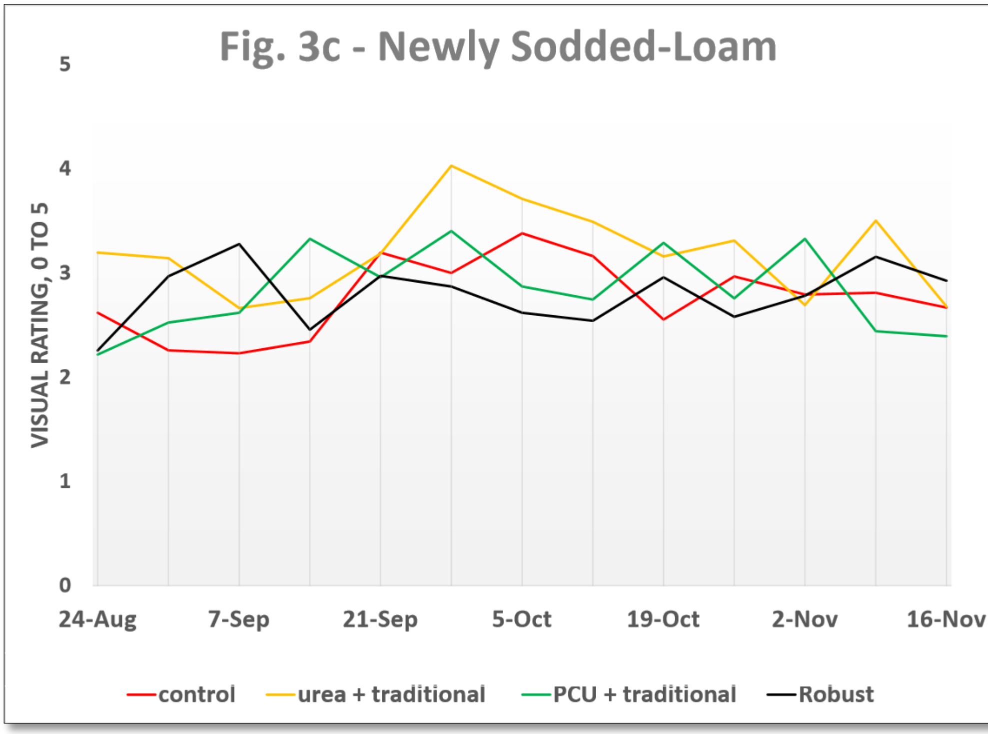
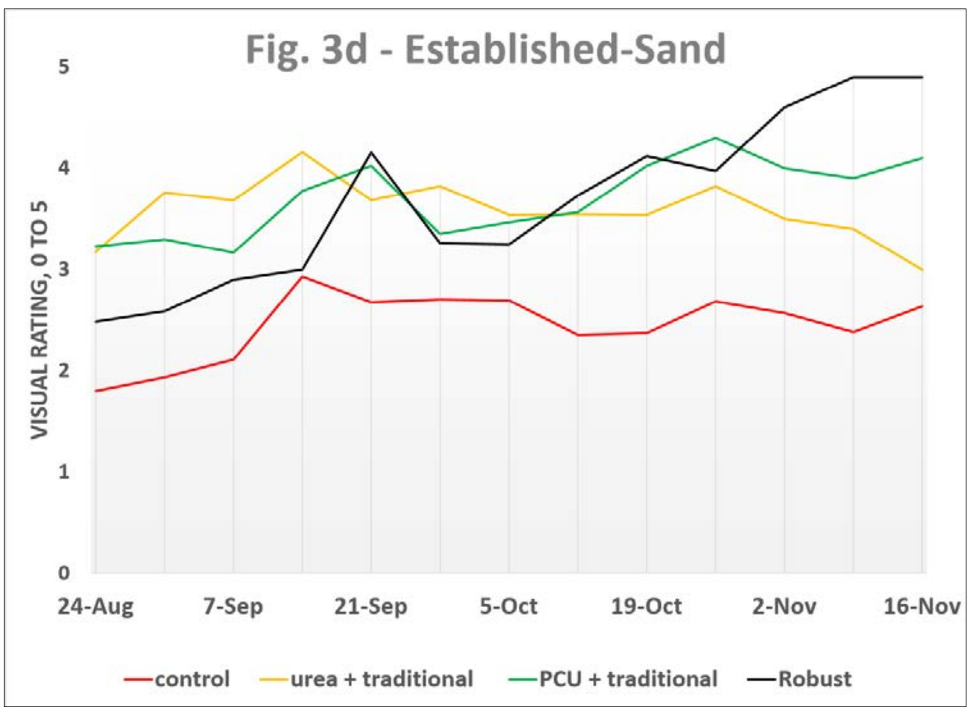
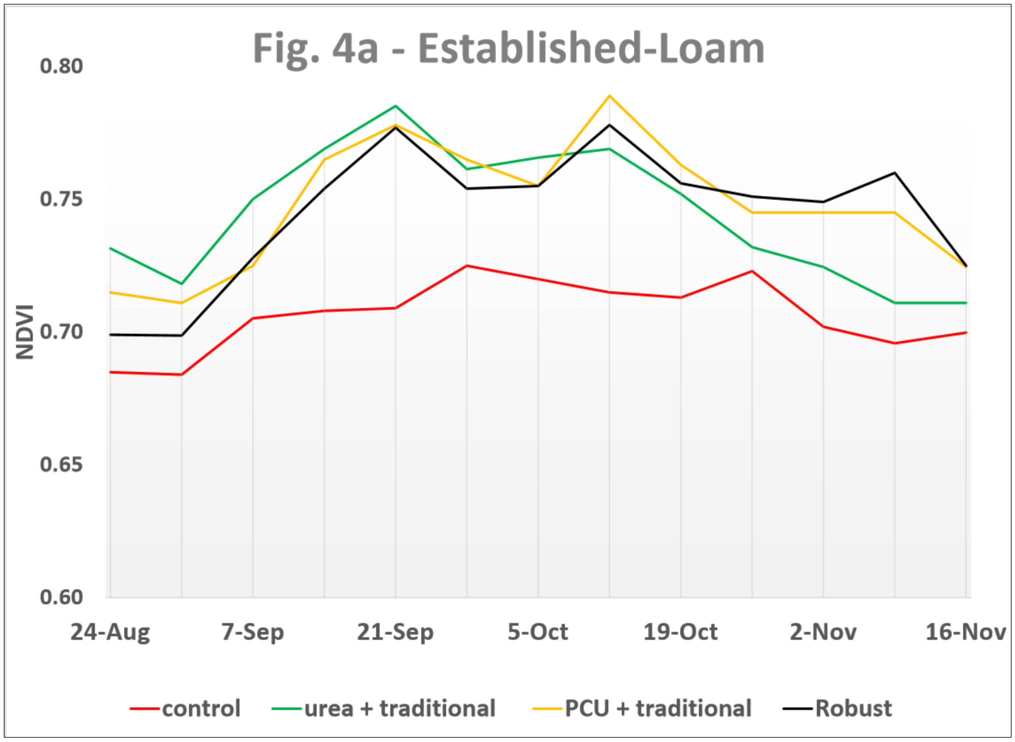


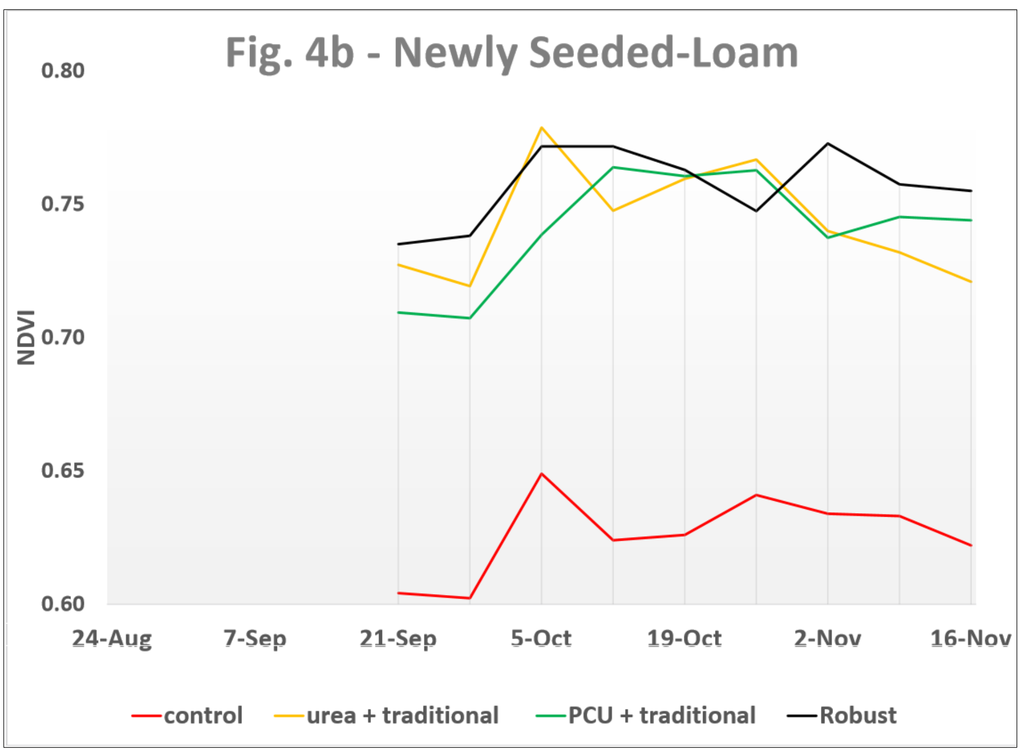
Fig. 3b - Newly Seeded-Loam
VISUAL RATING, 0 TO 5
5
4
3
2
1
0
24-Aug
7-Sep
21-Sep
5-Oct
19-Oct
2-Nov
16-Nov
control
urea + traditional
PCU + traditional
Robust

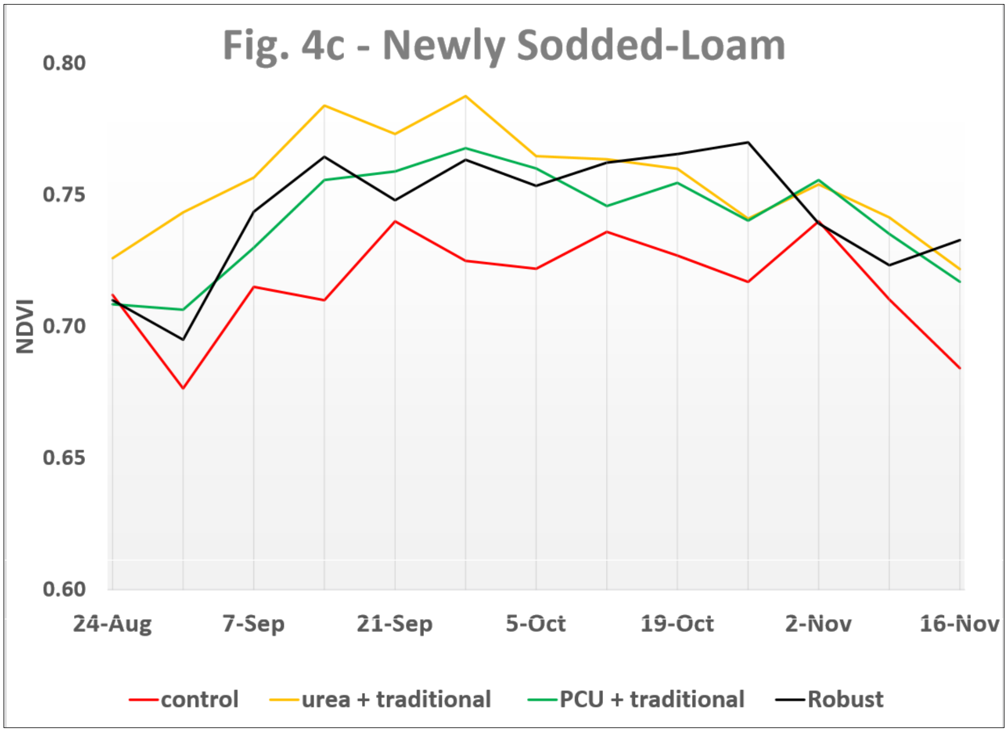


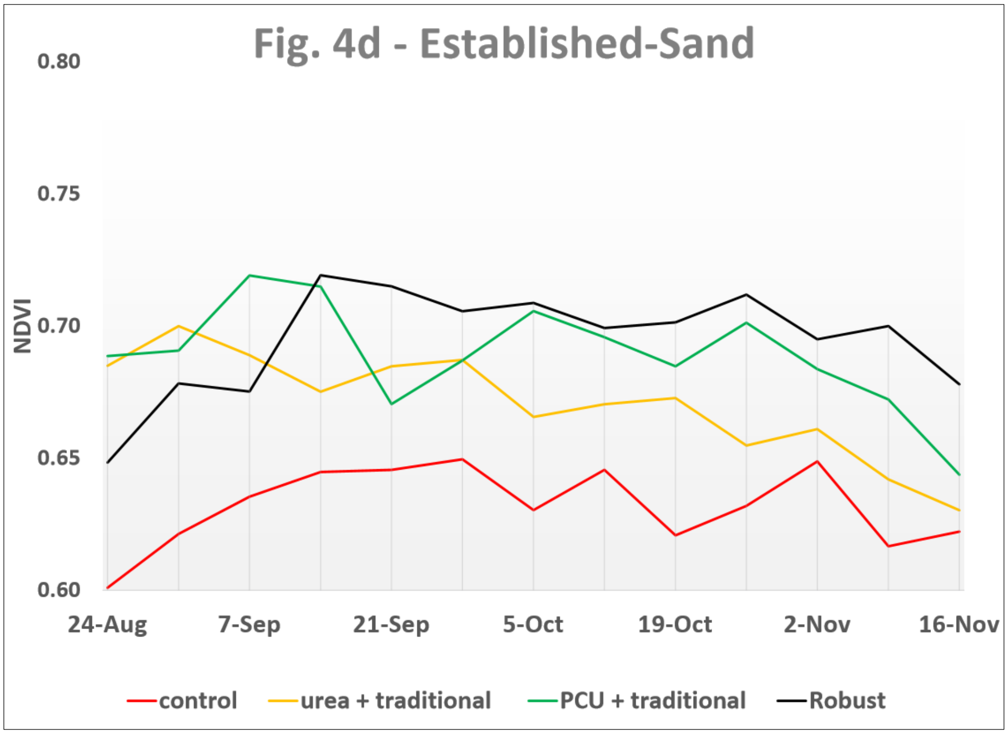


The NDVI readings are an indication of plant health. Plants that are less than perfectly healthy tend to reflect less when near infrared light. Although not visible to the naked eye, NDVI instruments can be used to measure this reflectance to compare with the visible spectrum and provide an assessment that is less biased and more scientific than a visual rating. In addition, problems with plant health can be spotted 10-20 days earlier with NDVI than when visual symptoms occur. When averaging NDVI visually over the course of the fall season, there were no differences between sources.

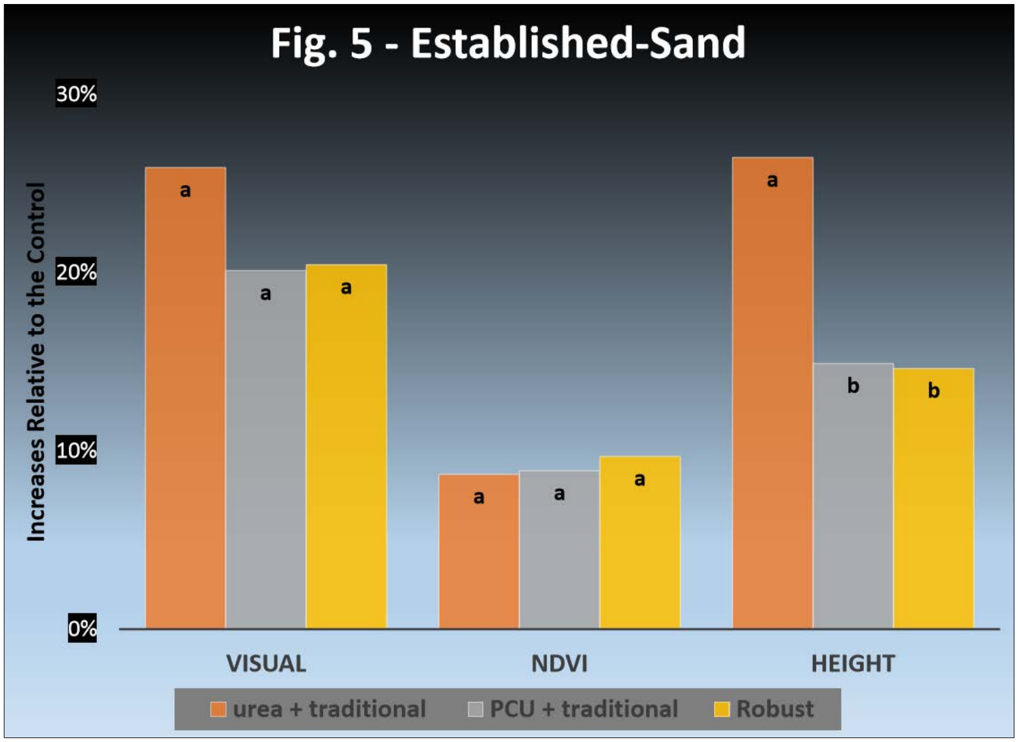








When averaged over the course of the fall season, there were no differences for visual and NDVI when examining the average increase relative to the control (Fig. 5). However, the urea resulted in significantly greater height than PCU or Robust, which would result in more mowing and clipping removal costs with no overall favorable impact on health or aesthetics (Fig. 5).



Note that most of the visual appeal occurred very early for the urea at the expense of excessive mowing; whereas, PCU and Robust gave similar health and aesthetics without excessive mowing early on.

Additionally, it is of interest to note the response of Robust in the sand soil. The NDVI values were low initially, but then were numerically greater than all others from September 14, 2015, onward (Fig. 4d). PCU fertilized grass was somewhat steady for NDVI. But the grass fertilized with urea started well, but then dropped nearly to the level of the control by the end of the season.

There were no differences for most nutrients (Tables 1-4), with the exception of N (Figs. 6a-d) and P (Fig. 7).

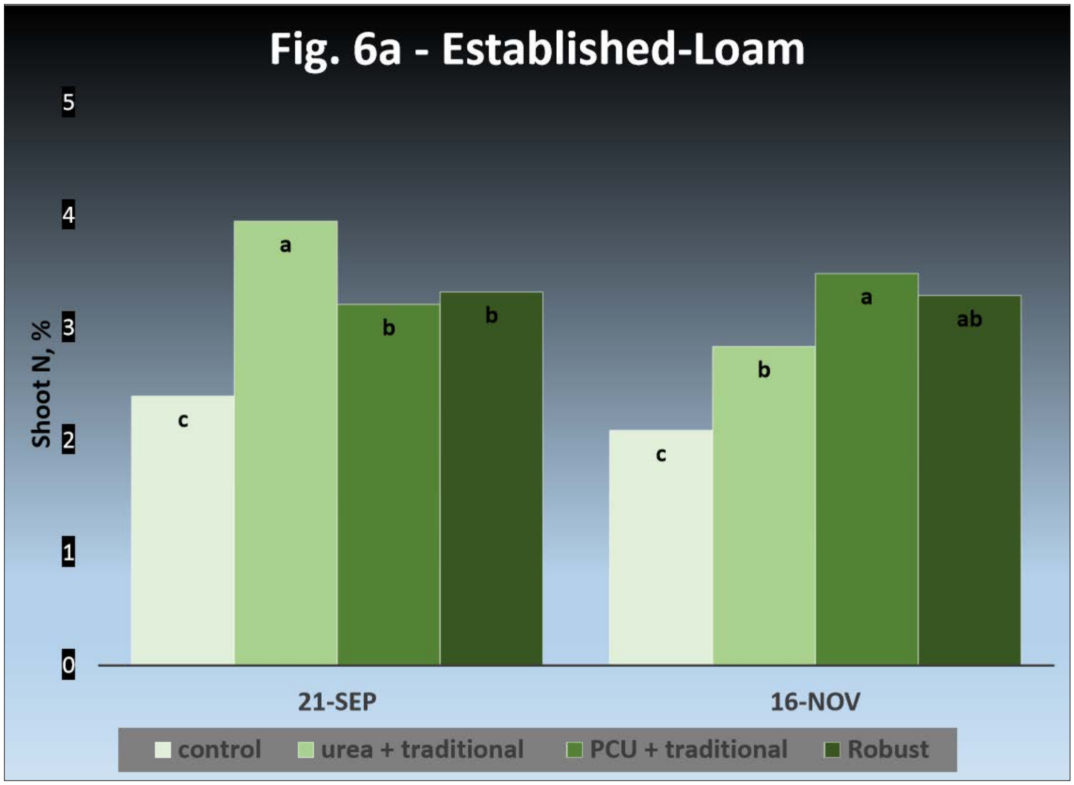


Fig. 6a - Established-Loam
Shoot N, %
0
1
2
3
4
5
a
b
b
c
c
b
a
ab
21-SEP
16-NOV
control
urea + traditional
PCU + traditional
Robust

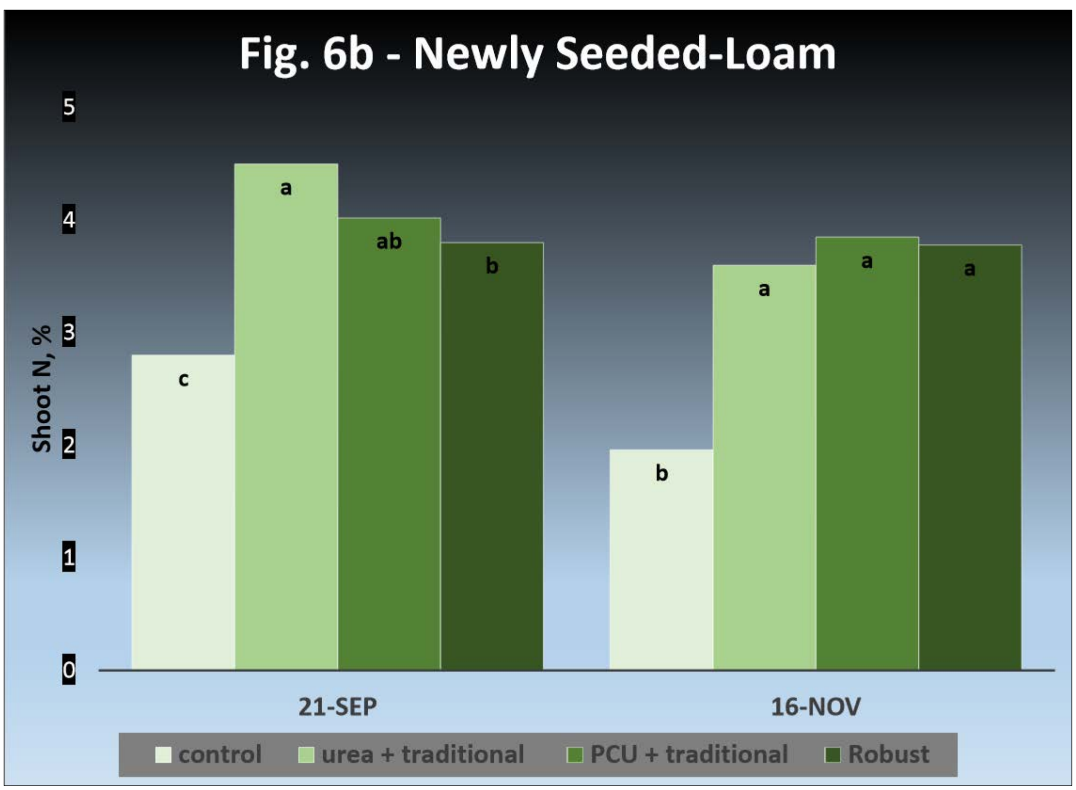
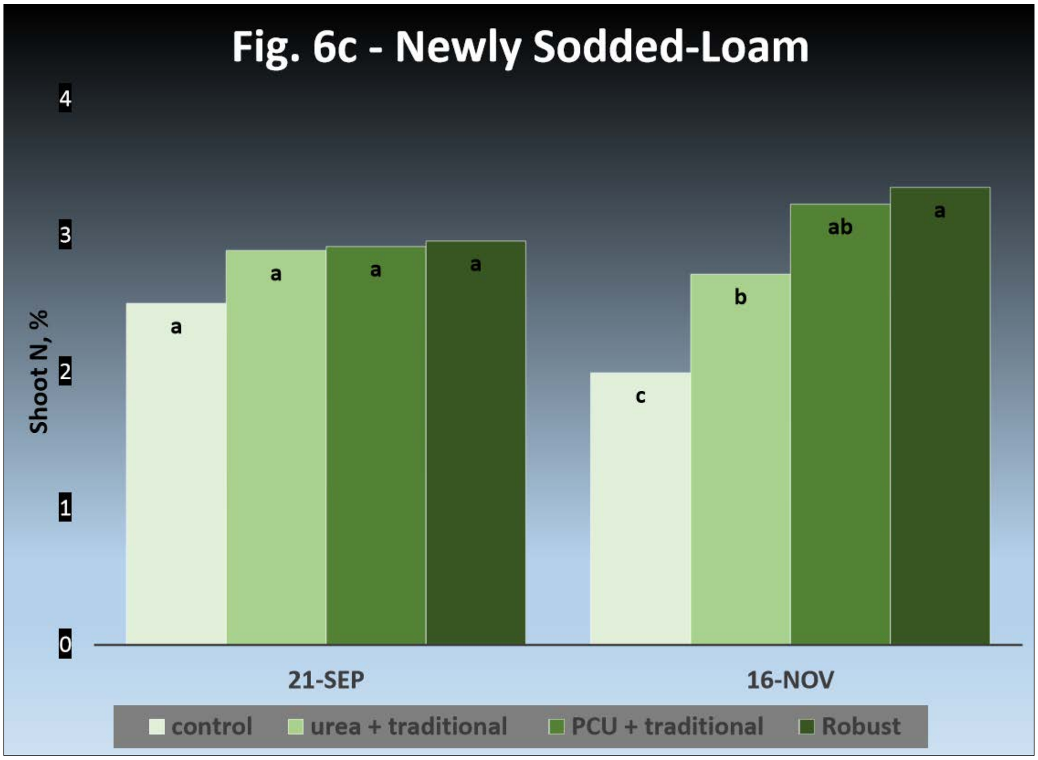
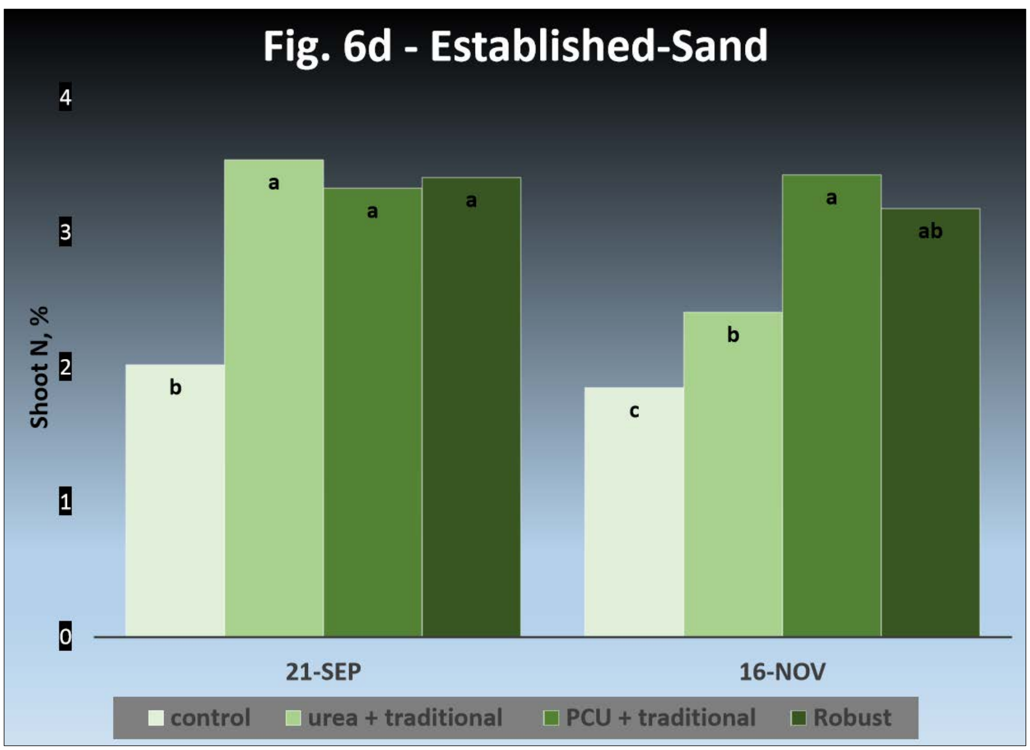


Fig. 6b - Newly Seeded-Loam
Shoot N, %
0
1
2
3
4
5
a
ab
b
c
b
a
a
a
21-SEP
16-NOV
control
urea + traditional
PCU + traditional
Robust





It is no surprise that the general trend was for N to be higher for the urea initially, then tapering off, since its N availability was all immediate and then lost (especially in the sand).

PCU and Robust showed a steadier supply of N.

The differences for P uptake were nearly identical across all sites and, thus, were combined for graphical purposes (Fig. 7). Robust showed a clear advantage over all the other treatments.

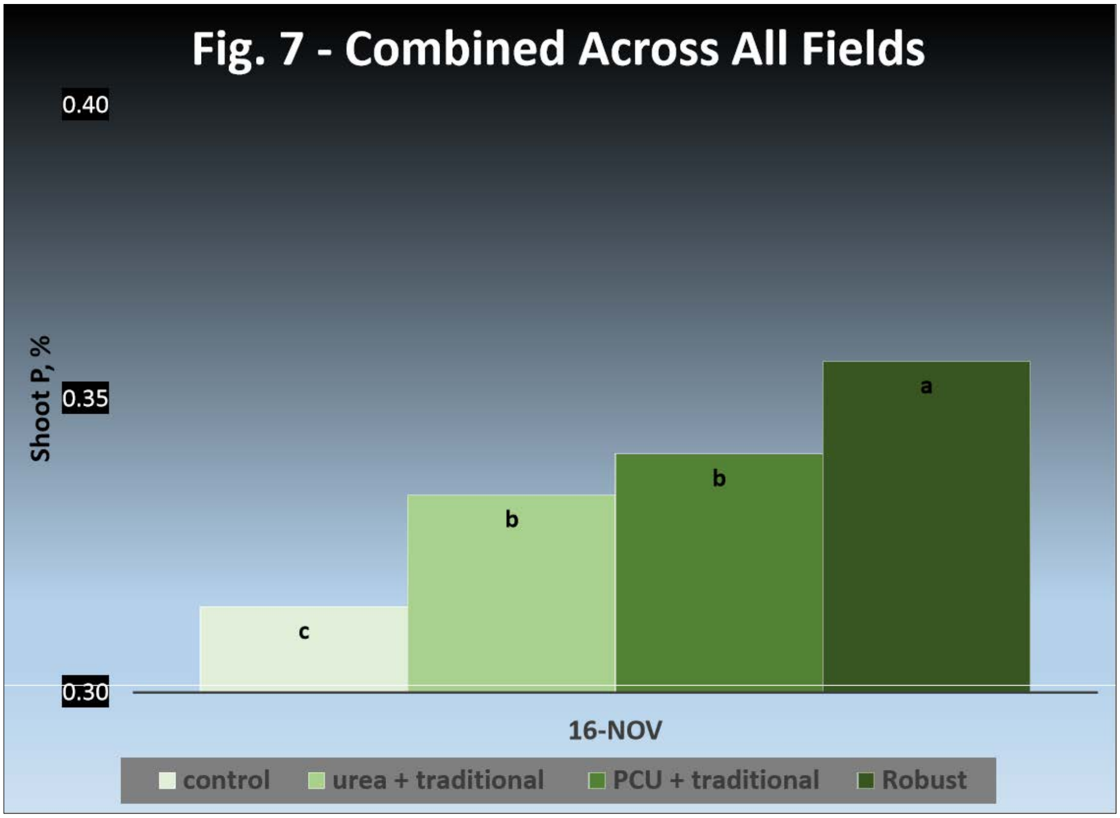


Table 1. Macronutrient concentrations in new turfgrass shoot tissue taken on Sept. 21, 2015

Site		treatment	P	K	Ca	Mg	S
			%				
loam established	1	control	0.30	2.4	0.30	0.16	0.29
	2	urea+traditional	0.31	3.0	0.32	0.17	0.29
	3	PCU+traditional	0.36	3.1	0.32	0.17	0.30
	4	Robust	0.34	2.8	0.30	0.17	0.28
loam new seed	1	control	0.31	2.5	0.29	0.16	0.29
	2	urea+traditional	0.32	3.1	0.31	0.17	0.30
	3	PCU+traditional	0.32	3.1	0.31	0.17	0.30
	4	Robust	0.35	2.6	0.32	0.17	0.29
loam new sod	1	control	0.29	2.4	0.30	0.16	0.28
	2	urea+traditional	0.33	2.9	0.31	0.17	0.31
	3	PCU+traditional	0.33	3.0	0.33	0.17	0.29
	4	Robust	0.34	2.9	0.32	0.17	0.30
sand established	1	control	0.31	2.5	0.31	0.16	0.29
	2	urea+traditional	0.31	2.9	0.32	0.17	0.31
	3	PCU+traditional	0.32	3.0	0.32	0.17	0.29
	4	Robust	0.35	2.7	0.30	0.17	0.30
mean	1	control	0.30	2.4	0.30	0.16	0.28
	2	urea+traditional	0.32	2.9	0.32	0.17	0.30
	3	PCU+traditional	0.33	3.1	0.32	0.17	0.30
	4	Robust	0.35	2.8	0.31	0.17	0.30

Table 2. Micronutrient concentrations in new turfgrass shoot tissue taken on Sept. 21, 2015

Site		treatment	ppm Zn	ppm Fe	ppm Mn	ppm Cu	ppm B
loam established	1	control	29	189	56	11	7.3
	2	urea+traditional	31	209	58	11	8.2
	3	PCU+traditional	29	200	61	12	7.6
	4	Robust	30	199	58	12	7.9
loam new seed	1	control	30	190	59	11	7.4
	2	urea+traditional	30	195	57	12	7.7
	3	PCU+traditional	29	192	60	13	8.1
	4	Robust	30	201	57	12	7.6
loam new sod	1	control	29	196	60	12	8.0
	2	urea+traditional	29	191	61	12	7.6
	3	PCU+traditional	30	201	59	12	7.8
	4	Robust	30	197	58	12	8.0
sand established	1	control	30	183	57	12	7.8
	2	urea+traditional	30	202	61	11	8.4
	3	PCU+traditional	29	193	57	13	7.7
	4	Robust	31	189	57	12	7.5
mean	1	control	29	189	58	11	7.6
	2	urea+traditional	30	199	59	11	8.0
	3	PCU+traditional	29	196	59	12	7.8
	4	Robust	30	196	58	12	7.7

Table 3. Macronutrient concentrations in new turfgrass shoot tissue taken on Nov. 16, 2015

Site		treatment	P	K	Ca	Mg	S
			---------------------------- % ----------------------------				
loam established	1	control	0.31	2.2	0.28	0.15	0.27
	2	urea+traditional	0.33	2.6	0.29	0.16	0.29
	3	PCU+traditional	0.34	2.6	0.31	0.16	0.28
	4	Robust	0.36	2.6	0.31	0.17	0.30
loam new seed	1	control	0.31	2.2	0.27	0.15	0.26
	2	urea+traditional	0.33	2.6	0.29	0.16	0.29
	3	PCU+traditional	0.36	2.7	0.29	0.16	0.28
	4	Robust	0.36	2.8	0.32	0.17	0.29
loam new sod	1	control	0.33	2.1	0.27	0.15	0.26
	2	urea+traditional	0.34	2.7	0.31	0.16	0.28
	3	PCU+traditional	0.33	2.5	0.31	0.16	0.29
	4	Robust	0.35	2.6	0.32	0.17	0.29
sand established	1	control	0.32	2.1	0.29	0.15	0.26
	2	urea+traditional	0.33	2.5	0.29	0.16	0.29
	3	PCU+traditional	0.33	2.5	0.29	0.16	0.28
	4	Robust	0.37	2.7	0.31	0.17	0.31
mean		control	0.31	2.2	0.28	0.15	0.26
		urea+traditional	0.33	2.6	0.30	0.16	0.29
		PCU+traditional	0.34	2.6	0.30	0.16	0.28
		Robust	0.36	2.7	0.31	0.17	0.29

Table 4. Micronutrient concentrations in new turfgrass shoot tissue taken on Nov. 16, 2015

Site		treatment	Zn	Fe	Mn	Cu	B
			ppm				
loam established	1	control	27	168	53	11	7.2
	2	urea+traditional	28	182	58	11	7.6
	3	PCU+traditional	28	184	58	12	7.2
	4	Robust	30	201	60	12	8.3
loam new seed	1	control	25	173	50	11	6.7
	2	urea+traditional	28	197	58	12	7.6
	3	PCU+traditional	29	191	55	11	7.7
	4	Robust	30	198	58	11	7.9
loam new sod	1	control	27	180	54	10	6.9
	2	urea+traditional	28	183	59	11	7.6
	3	PCU+traditional	30	185	57	11	7.8
	4	Robust	29	201	57	12	8.3
sand established	1	control	27	184	55	10	7.0
	2	urea+traditional	30	187	59	11	7.9
	3	PCU+traditional	28	198	56	11	7.8
	4	Robust	29	189	60	12	8.0
mean		control	27	176	53	10	7.0
		urea+traditional	28	187	58	11	7.7
		PCU+traditional	29	190	57	11	7.6
		Robust	29	197	59	12	8.1

ACKNOWLEDGEMENTS

Several people assisted with this project. The growers, John and Dutch Pocock, initiated the project and provided the Robust fertilizer. Many BYU-Provo students were involved in all phases of this trial. Rachel Buck and student employees of the Brigham Young University Environmental Analytical Laboratory conducted the tissue analysis.