

Classic Russet and Russet Norkotah Potato Yield and Quality Response to Nitrogen Fertilization

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Introduction: Classic Russet is a new variety release that has shown higher yield potential and improved pest resistance compared to Russet Norkotah in University trials. Classic Russet was grown on limited acreage in the Pacific Northwest in 2010. The variety performed well at several locations, but some growers noted problems with bruising and rot. University of Idaho and Washington State University studies have shown Classic Russet is susceptible to shatter bruise and black spot bruise. Studies have also shown that Classic Russet's nitrogen fertilization requirement is lower than Russet Norkotah and that excessive nitrogen fertilization may increase susceptibility to bruising and rot.

This study evaluated the influence of nitrogen fertilizer on Classic Russet and Russet Norkotah yield, quality, and revenue on the high organic matter soils of Tulelake. Treatments evaluated split application of nitrogen with 50% applied at planting and 50% from tuber initiation to mid-bulking. Rates ranged from 0 to 300 lbs applied N per acre per season. Additional treatments evaluated the influence of different nitrogen application timings. Three nitrogen additive products were also tested. These products have been claimed to improve nitrogen use-efficiency or tuber size distribution.

General Trial Information

Location: IREC, Tulelake, CA
Soil Type: Tulebasin mucky silty clay loam with 4.2% organic matter
Nitrate and Ammonium at planting: NO₃= 8 ppm and NH₄= 2 ppm
Planting Date: May 27, 2011
Vine Kill Date: September 16, 2011
Days to Vine Kill: 113 days
Harvest Date: October 17, 2011
Days between Vine Kill and Harvest: 31 (23 days from complete vine death to harvest)
Soil Temperature at Harvest: 45 degrees F
Irrigation: Solid-set sprinklers
Plot Size: 2 rows (6 ft) wide by 28.1 ft long
In-Row Spacing: 11.3 inches
Row Spacing: 36 inch spacing
Number of Reps: 6 replications

General Trial Information Continued

Nitrogen Fertilizer Treatments: Nitrogen was applied as urea fertilizer. Urea was immediately incorporated after application via tillage or with overhead irrigation.

Applied Fertilizer other than Nitrogen: P₂O₅ = 80 lb/A, K₂O = 100 lb/A, S = 93 lb/A, Zn = 10 lb/A (applied and incorporated over the entire plot area before planting)

Herbicides: Matrix and metribuzin

Insecticides: Movento and Coragen

Fungicides: Quadris and Endura

Potato Fresh Market Pack-Out Revenue Assumptions

IREC Grade Size	Market/Packaging	4 yr Price Avg. \$/cwt	Packaging & Handling Cost \$/cwt
4-8 oz tubers	20% to 90 & 100 count	14.13	5.75
	80% to 10 lb. poly bags	9.15	5.75
8-12 oz tubers	70, 80, 90 count	16.45	5.75
>12-20 oz	50 & 60 count	17.33	5.75
<4 oz and culls	Bulk culls	1.15	5.75
No. 2	100 lb burlap sacks	8.60	5.75

Results

Averaged across nitrogen fertilizer treatments, Classic Russet produced around 100 cwt/A higher total and US No. 1 yield and \$1300/A higher fresh market revenue compared to Russet Norkotah (Table 1). Classic Russet average tuber size, tubers per plant, and specific gravity were higher than Russet Norkotah (Tables 1 and 2). Classic Russet was more prone to shatter bruise, black spot bruise, and white knot bruise compared to Russet Norkotah averaged across nitrogen fertilizer treatments (Table 2).

Nitrogen fertilization increased Classic Russet and Russet Norkotah total yield compared to the unfertilized control (Figure 1). When comparing regression curves, Russet Norkotah total yield reached a plateau around 228 lbs applied N/A while Classic Russet yield was highest at the maximum 328 lbs applied N/A rate (Figure 1).

Nitrogen fertilization increased US No. 1 yield and fresh market revenue for both varieties, but No.1 yield and revenue for both varieties peaked at a lower nitrogen rate (78 lbs applied N/A) compared to total yield (Figures 2 and 3). The reason why total yield peaked at the highest N rates yet No. 1 yield did not increase at higher N rates and maximum revenue occurred at lower nitrogen rates is because more of the total yield at high nitrogen rates was made up of culls, 2's, and oversized tubers (Table 3).

Regarding nitrogen fertilizer application timing, readily available nitrogen at planting appeared to be important for both varieties (Table 4). For example, at the 128 lb N/A rate, applying all nitrogen at the time of planting resulted in higher yield (total yield, US No. 1 yield, and tubers per plant) for both varieties compared to delaying applications until tuber initiation and bulking. For Russet Norkotah,

applying 128 lb N/A at planting resulted in higher average tuber size and an additional \$614/A in revenue compared to delaying nitrogen application until tuber initiation and bulking (Table 4). In contrast, for Classic Russet, applying 128 lb N/A at planting actually decreased average tuber size compared to delaying applications until tuber initiation and bulking, and Classic Russet revenue was the same for both 128 lb N/A application timing treatments. This is most likely because applying all the N at planting resulted in more tubers per plant with Classic Russet (7.7 tubers per plant) compared with the delayed application timing (5.8 tubers per plant). The number of tubers per plant with Norkotah was less affected by fertilizer application timing (7.0 compared to 6.6 tubers per plant for applying all the N at planting vs. the delayed application). At the 228 lb N/A rate, total yield, US No. 1 yield, tuber set, average tuber size, and revenue did not differ between applying 200 lb N/A at planting and split-applying 100 lbs N/A at planting and 100 lbs N/A at tuber initiation and bulking. This may have been because both treatments included some N at planting unlike the 128 lb N/A rate.

The increase in tuber yield from nitrogen was driven by different factors for each variety (Tables 3 and 4). For Classic Russet, increasing nitrogen rate had a large influence on tuber set (increasing nitrogen rate increased the number of tubers per plant) and lesser influence on average tuber size. For Russet Norkotah, increasing nitrogen rate had large influence on tuber size (increasing nitrogen rate increased average tuber size) and a lesser influence on tuber set. Classic Russet's tendency to increase tuber set with increasing nitrogen suggests adequate early season nitrogen is important in setting yield potential. A higher tuber set with increased nitrogen availability also means complimentary fertility and growing conditions should be available during tuber initiation and tuber bulking to adequately size the high tuber set. Conversely, organic growers with limited nitrogen that desire large tubers may want to minimize early season nitrogen and focus nitrogen applications at tuber initiation and early bulking to prevent a high tuber set of undersized tubers.

Classic Russet left less available nitrogen in the soil at harvest compared to Russet Norkotah at both medium and high fertilization rates (Table 3). Residual nitrate and ammonium in Russet Norkotah plots increased with increasing nitrogen rate and reached 32 ppm in the high 328 lb N/A treatment. The high amount of residual nitrogen in the 328 lb N/A treatment along with the plateau in Russet Norkotah yield around 228 lb N/A suggest rates over 300 lbs N/A were likely excessive.

A few products designed to increase nitrogen availability, nitrogen uptake, or potato tuber size distribution were tested in 2011. These products were applied along with 200 lb N/A split-applied at planting, tuber initiation, and tuber bulking. We also tested a slow-release nitrogen fertilizer applied at 200 lb N/A at planting. The slow release fertilizer treatment and all additive products except N-Boost did not increase yield and potato revenue compared to split-applying 200 lb N/A as a stand-alone (Table 5). N-Boost increased yield and revenue for both varieties compared to the stand-alone 200 lb N/A treatment, but the differences were not statistically significant. N-Boost merits further research and we plan to include N-Boost in 2012 trials.

The 2011 trial was planted in a field with a known history of Verticillium wilt problems. Across nitrogen rates, Classic Russet was tolerant of Verticillium wilt (Table 5). Russet Norkotah was susceptible to Verticillium wilt at all nitrogen rates, but Verticillium wilt symptoms decreased with increasing nitrogen rate up until the 278 lb N/A rate (Table 6).

Classic Russet was more susceptible to skinning, shatter bruise, black spot bruise, and white knot bruise compared to Russet Norkotah (Tables 2 & 6). Nitrogen increased the percentage of Classic Russet and Russet Norkotah tubers with skinning compared to unfertilized plots (Table 6). Nitrogen also increased

the percentage of Classic Russet tubers with black spot bruise compared to unfertilized plots, but Classic’s susceptibility to black spot bruise at increasing nitrogen rates was variable (Tables 6 & 7). Nitrogen did not influence susceptibility of Classic Russet to shatter bruise and white knot bruise (Tables 6 & 7). Similar to previous studies, specific gravity decreased with increasing nitrogen rate, although the effect was not statistically significant (Table 6). With regard to tuber growth irregularities, increasing nitrogen rate increased Classic Russet’s susceptibility to knobs, and increased both varieties susceptibility to irregular shaped tubers (Tables 6 & 7).

Classic Russet provided higher total yield, average tuber size, revenue, and nitrogen use efficiency compared Russet Norkotah averaged across nitrogen rates. Classic Russet was also considerably less susceptible to Verticillium wilt compared to Russet Norkotah. However, on the flip side, Classic Russet was more susceptible to skinning, shatter bruise, black spot bruise, and white knot bruise compared to Russet Norkotah. In 2011, we grew a half acre of Classic Russet at the Intermountain Research and Extension Center and ran the potatoes through a commercial shed after 2 months in storage. When graded a significant portion of the potatoes were categorized as No. 2’s due to unacceptable black spot bruise and white knot bruise on the stem end of the tubers. Under close inspection and hand-peeling, it was apparent that several US No. 1 tubers had significant white knot bruise that went undetected during grading. White knot bruise may be the most problematic bruising issue with Classic Russet as it can go undetected until the potato is peeled and little information is available on minimizing white knot bruise.

Fresh market growers must prioritize management that minimizes bruising when growing Classic Russet. A PVMI publication is available that details suggested nutrient, irrigation, and harvest management for Classic Russet (use link below). Additional research is needed to investigate the cause of white knot bruise in Classic Russet and management steps that minimize white knot bruise.

<http://www.pvmi.org/storage/General/Classic%20Management%20Update%20June%202011.pdf>

Table 1. Classic Russet and Russet Norkotah Tuber Yield, Revenue, and Tuber Defects Averaged Across Nitrogen Fertilization Treatments at IREC in 2011.

Variety	Total		Avg Tuber Size (oz)	Potato Revenue \$/A	Growth Irregular				Hollow		
	U.S. No. 1's (cwt/A)	Total Yield (cwt/A)			Tubers/ Plant	Knobs % ¹	Cracks % ¹	Shape % ¹	Green % ¹	Elephant Hide % ²	Heart % ³
Classic Russet	411	503	7.2	7.8	\$3,597	1.4	0.5	5.4	1.2	2.5	0.7
Russet Norkotah	303	411	7.1	6.4	\$2,284	1.2	0.3	3.7	1.8	5.4	8.1
95% confidence Interval	17	20	0.2	0.2	\$259	NS	0.1	0.7	0.3	NS	2.0

¹ Percentage of Total Yield

² 20 tubers evaluated from each plot (8-16oz)

³ 10 tubers evaluated from each plot (8-16oz) at harvest

Table 2. Classic Russet and Russet Norkotah Skin Set, Bruising, and Specific Gravity Averaged Across Nitrogen Fertilization Treatments at IREC in 2011.

Variety	Ruptured	Shatter		Shatter	Black	White	Specific Gravity
	Lenticel Rating ¹	Bruise Rating ¹	Skinning Rating ¹	Bruise % ²	Spot Bruising % ³	Knot Bruising % ⁴	
Classic Russet	2.7	2.5	3.1	92.7	18.1	48.8	1.088
Russet Norkotah	4.2	4.3	3.8	30.7	7.3	1.1	1.082
95% confidence Interval	0.2	0.2	0.1	4.7	4.0	5.6	0.002

¹ Rating Scale of 1-5, 5=no problem; Reglone Application occurred on 9/15/2011; Harvested on 10/17/2011

² 20 tubers evaluated from each plot (8-16oz); 6 inch soil temperature was 45 degrees F at harvest

³ 10 tubers evaluated from each plot (8-16oz) at harvest

⁴ 10 tubers evaluated from each plot (8-16oz) 54 days after harvest; storage at 40°F with 100% humidity

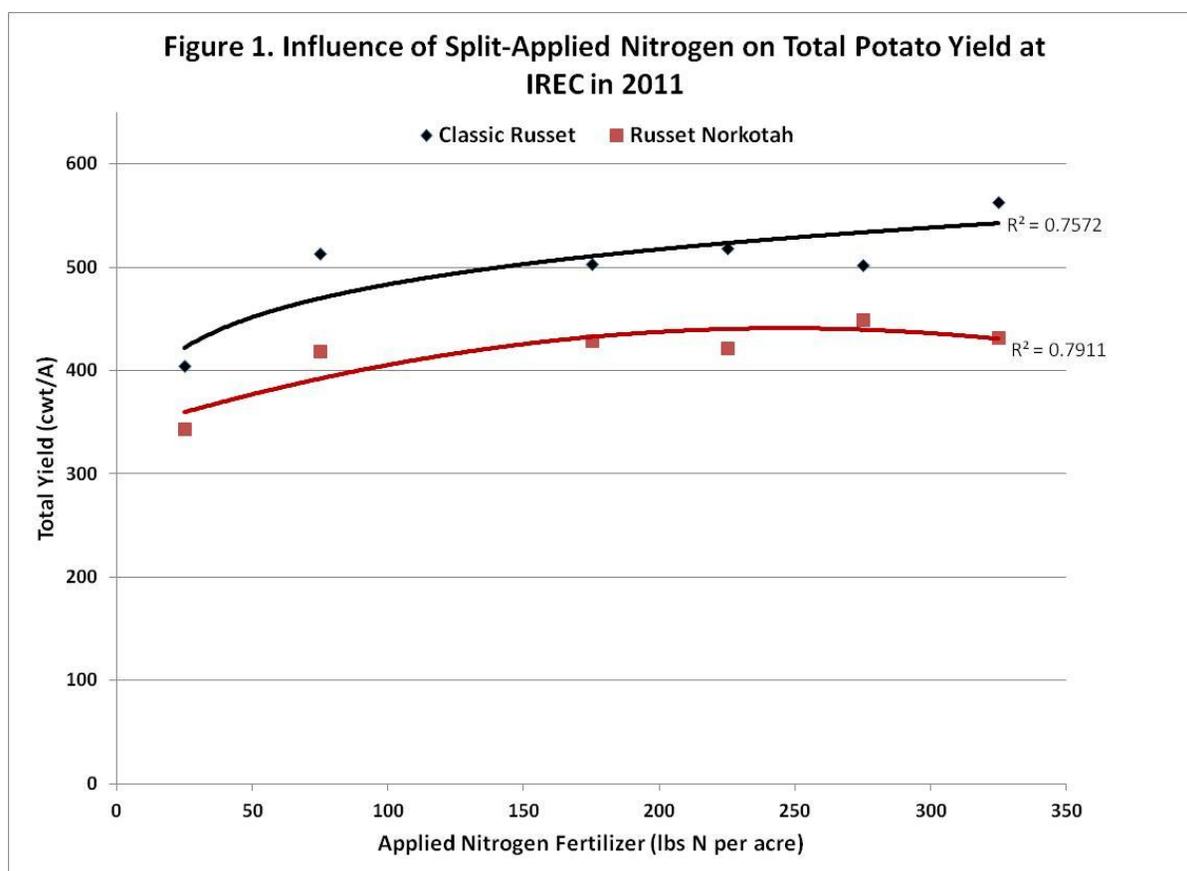


Figure 2. Influence of Split-Applied Nitrogen on US #1 Potato Yield at IREC in 2011

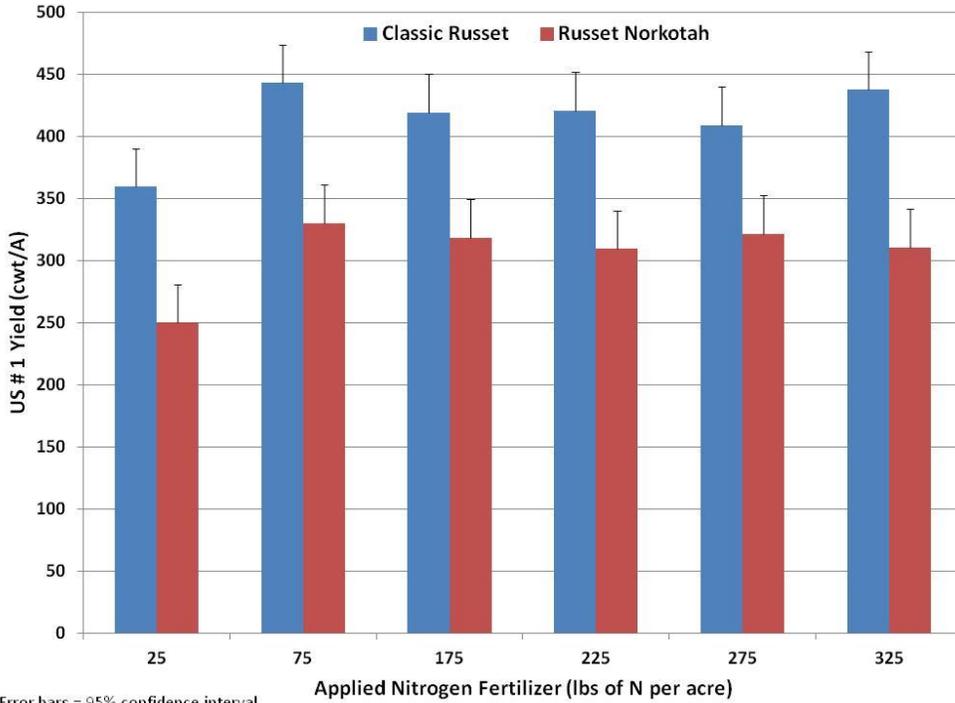
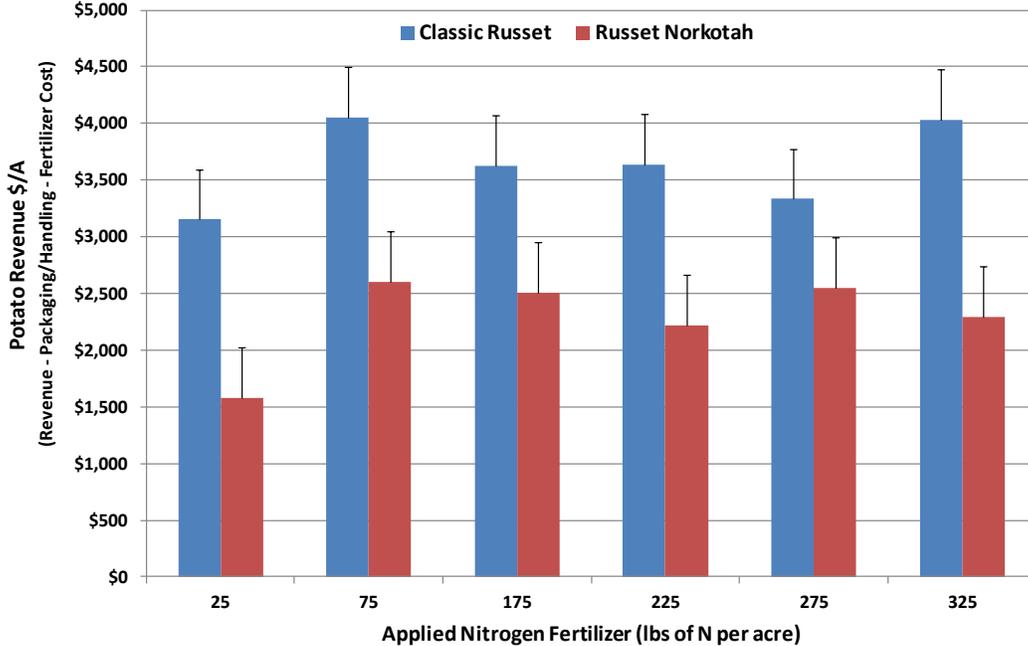


Figure 3. Influence of Split-Applied Nitrogen on Potato Revenue (Pack-out Revenue - Fertilizer Cost) at IREC in 2011



Error bars = 95% confidence interval
 Revenues calculated using 4-year average potato prices in the Columbia Basin; Price per lb of N = 0.90; Packaging and Handling = \$5.75 per CWT

Table 3. Influence of Split-Applied Nitrogen Fertilizer Rates on Classic Russet & Russet Norkotah Tuber Yield, Revenue, and Residual Soil Nitrate at IREC in 2011.

Season	Tuber			Tuber Yield (cwt/A)											Avg Tuber Size (oz)	Potato Revenue \$/A ⁶	Residual Soil NO ₃ ppm ⁷	Residual Soil NO ₃ + NH ₄ ppm ⁷
	Total lbs N/A ¹	Planting lbs N/A ²	Initiation lbs N/A ³	Early Bulking lbs N/A ⁴	U.S. No. 1's (cwt)							Culls + 2's Total	Plants/ Tubers/ Plot ⁵ Plant					
					Total 1's	12- 16oz	8- 12oz	4-8oz	<4oz	>16oz	>2's							
Classic																		
28	0	0	0	359	63	162	135	15	15	15	405	55.3	5.8	7.9	\$3,153	6.8	10.8	
78	25	12.5	12.5	443	84	211	149	19	22	28	513	56.0	7.0	8.2	\$4,056	n/a	n/a	
178	75	37.5	37.5	419	79	189	151	24	19	41	504	55.8	7.3	7.7	\$3,628	n/a	n/a	
228	100	50	50	421	85	187	152	25	20	53	518	56.1	7.3	7.9	\$3,633	7.5	11.0	
278	125	62.5	62.5	409	77	171	161	27	16	50	502	55.8	7.5	7.5	\$3,332	n/a	n/a	
328	150	75	75	438	107	180	149	24	45	57	564	54.4	7.9	8.2	\$4,028	12.0	19.5	
Norkotah																		
28	0	0	0	250	26	76	149	64	8	22	344	57.0	6.9	5.4	\$1,575	8.5	16.8	
78	25	12.5	12.5	330	55	123	150	47	21	22	419	56.2	7.1	6.5	\$2,603	n/a	n/a	
178	75	37.5	37.5	318	54	114	150	50	31	29	429	56.7	7.2	6.5	\$2,510	n/a	n/a	
228	100	50	50	309	44	116	150	55	21	36	422	56.7	7.4	6.2	\$2,219	16.5	26.3	
278	125	62.5	62.5	321	61	116	144	49	35	43	449	56.5	7.3	6.8	\$2,550	n/a	n/a	
328	150	75	75	310	52	111	147	50	28	43	432	56.2	7.3	6.5	\$2,293	22.3	32.0	
95% confidence interval				31	20	19	13	7	11	10	37	NS	0.4	0.4	\$445	5.8	8.3	

¹ Nitrogen fertilizer rates are expressed as lbs of nitrogen per acre. Nitrogen was applied in the form of urea. All treatments included split application at planting, tuber initiation, and early bulking. Urea was incorporated via irrigation or tillage immediately after application. All treatments accidentally received an additional 14lbs/A of N in the form of Thiosol on July 1 & 9th. Soil Type= Silty Clay Loam; Preplant Nitrate and Ammonium = 10 ppm.

² At planting treatments were applied on May 27th.

³ Tuber initiation treatments were applied on July 13th.

⁴ Early bulking treatments were applied on July 28th.

⁵ Seed spacing was 11.3 inches for both varieties.

⁶ Revenue per Acre = Gross Revenue using the 4 year average for Columbia Basin Carton and Bag Prices - \$5.75/CWT Packing and Handling Charges - Fertilizer Cost at \$0.90 per lb of N)

⁷ Residual soil nitrate and ammonium (0-12 inch depth) was measured shortly after harvest on Oct. 17th for select treatments. n/a = treatments not sampled for residual nitrate and ammonium.

Table 4. Influence of Nitrogen Application Timing (N at planting versus N split-application) on Classic Russet & Russet Norkotah Tuber Yield, Revenue, and Residual Soil Nitrate at IREC in 2011.

Season	Tuber Total lbs N/A ¹	Tuber Planting lbs N/A ²	Early Initiation lbs N/A ³	Early Bulking lbs N/A ⁴	Tuber Yield (cwt/A)										Avg Tuber Size (oz)	Potato Revenue \$/A ⁶	Residual	
					U.S. No. 1's (cwt)												Residual Soil NO ₃ ppm ⁷	Residual Soil NO ₃ + NH ₄ ppm ⁷
					Total	12-1's	8-16oz	8-12oz	4-8oz	<4oz	>16oz	+2's	Total	Plants/ Plot ⁵				
Classic																		
128	0	75	25	376	103	163	108	17	38	31	461	56.0	5.8	8.7	\$3,732	5.5	11.0	
128	100	0	0	434	80	194	164	28	16	46	524	55.7	7.7	7.6	\$3,723	7.0	13.5	
228	100	50	50	421	85	187	152	25	20	53	518	56.1	7.3	7.9	\$3,633	7.5	11.0	
228	200	0	0	409	83	181	146	20	27	66	522	54.8	7.6	7.8	\$3,642	6.8	16.8	
Norkotah																		
128	0	75	25	271	38	97	136	49	22	30	373	57.0	6.6	6.2	\$2,037	12.5	18.8	
128	100	0	0	323	55	120	147	45	32	30	429	57.2	7.0	6.7	\$2,651	11.5	17.5	
228	100	50	50	309	44	116	150	55	21	36	422	56.7	7.4	6.2	\$2,219	16.5	26.3	
228	200	0	0	315	60	114	139	41	36	35	426	56.8	6.8	6.9	\$2,597	22.5	28.5	
95% confidence interval				31	20	19	13	7	11	10	37	NS	0.4	0.4	\$445	5.8	8.3	

¹ Nitrogen fertilizer rates are expressed as lbs of nitrogen per acre. Nitrogen was applied in the form of urea. Urea was incorporated via irrigation or tillage immediately after application. All treatments accidentally received an additional 14lbs/A of N in the form of Thiosol on July 1 & 9th. Soil Type= Silty Clay Loam; Preplant Nitrate and Ammonium = 10 ppm.

² Planting treatments were applied on May 27th.

³ Tuber initiation treatments were applied on July 13th.

⁴ Early bulking treatments were applied on July 28th.

⁵ Seed spacing was 11.3 inches for both varieties.

⁶ Revenue per Acre = Gross Revenue using the 4 year average for Columbia Basin Carton and Bag Prices - \$5.75/CWT Packing and Handling Charges - Fertilizer Cost at \$0.90 per lb of N)

⁷ Residual soil nitrate and ammonium (0-12 inch depth) was measured shortly after harvest on Oct. 17th for select treatments. n/a = treatments not sampled for residual nitrate and ammonium.

Table 5. Influence of Nitrogen Fertilizer Additives on Classic Russet & Russet Norkotah Tuber Yield and Revenue at IREC in 2011.

Nitrogen Fertilizer Rate, Timing, and Additive Product ¹	Season Total lbs N/A ²	Tuber Yield (cwt/A)										Avg Tuber Size (oz)	Potato Revenue \$/A
		U.S. No. 1's (cwt)							Culls Total	Plants/ Plot ³	Tubers/ Plant		
		Total 1's	12- 16oz	8- 12oz	4-8oz	<4oz	>16oz	+ 2's					
Classic													
100-50-50	228	420	86	185	149	25	20	52	518	56.2	7.3	7.9	\$3,633
100-50-50 + N-Boost ⁴	228	441	93	186	162	25	27	43	537	56.0	7.7	7.8	\$3,839
100-50-50 + Stimulate Program ⁵	228	369	52	151	165	39	11	86	504	54.4	8.2	7.1	\$2,885
200-0-0 Osmocote slow release ⁶	228	421	86	180	153	22	14	31	485	55.8	6.9	7.8	\$3,514
Norkotah													
100-50-50	228	309	44	116	150	55	21	36	422	56.7	7.4	6.2	\$2,219
100-50-50 + N-Boost ⁴	228	325	58	123	144	47	33	31	435	57.0	7.2	6.6	\$2,594
100-50-50 + Stimulate Program ⁵	228	285	44	96	146	62	18	40	405	56.5	7.5	6.0	\$1,944
200-0-0 Osmocote slow release ⁶	228	280	36	91	153	52	16	25	373	55.7	7.0	5.9	\$1,842
95% confidence interval		NS	NS	NS	11.9	NS	NS	10.41	NS	NS	NS	NS	\$447

¹All nitrogen additive treatments received 228 lbs of nitrogen per acre. Nitrogen rates are expressed as lbs of nitrogen (N) per acre and are shown as lbs of N/A at planting - lbs of N/A at tuber initiation - lbs of N/A at early bulking. Urea was incorporated via irrigation or tillage immediately after application.

²All treatments accidentally received an additional 14 lbs of N/A in the form of thiosol on July 1st and 9th.

³The seed spacing for this trial was 11.3 inches for both varieties.

⁴N-Boost treatments were applied at 5 Pints/A on July 13th and August 4th.

⁵Stimulate Program included Stimulate Seed treatment @ 1oz/CWT; Calcium 5s @ 8 fl oz/A & Resist @ 4 fl oz/A on June 30th; N-Large @ 1 fl oz/A & 5X @ 8 fl oz/A on July 11th; Nitro + 9 @ 5 gallon/A on August 4th and 25th; Sugar mover @ 4 pts/A on July 20th and August 25th.

⁶200 lbs of N/A applied as Osmocote slow release fertilizer was applied and incorporated at planting.

Table 6. Influence of Split-Applied Nitrogen Fertilizer Rates on Classic Russet & Russet Norkotah Vine Vigor, Disease Rating, Tuber Defects, Bruising, Specific Gravity, and Storage at IREC in 2011.

Season	Tuber			Vigor Rating	Vigor Rating	Vert Wilt Rating	Growth	Irregular	Skinning	Shatter	Black		White			
	Total	Initiation	Early Bulking								Spot	Shrink in	Rot in	Knot		
lbs N/A ¹	lbs N/A	lbs N/A	lbs N/A	8/8/11 ²	9/13/11 ³	8/17/11 ⁴	Knobs % ⁵	Cracks % ⁵	Shape % ⁵	Rating ⁶	Bruise % ⁷	% ⁸	Specific Gravity	% ⁹	% ⁹	% ⁹
Classic																
28	0	0	0	4.0	6.2	0.2	2.7	1.7	4.5	3.5	96.3	2.5	1.089	4.2	0.0	50.0
78	25	12.5	12.5	4.6	6.6	0.0	4.5	2.8	8.6	3.0	93.4	20.1	1.091	3.7	0.3	52.8
178	75	37.5	37.5	5.0	6.9	0.2	6.0	1.7	21.0	3.1	87.5	12.5	1.089	3.7	0.0	42.5
228	100	50	50	5.0	7.6	0.0	6.4	2.8	23.0	3.0	89.6	36.3	1.086	3.5	0.0	50.7
278	125	62.5	62.5	5.0	7.6	0.2	5.8	0.7	25.3	2.9	92.5	15.0	1.085	3.4	0.6	50.0
328	150	75	75	5.0	7.7	0.2	6.4	1.3	27.1	3.0	94.0	23.4	1.083	3.2	0.3	52.9
Norkotah																
28	0	0	0	3.0	1.4	7.7	5.2	1.8	10.5	4.1	20.0	15.0	1.087	4.4	0.0	0.0
78	25	12.5	12.5	3.3	1.6	6.8	7.4	1.4	7.2	4.1	21.3	2.5	1.084	3.4	0.0	2.5
178	75	37.5	37.5	4.0	1.7	6.2	6.0	0.7	12.5	3.6	23.8	10.0	1.082	3.2	0.0	0.0
228	100	50	50	4.0	1.6	6.3	2.8	0.3	19.2	3.8	27.5	9.8	1.080	3.1	0.0	0.0
278	125	62.5	62.5	4.1	2.1	5.7	6.0	1.0	15.5	3.7	34.8	2.5	1.078	2.5	0.0	2.5
328	150	75	75	4.0	1.3	6.7	3.3	0.8	21.5	3.5	38.8	12.5	1.079	3.1	0.0	2.5
95% confidence interval				0.2	0.4	0.5	3.2	NS	6.8	0.4	NS	10.8	NS	0.7	NS	NS

¹ Nitrogen fertilizer rates are expressed as lbs of nitrogen per acre. Nitrogen was applied in the form of urea. All treatments included split application at planting, tuber initiation, and early bulking. Urea was incorporated via irrigation or tillage immediately after application. All treatments accidentally received an additional 28 lbs of N/A in the form of thiosol around tuber initiation.

² Vigor Rating 0-5 Scale, 5= highest vigor

³ Late Season Vine Vigor Rating 0-10 Scale, 10= highest vigor

⁴ Verticillium Wilt Rating 0-9 scale, 0= 0 Symptoms, 1= Trace, 2= 1-5% of plants show symptoms of disease, 3= 5-10%, 4= 10-20%, 5= 20-40%, 6= 40-60%, 7= 60-75%, 8= 75-90%, 9= 90-100%

⁵ Percentage of Total Yield

⁶ Skinning Rating (20 tubers/plot) 0-5 Scale, 5= no skinning; Reglone Application occurred on 9/15/2011; Harvested on 10/17/2011

⁷ 20 tubers evaluated from each plot (8-16oz tubers); 6 inch soil temperature was 45 degrees F at harvest

⁸ 10 tubers evaluated from each plot (8-16oz tubers)

⁹ 10 tubers evaluated from each plot (8-16oz) 54 days after harvest; storage at 40°F with 100% humidity

Table 7. Influence of Nitrogen Application Timing (N at planting versus N split-application) on Classic Russet & Russet Norkotah Vine Vigor, Disease Rating, Tuber Defects, Bruising, Specific Gravity, and Storage at IREC in 2011.

Season	Tuber			Vigor Rating	Vigor Rating	Vert Wilt Rating	Growth	Irregular	Skinning	Shatter	Black		White			
	Total	Planting	Early								Spot	Shrink in	Rot in	Knot		
lbs N/A ¹	lbs N/A	lbs N/A	lbs N/A	8/8/11 ²	9/13/11 ³	8/17/11 ⁴	Knobs % ⁵	Cracks % ⁵	Shape % ⁵	Rating ⁶	Bruise % ⁷	% ⁸	Specific Gravity	% ⁹	% ⁹	
Classic																
128	0	75	25	4.6	6.9	0.0	3.1	4.3	7.8	3.0	95.9	23.5	1.085	3.8	0.0	53.6
128	100	0	0	4.9	6.6	0.0	5.0	2.0	27.4	3.8	89.6	13.0	1.088	3.5	0.0	54.0
228	100	50	50	5.0	7.6	0.0	6.4	2.8	23.0	3.0	89.6	36.3	1.086	3.5	0.0	50.7
228	200	0	0	5.0	7.4	0.0	8.3	1.3	35.8	3.0	90.0	27.5	1.089	4.0	0.3	32.5
Norkotah																
128	0	75	25	3.5	1.8	6.7	6.5	2.2	14.0	3.8	37.5	2.5	1.082	4.1	0.0	0.0
128	100	0	0	4.0	1.4	6.2	2.8	0.6	14.0	3.9	32.3	2.5	1.081	3.8	0.2	0.0
228	100	50	50	4.0	1.6	6.3	2.8	0.3	19.2	3.8	27.5	9.8	1.080	3.1	0.0	0.0
228	200	0	0	4.0	1.8	6.4	4.0	1.0	16.0	3.6	33.8	5.0	1.081	3.2	0.3	0.0
95% confidence interval				0.2	0.4	0.5	3.2	NS	6.8	0.4	NS	10.8	NS	0.7	NS	10.8

¹ Nitrogen fertilizer rates are expressed as lbs of nitrogen per acre. Nitrogen was applied in the form of urea. All treatments included split application at planting, tuber initiation, and early bulking. Urea was incorporated via irrigation or tillage immediately after application. All treatments accidentally received an additional 28 lbs of N/A in the form of thiosol around tuber initiation.

² Vigor Rating 0-5 Scale, 5= highest vigor

³ Late Season Vine Vigor Rating 0-10 Scale, 10= highest vigor

⁴ Verticillium Wilt Rating 0-9 scale, 0= 0 Symptoms, 1= Trace, 2= 1-5% of plants show symptoms of disease, 3= 5-10%, 4= 10-20%, 5= 20-40%, 6= 40-60%, 7= 60-75%, 8= 75-90%, 9= 90-100%

⁵ Percentage of Total Yield

⁶ Skinning Rating (20 tubers/plot) 0-5 Scale, 5= no skinning; Reglone Application occurred on 9/15/2011; Harvested on 10/17/2011

⁷ 20 tubers evaluated from each plot (8-16oz tubers); 6 inch soil temperature was 45 degrees F at harvest

⁸ 10 tubers evaluated from each plot (8-16oz tubers)

⁹ 10 tubers evaluated from each plot (8-16oz) 54 days after harvest; storage at 40°F with 100% humidity

Table 8. Influence of Nitrogen Application Timing + Additives on Classic Russet and Russet Norkotah Vine Vigor, Disease Rating, Tuber Defects, Bruising, and Specific Gravity at IREC in 2011.

Nitrogen Fertilizer Rate, Timing, and Additive Product ¹	Season Total lbs N/A ²	Vigor	Vigor	Vert Wilt	Knobs % ⁶	Growth Cracks % ⁶	Irregular Shape % ⁶	Skinning Rating ⁷	Shatter Bruise % ⁸	Black Spot	Specific Gravity
		Rating 8/8/11 ³	Rating 9/13/11 ⁴	Rating 8/17/11 ⁵						Bruising % ⁹	
Classic											
100-50-50	228	5.0	7.6	0.0	1.5	0.7	5.5	3.0	89.1	36.3	1.086
100-50-50 + N-Boost	228	5.0	7.3	0.2	1.6	0.3	4.1	3.0	93.8	18.3	1.087
100-50-50 + Stimulate Program	228	5.0	7.5	0.0	2.5	0.2	12.1	3.0	94.6	9.2	1.087
200-0-0 Osmocote slow release	228	4.3	6.6	0.0	0.6	0.5	4.1	2.9	95.0	15.0	1.090
Norkotah											
100-50-50	228	4.0	1.6	6.3	0.7	0.1	4.6	3.8	27.5	9.8	1.080
100-50-50 + N-Boost	228	4.0	2.0	7.0	0.8	0.5	4.3	3.6	31.4	11.1	1.081
100-50-50 + Stimulate Program	228	4.4	1.5	6.8	1.0	0.2	5.7	3.8	27.5	5.0	1.081
200-0-0 Osmocote slow release	228	3.5	1.3	6.7	1.4	0.5	2.5	3.9	40.0	10.0	1.085
95% confidence interval		NS	0.5	NS	NS	0.2	1.7	NS	NS	NS	NS

¹All nitrogen additive treatments received 228 lbs of nitrogen per acre. Nitrogen rates are expressed as lbs of nitrogen (N) per acre and are shown as lbs of N/A at planting - lbs of N/A at tuber initiation - lbs of N/A at early bulking. Urea was incorporated via irrigation or tillage immediately after application.

²All treatments accidentally received an additional 28 lbs of N/A in the form of thiosol around tuber initiation.

³Vigor Rating 0-5 Scale, 5= highest vigor

⁴Late Season Vine Vigor Rating 0-10 Scale, 10= highest vigor

⁵Verticillium Wilt Rating 0-9 scale, 0= 0 Symptoms, 1= Trace, 2= 1-5% of plants show symptoms of disease, 3= 5-10%, 4= 10-20%, 5= 20-40%, 6= 40-60%, 7= 60-75%, 8= 75-90%, 9= 90-100%

⁶Percentage of Total Yield

⁷Skinning Rating (20 tubers/plot) 0-5 Scale, 5= no skinning; Reglone Application occurred on 9/15/2011; Harvested on 10/17/2011

⁸20 tubers evaluated from each plot (8-16oz tubers); 6 inch soil temperature was 45 degrees F at harvest

⁹10 tubers evaluated from each plot (8-16oz tubers)