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Simplot FŪSN™ Fertilizer Potato Trials

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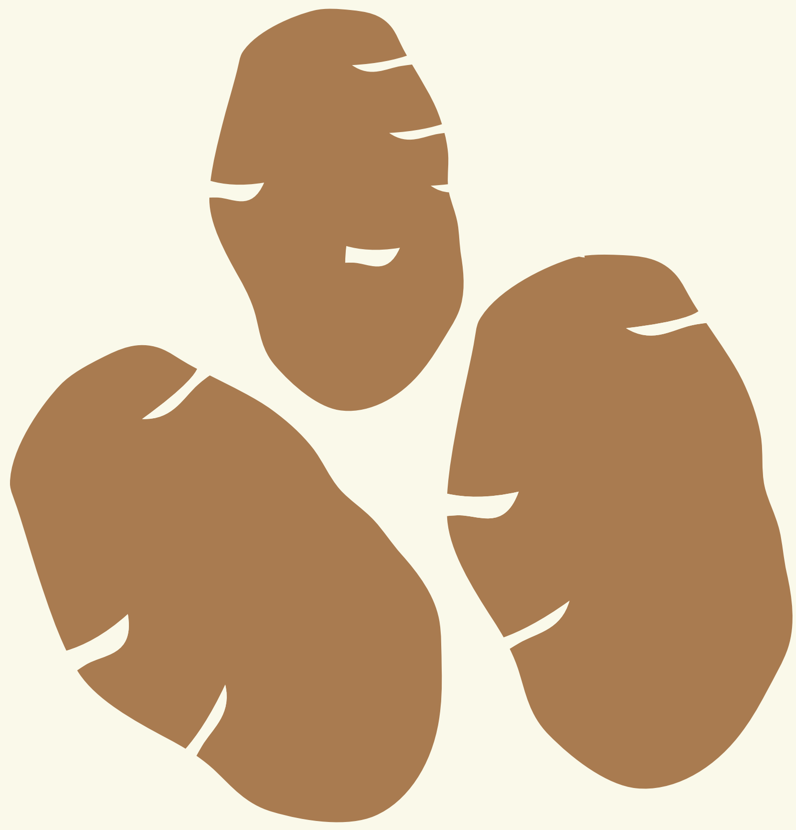
Rexburg, Idaho, 2015



Simplot
Bringing Earth's Resources to Life

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Executive Summary

Efficient nitrogen (N) management is an essential part of any potato fertilization program. Nitrogen management can affect potato yield and tuber size and shape, as well as many other tuber quality factors. FŪSN is a relatively new, dry granular ammonium sulfate nitrate fertilizer made from a patented process that chemically fuses ammonium sulfate and ammonium nitrate to produce an entirely new and highly stable molecule, a 26-0-0-14S fertilizer. Two trials were conducted at Rexburg, Idaho, in 2015 on Russet Burbank and Russet Norkotah potato cultivars. FŪSN was compared to urea at three rates. There was no response to N beyond the lowest rate of 70 lbs N/ac and, therefore, the yields at this lowest rate of N fertilization were compared. FŪSN resulted in increases for U.S. No. 1 and total yield in all cases, with the increase being significant for Russet Norkotah. It is also noteworthy that the petiole NO_3-N concentrations were consistently lower for FŪSN versus urea at the lowest rate of N, possibly due to added growth of the plants and a dilution effect. Tuber size was numerically higher for FŪSN, although not statistically significant. These data show that FŪSN does not result in any negative impacts when used in place of urea and may possibly result in better tuber quality.

Introduction

Efficient nitrogen (N) management is an essential part of any potato (*Solanum tuberosum* L.) fertilization program. Nitrogen management can affect potato yield and tuber size and shape, as well as many other tuber quality factors. Most N management systems for irrigated potato in Idaho "spoon feed" the N fertilizer through a combination of pre-plant and in-season fertilization/fertigation applications. FŪSN is a relatively new, dry granular ammonium sulfate nitrate fertilizer made from a patented process that chemically fuses ammonium sulfate and ammonium nitrate to produce an entirely new and highly stable molecule, a 26-0-0-14S fertilizer. Independent research on a range of agronomic and vegetable crops has shown that the new fertilizer is safe and effective for agricultural use compared with traditional ammonium nitrate-based fertilizers. FŪSN is compatible with other fertilizers in prescription blends and safe to transport, handle, and store. However, research is needed to document the relative effectiveness of FŪSN compared to urea with respect to yield response and tuber quality in Russet-type potatoes.

Materials and Methods

Cut potato seed was treated then mechanically planted at 10-12-inch spacing with 36-inch-wide rows at 20 cwt/ac rate with a four row cup planter on 5 May at a depth of six inches at the Brigham Young University-Idaho Hillside Farm in Rexburg, ID (43.805806 N 111.786670 W elev. 1,536m). Three rates (70, 140, and 210 lbs N/ac) as either urea or FŪSN were compared to an N control (0 lbs N/ac) in Russet Burbank and Russet Norkotah field plots. Six replicates of each treatment were applied in a Randomized Complete Block Design (RCBD). Plot widths were six rows wide (12 feet) by 40 feet in length.

The soil was a Pocatello variant with some minor inclusions of Ririe silt loam—being uniform over the study area with modest fertility levels and good water infiltration and drainage. There were no impactful pesticide residues in the soil from previous crops and nutrient residues were not abnormally high or low (Table 1). Broadcast pre-plant fertilizer was applied at 0-100-100-100(S)-10(Mn) lbs of each nutrient per acre. Nitrogen treatments were applied in five even splits beginning at planting, and the remaining applications beginning the first of July and then occurring every two weeks.

The crop was raised following standard management practices—including nutrient, soil, water, pest, and crop management. The crop was scouted at least twice weekly for weed, disease, and insect pressure. Insect, weed, and nematode control was excellent. Disease incidence was minimal. There were some minor levels of *Verticillium* and early blight. Black scurf (*Rhizoctonia solani*) was widespread on harvested tubers. Late blight was discovered in a neighboring field and, as a result, multiple in-season foliar applications of fungicide were applied via chemigation (Aug. 19 – Gavel Zing @ 1 qt/ac; Aug. 24 and 28 – Previcure @ 1.2 pt/ac and Pencozeb @ 1.5 lbs/ac). Disease ratings were made but the results between treatments were nearly identical.

Weather was mostly typical for the Rexburg area with a moderate amount of precipitation and near average winter and summer temperatures (Figs. 1 and 2). The end of May and early June had relatively higher amounts of precipitation and temperatures. However, the crop was never water stressed with the aid of irrigation. The crop was irrigated with a center-pivot irrigation system with approximately 5, 8, 10, and 5 inches of water applied in May, June, July, and August, respectively.

NDVI measurements were taken every 7–14 days. Composite petiole samples were taken about weekly. Based on the NDVI and these petiole concentrations, a thorough sampling of every plot was made toward the end of the growing season on August 5. Petiole samples were taken from rows 2 and 5 of each plot to avoid damaging plants to be used for harvest.

Vines were killed on September 9 with sulfuric acid foliar application and harvest occurred September 28 and 29 by mechanically lifting two rows (rows 3 and 4 of each plot were harvested) of tubers and collecting and weighing all tubers in a 20-foot distance (total of 40 row-feet harvested). Tubers were weighed and then graded for quality, size, specific gravity, and defects. Statistical analysis was performed by Analysis of Variance with mean separation with a Tukey-Kramer test using SAS software (SAS 9.3, Cary, NC).

Table 1. Pre-season soil test values (April 10, 2014)

pH (2:1)		8.3
ECe (2:1)		0.5
ex. lime	%	2
OM (c)		1.3
NO_3-N	ppm	3
NH_4-N		4
P(modified)		51
P(bicarb)		29
K		365
S		13
Ca	meq/100g	9.5
Mg		2.1
Na		0.2
Zn DTPA	ppm	2.5
Fe		6
Mn		2
Cu		0.5
Cl		8
B H_2O		1.0

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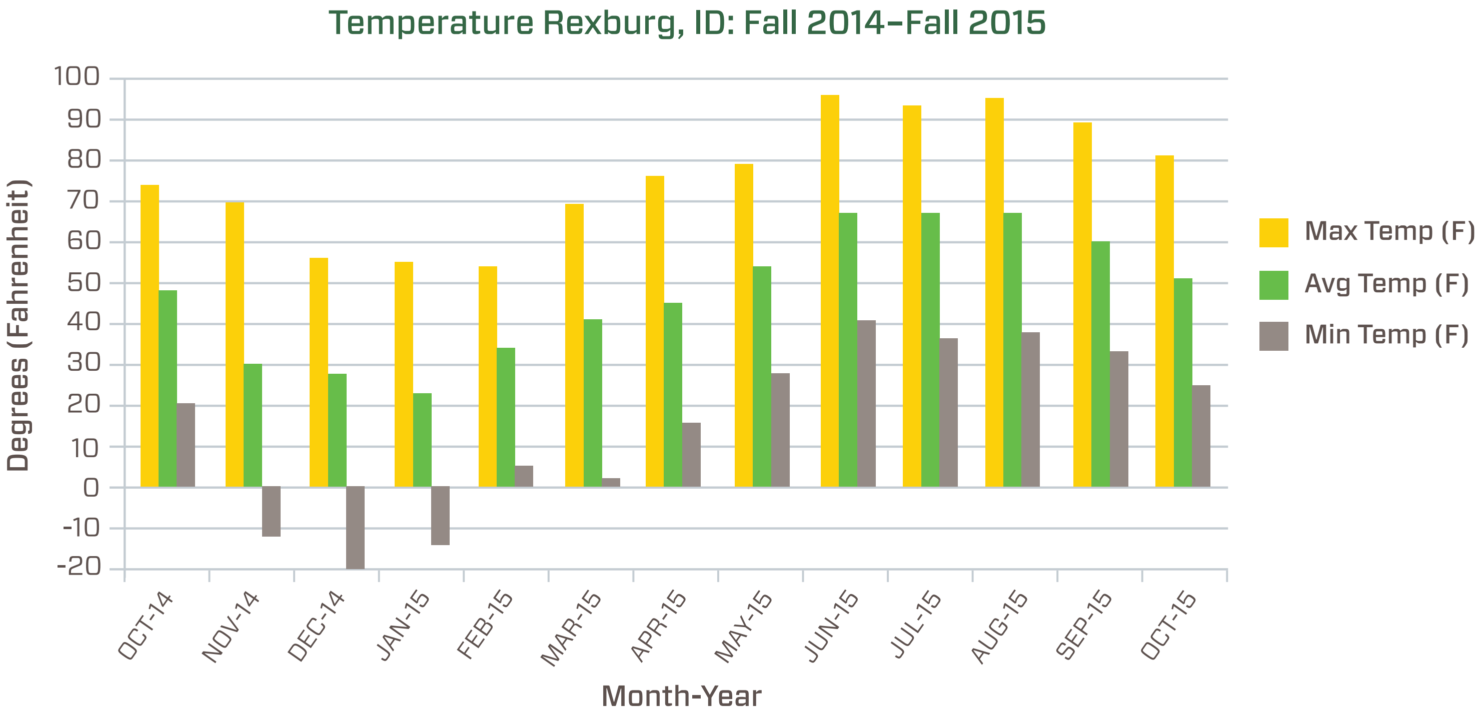

Figure 1. Air temperatures for Rexburg, ID, fall 2014 through fall 2015.

(www.wunderground.com: http://bit.ly/1TVZoVG)

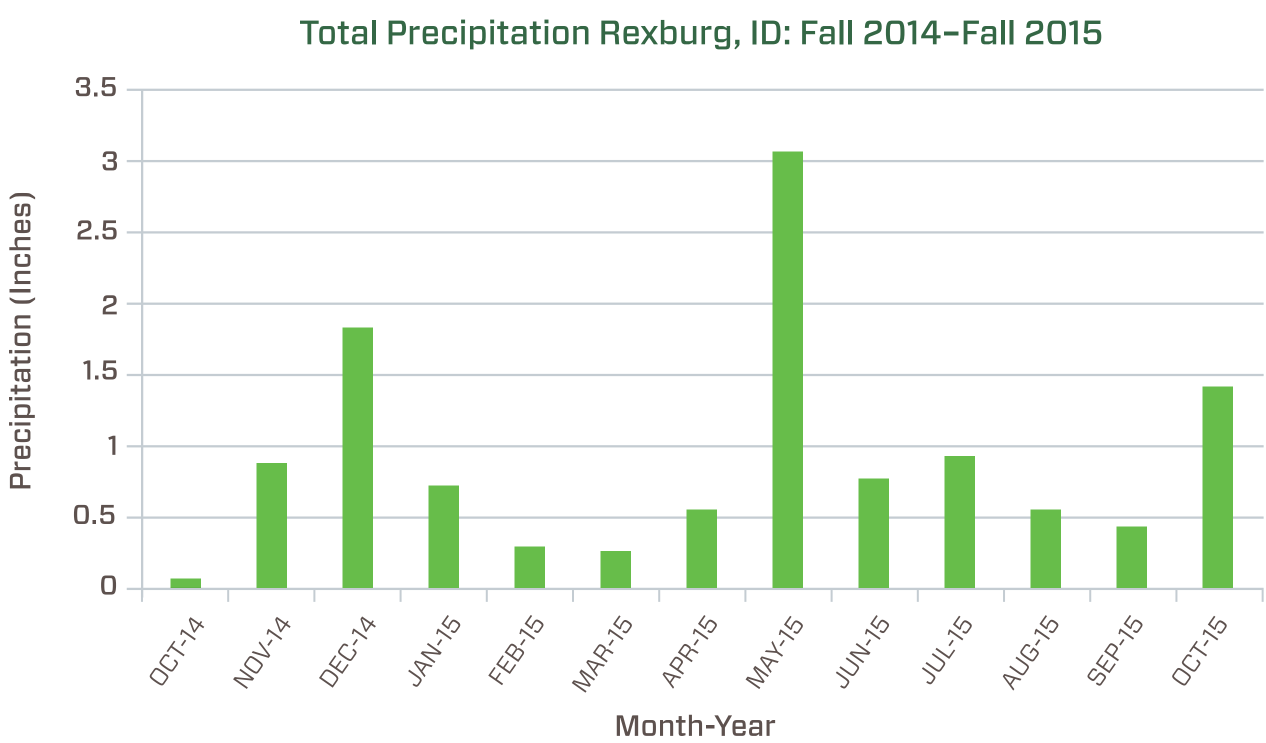

Figure 2. Precipitation monthly totals for Rexburg, ID, fall 2014 through fall 2015.

(www.wunderground.com: http://bit.ly/1TVZoVG)

Results and Discussion

Overall Results

There were statistically significant differences in this trial—with most P-values for the overall models showing significance.

With regard to yield, there was a general response to N fertilizer—with similar responses for both cultivars (Tables 2 and 3). In general, the U.S. No. 1 yields increased with the first increment of N fertilization, which resulted in overall increases for marketable and total yields as well.

Surprisingly, increasing N rate did not result in continued increases of yield or quality. Based on soil and water tests, there is not a good explanation for this lack of response—as there were not atypical amounts of N in these sources. The previous crop was a small grain with normal yields and should not have resulted in undue carryover of N. It is very unlikely that inadvertent N was applied to the field.

Petiole NO_3-N values could be a possible clue to this response. Overall, the petiole NO_3-N concentrations did follow the N fertilizer application rates by the end of the season for both cultivars—suggesting accurate application and plant uptake (Table 4). However, these concentrations did not necessarily follow typical patterns expected in terms of overall concentrations, especially early in the season.

The Russet Burbank petiole NO_3-N values shortly after tuber initiation were low at 10,600 and 12,100 ppm on July 15 for the urea and FŪSN highest N-rate treatments, respectively (Table 4). These values would normally be desired to be at above 15,000 ppm. Two weeks earlier composite samples were taken with a value of 15,100 ppm over the entire plot area—with a desirable level at 20,000–25,000 ppm. It is normal for these values to decline during the course of the season, which they did the following week, but then plateaued toward the end of the season. These data suggest that the plants could have been N deficient early in the season. However, yields were at acceptable levels for this region. Nevertheless, in future studies it would be suggested that a higher rate of N be applied early season (~50%) and then the remaining N be tailored per petiole results rather than the protocol that was followed in this study of even splits of N on a timing basis.

The Russet Norkotah results did not show this same pattern, with ample N early in the season and with the N not falling to levels that are typical (<10,000 ppm) toward the end of the season. Again, yields were at normal levels for this region for this cultivar. The fact that the yields did not increase with additional N fertilizer is not surprising for the Norkotah cultivar given these results. There was not a clear difference between urea and FŪSN during the course of the season for petiole NO_3-N with averages for each being approximately equivalent (Table 4).

With regard to other nutrients, the values were mostly adequate (Tables 5 and 6). The phosphorus and sulfur levels were lower than desirable despite applications of these fertilizers. Additional levels and enhanced products would be recommended in the future for this site. The manganese soil test levels were very low for this field and, despite a significant amount of this nutrient applied as fertilizer, the petiole levels also were very low. It is also recommended that the Mn be increased for this field. With regard to the manganese, it is important to note that an additional study on manganese was performed in this same field. The results of that study showed a slight yield increase with fertilization at the rate applied to the FŪSN study and with similar petiole concentrations. Additional fertilizer did not result in a further increase in yield, suggesting that manganese was not a limiting factor for this trial.

In addition to yield, there were significant differences for specific gravity (Table 7). There was a typical decrease in specific gravity with increasing N rate. Urea and FŪSN did not respond differently than one another with regard to this parameter. Also, there were no differences for average tuber size (Table 7). There was virtually no brown center or hollow heart in this field for any of the treatments for both cultivars and, thus, the data is not shown.

FŪSN versus Urea

With regard to urea compared to FŪSN, an orthogonal comparison was made. Because there was no response to N beyond the lowest rate of 70 lbs N/ac, the yields at this lowest rate of N fertilization were compared (Fig. 3). FŪSN resulted in increases for U.S. No. 1 and total yield in all cases, with the increase being significant for Russet Norkotah.

It is noteworthy that the petiole NO_3-N concentrations were consistently lower for FŪSN versus urea at the lowest rate of N (Table 4). This is possibly due to added growth of the plants and a dilution effect. Tuber size was numerically higher for FŪSN, although not statistically significant.

These data show that FŪSN does not result in any negative impacts when used in place of urea and may possibly result in better tuber quality.

Table 2. Russet Burbank yields (cwt/ac)

Trt #	Fertilizer	N rate, lbs N/ac	All	4.0 -7.3	7.3-9.5	>9.5	U.S. No. 2	Marketable	Total
			------- U.S. No. 1 ----------						
1	N/A	0	246 b	149 b	60	37	4	250 b	337 b
2	Urea	70	319 a	177 ab	55	87	7	326 a	412 a
3	Urea	140	324 a	146 b	92	86	7	332 a	386 b
4	Urea	210	318 a	143 b	78	96	7	325 a	373 b
5	FŪSN	70	343 a	197 a	61	86	3	346 a	427 a
6	FŪSN	140	320 a	166 ab	77	77	4	325 a	392 ab
7	FŪSN	210	317 a	149 b	83	86	19	336 a	394 ab
	P-values		*0.014*	*0.026*	*NS*	*NS*	*NS*	*0.047*	*0.008*

Table 3. Russet Norkotah yields (cwt/ac)

Trt #	Fertilizer	N Rate, lbs N/ac	All	4.0-7.3	7.3-9.5	>9.5	U.S. No. 2	Marketable	Total
			---------U.S. No. 1---------						
1	N/A	0	231 ab	94	44	94	7	239 ab	300 b
2	Urea	70	195 bc	92	39	64	10	206 b	341 ab
3	Urea	140	235 ab	103	63	69	20	255 a	380 a
4	Urea	210	190 bc	93	53	44	16	206 b	334 ab
5	FŪSN	70	228 ab	99	43	86	13	241 ab	382 a
6	FŪSN	140	251 a	122	47	82	10	261 a	373 a
7	FŪSN	210	166 c	86	28	52	15	181 b	317 b
	P-values		*0.038*	*NS*	*NS*	*NS*	*NS*	*0.012*	*0.027*

Table 4. Potato petiole nitrate-N concentrations. The first two sampling dates were not replicated and, thus, no statistical analysis performed. Values followed by the same letters within a cultivar are not statistically different for the August 5, 2015, sampling date.

			-------------	ppm	-------------
Trt #	Fertilizer	N Rate, lbs/ac	15-Jul	21-Jul	5-Aug
			Russet Burbank		
1	N/A	0	12200	9000	3020 d
2	Urea	70	11800	8900	8180 c
3	Urea	140	12100	9150	11780 b
4	Urea	210	12100	9070	13290 a
5	FŪSN	70	10800	8100	6160 c
6	FŪSN	140	8360	6300	13210 a
7	FŪSN	210	10600	7950	14200 a
		P-value			*0.022*
			Russet Norkotah		
1	N/A	0	13400	8060	4060 d
2	Urea	70	17600	12500	8350 c
3	Urea	140	19900	14700	12200 b
4	Urea	210	19200	15600	14900 a
5	FŪSN	70	14700	12300	7630 c
6	FŪSN	140	20700	13200	12500 b
7	FŪSN	210	21000	18700	16700 a
		P-value			*0.002*

Table 5. Potato petiole macronutrient concentrations

Cultivar	Date	P	K	S	Ca	Mg
		%				
Russet Norkotah	1-Jul	0.26	9.0	0.20	1.2	0.66
	15-Jul	0.19	8.1	0.21	1.2	0.65
	21-Jul	0.23	7.7	0.22	1.0	0.45
	28-Jul	0.20	8.2	0.25	1.3	0.68
	5-Aug	0.17	8.2	0.28	1.4	0.78
Russet Burbank	1-Jul	0.27	8.3	0.17	1.2	0.53
	15-Jul	0.25	7.6	0.19	1.1	0.51
	21-Jul	0.23	7.1	0.19	1.0	0.50
	28-Jul	0.21	7.7	0.20	1.2	0.53
	5-Aug	0.19	7.8	0.25	1.3	0.61

Table 6. Potato petiole sodium and micronutrient concentrations

		ppm					
Cultivar	Date	Na	Zn	Fe	Mn	Cu	B
Russet Norkotah	1-Jul	222	43	78	21	5.3	25
	15-Jul	200	41	88	19	5.1	24
	21-Jul	181	27	61	18	5.9	24
	28-Jul	257	35	74	19	5.5	28
	5-Aug	313	34	73	20	5.5	31
Russet Burbank	1-Jul	222	42	58	19	4.9	22
	15-Jul	197	40	68	17	4.8	21
	21-Jul	185	30	50	17	5.7	21
	28-Jul	251	35	57	18	5.1	25
	5-Aug	305	33	53	18	4.9	26

Table 7. Potato specific gravity and size

			Russet Burbank		Russet Norkotah	
Trt #	Fertilizer	N Rate, lbs N/ac	Specific Gravity	Size, oz/Tuber	Specific Gravity	Size, oz/Tuber
1	N/A	0	1.089 a	10.5	1.090 a	10.1
2	Urea	70	1.088 ab	10.3	1.088 ab	10.5
3	Urea	140	1.086 bc	9.4	1.086 bc	10.5
4	Urea	210	1.086 bc	11.2	1.086 bc	11.5
5	FŪSN	70	1.087 a	11.4	1.088 ab	12.3
6	FŪSN	140	1.085 bc	10.8	1.085 c	11.0
7	FŪSN	210	1.084 c	10.2	1.084 c	10.5
	P-values		*<0.001*	*NS*	*<0.001*	*NS*

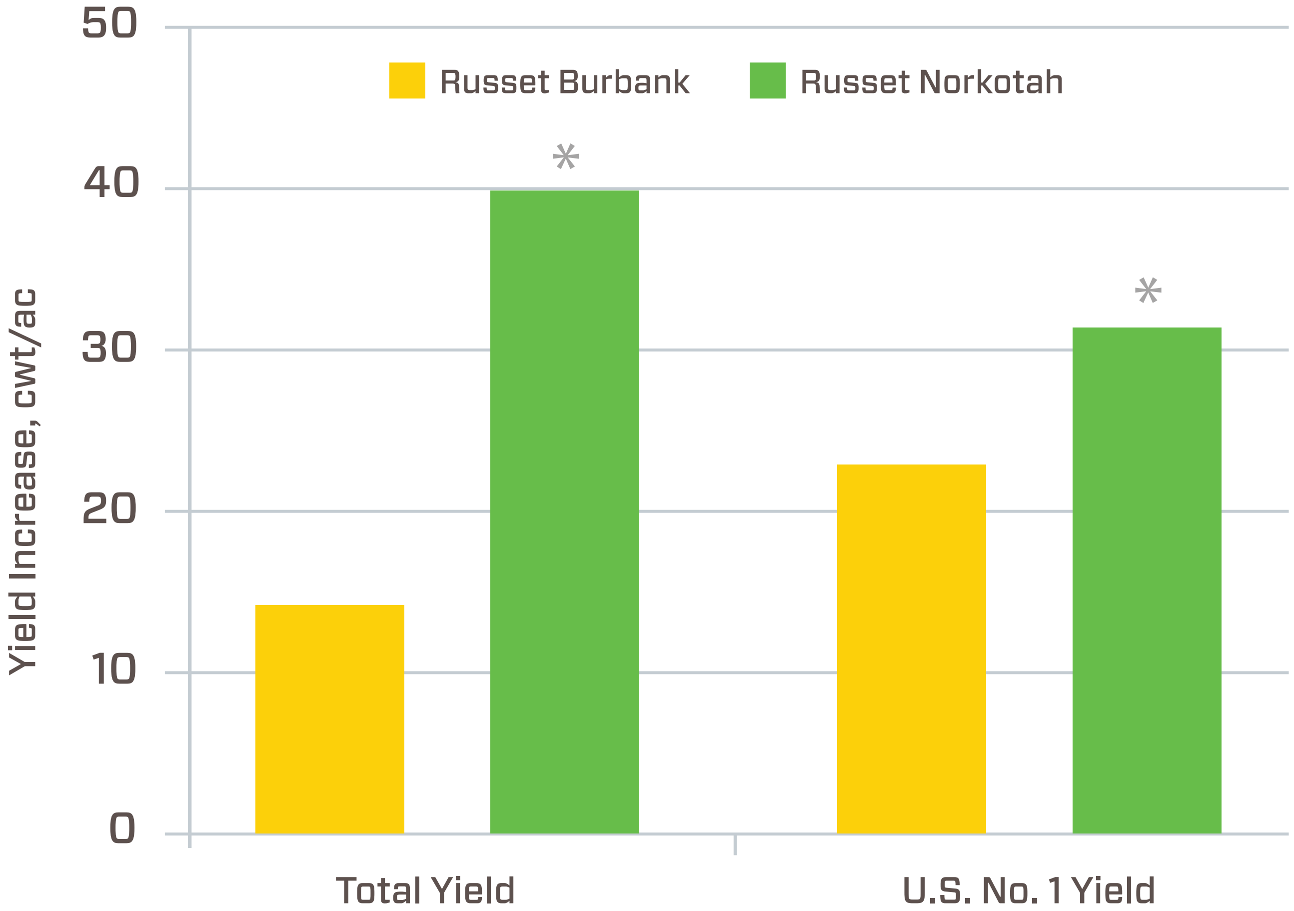

Figure 3. Yield increase for FŪSN compared to urea at the lowest N rate (70 lbs N/ac) in a potato trial near Rexburg, ID, in 2015 (* = $P < .10$).

Acknowledgments

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