NITROGEN REQUIREMENTS FOR NEW POTATO VARIETIES UNDER FURROW IRRIGATION

Erik B. G. Feibert, Clinton C. Shock, and Lamont Saunders
Malheur Experiment Station
Oregon State University
Ontario, Oregon

Summary

A trial was designed to test potato nitrogen requirements for potato varieties under furrow irrigation in a N deficient field. The highest potato yield (518 cwt/ac over all varieties tested) was obtained in 1995 by the use of only 84 lb N/ac soon after planting. Additional N produced no additional economic returns. Varieties did not differ significantly in their response to N fertilizer. The new potato variety A082611-7 had higher total US Number One and marketable tuber yield than Russet Burbank and Shepody in this trial.

Introduction

The development of new potato varieties has made it possible to achieve good tuber yield and quality with furrow irrigation. These new varieties might differ from each other in their nitrogen requirements. Previous studies under sprinkler irrigation showed that the optimum N rate was less than the rate recommended by either the Oregon or Idaho fertilizer guides (Feibert et al., 1995). This trial compared Russet Burbank, Shepody, Frontier Russet, Ranger Russet, and three experimental lines AO82611-7 and COO83008-1 (both for processing), and NDTX 8-731-1R (a fresh market, red variety) as to their nitrogen requirements under furrow irrigation.

Procedures

The 1995 trial was conducted on an Owyhee silt loam previously planted to wheat at the Malheur Experiment Station. The field was bedded into 36-inch hills in the fall of 1994. A soil sample taken from the top foot on May 1, 1995 showed a pH of 7.8, 1.7 percent organic matter, 19 meq per 100 g of soil cation exchange capacity, 8 ppm nitrate-N, 4 ppm ammonium-N, 13 ppm phosphorus, 439 ppm potassium, 2350 ppm calcium, 383 ppm magnesium, 370 ppm sodium, 1.0 ppm zinc, 12.2 ppm iron, 8.8 ppm manganese, 1.0 ppm copper, 19 ppm sulfate-S and 0.7 ppm boron.

Two-ounce seed pieces were planted April 27 at 9-inch spacing. On May 19, Thimet 20G insecticide at 3 lbs ai/ac was shanked-in at the same time that urea for the nitrogen treatments was applied. The urea was applied before emergence to both sides of the hill (Figure 1). The shanks were adjusted to place the urea in bands

located at the same depth as the seed piece and offset 9 inches from the hill center. The hills were remade with a Lilliston cultivator. Prowl at 1 lb ai/ac and Dual at 2 lbs ai/ac were broadcast on the entire soil surface on May 23 and incorporated with the Lilliston. A late blight and insect control program consisting of weekly aerial applications of fungicide and insecticide mixes was initiated on July 14 and continued through August 26.

The experimental design had four N treatments as main plots and the seven potato varieties as split-plots within the main plots (Table 3). The main plots were 9 rows wide and 50 feet long. The four nitrogen treatments were replicated six times.

Nitrogen fertilizer rates were 0, 84, 144, and 204 lb N/ac (Table 1). Pre-emergence urea was applied on May 19. The second nitrogen application consisted of urea applied to the furrow bottom immediately before an irrigation to simulate water-run nitrogen.

Table 1. Nitrogen rates applied to seven potato varieties. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Treatment	Spring nitrate plus ammonium N 0-1 feet	Pre-emergence N (May 19)	Post-emergence "water-run" N (July 14)	Total nitrogen supply*
	lbs N/ac			
1	36	0	0	36
2	36	60	24	120
3	36	100	44	180
4	36	140	64	240

* Does not include mineralized nitrogen during the season.

Twenty four granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200, Irrometer Co., Riverside, CA) were installed in the top foot of soil and six GMS were placed in the second foot of soil. The daily sensor readings were used to schedule irrigations. The GMS in the top foot of soil were offset 6 inches from the hill top and centered 8 inches below the hill surface. The second foot GMS were placed in the hill center and centered 20 inches below the hill surface. Half of the first foot sensors were located on the wheel traffic side of the potato hill and the other half were located on the non-wheel traffic side of the hill. Sensors were read five times per week from June 10 to September 4 at 8 AM. Irrigations were started when the average soil water potential in the first foot of soil dried to -50 kPa.

At each irrigation, every other furrow was irrigated, with the irrigated furrows alternating from irrigation to irrigation. Seventeen irrigations were applied from June 12 to

September 1. Irrigation durations were 24 hours from June 12 through July 17 and 12 hours from July 17 through September 1.

Petiole samples were collected every two weeks from June 21 to August 16, and analyzed for nitrate.

Russet Burbank, Shepody, and Frontier Russet plants in each plot were sampled for petiole nitrate. Plant available-N contributed from organic matter mineralization was determined by the buried bag method (Westermann and Crothers, 1980).

Tubers from 40 feet in each plot were harvested on September 26 and evaluated for yield and grade. A subsample was stored and analyzed for tuber specific gravity and stem-end fry color in early November.

Results and Discussion

The soil remained generally wetter than -60 kPa until late in the season (Figure 2). We have shown that soil much drier than -60 kPa at the 8-inch depth can be associated with an increase in US Number Two tubers and other quality defects.

The maximum total potato yield, over all varieties, was 518 cwt/ac obtained at 84 lb N/ac (Table 3). This yield was achieved with substantially less N fertilizer than the university fertilizer guides would have recommended for this field (Table 2). The N in this trial was shanked in after planting, which would improve the use efficiency compared to pre-plant broadcast applications. When broadcast N applications are used, substantial amounts of N can be lost to leaching, lost to volatilization, or be located in tops of the potato hill that are inaccessible to the roots. The average total potato yield for Malheur County in 1995 was 405 cwt/ac, using substantially more N fertilizer than used in this trial (225 lb N/ac).

Total tuber yield, total US Number Ones, large US Number Ones and marketable tuber yield increased with 84 lb N/ac, over all varieties (Table 3). The proportion of large US Number One tubers increased with 84 lb N/ac (Table 4).

Varieties AO82611-7 and COO83008-1 had among the highest marketable yield and AO82611-7 had the highest total US Number One yield. Ranger Russet had the highest tuber specific gravity (Table 5). Shepody, AO82611-7, and COO83008-1 had among the lightest tuber stem-end fry color.

Organic matter mineralization in the top foot of soil released 10 lbs N/ac between May 1 and May 18 and 46 lb N/ac between May 18 and July 5, based on analysis of the soil in the buried bags (Figure 3). The nitrogen in the buried bags represents residual soil available nitrogen plus nitrogen released from organic matter mineralization without the effects of crop uptake, leaching, and other losses.

The positive response of potato yields to N fertilization in 1995 compared to 1994 was probably due to the lower pre-plant soil nitrate and ammonium N in 1995 (75 lb N/ac on May 1) compared to 1994 (108 lb N/ac on March 24). Nitrogen mineralization released about the same amount of N by June 30 both years (90 lb N/ac from March 24 to June 30 in 1994 and 98 lb N/ac from May 1 to July 5 in 1995). By July 5 the buried bags in the top two feet of soil contained amounts of nitrate and ammonium corresponding to 173 lb N/ac in 1995 compared to 198 lb N/ac on June 30 in 1994.

Only the 204 lb N/ac treatment for Russet Burbank and Shepody and the 144 lb N/ac and 204 lb N/ac treatments for Frontier Russet resulted in petiole nitrate in the sufficiency range (Jones and Painter, 1974); levels that proved to be unnecessary for maximum yields (Figures 4-6).

Conclusions

Sidedressed N fertilization beyond 84 lb N/ac did not increase potato yields in 1995, over all varieties. The 84 lb N/ac resulting in the maximum total yield of 518 cwt/ac is substantially less than the university fertilizer recommendations for this field.

Averaged over all N rates, the experimental processing varieties AO82611-7 and COO83008-1, performed as well as, or better than Shepody and Ranger Russet in US Number One and marketable yield. Russet Burbank and Frontier Russet had among the darkest stem-end fry color and lowest tuber specific gravity.

Table 2. University N fertilizer recommendations compared to actual sidedressed N fertilizer needed to maximize furrow irrigated potato yield. Malheur Experiment Station, Ontario, Oregon, 1995.

Year	Soil nitrate & ammonium, 0-24 inches at planting	University recommendation		Lowest N rate tested achieving top yield
		Oregon	Idaho	
	——— lb/ac ———			
1994	108	80	110	0
1995	75	236*	220**	84

* 176+ 60 (20 lb N/ac per ton of wheat straw residue)

** 175+45 (15 lb N/ac per ton of wheat straw residue)

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Table 3. Yield response of seven potato cultivars to four nitrogen fertilizer treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Nitrogen fertilizer rate	Potato yield by market grade										
		US Number One				US Number Two				Marketable	Undersize	Total yield
		4-6 oz	6-10 oz	>10 oz	total	4-6 oz	6-10 oz	>10 oz	total			
	lb N/ac	cwt/ac										
R. Burbank	0	126.0	174.3	122.1	422.3	2.8	8.9	20.5	32.1	454.4	94.2	548.6
	84	119.1	175.2	138.0	432.3	5.8	12.3	30.4	48.5	480.9	86.7	567.6
	144	106.4	170.2	152.2	428.8	6.3	15.0	30.8	52.1	480.9	80.6	561.5
	204	92.2	149.2	150.1	391.5	3.1	13.8	29.6	46.5	438.0	84.0	522.0
	Average	110.9	167.2	140.6	418.7	4.5	12.5	27.8	44.8	463.5	86.4	549.9
Shepody	0	39.0	98.7	278.0	415.6	0.3	1.8	5.4	7.5	423.2	17.3	440.4
	84	32.8	84.7	332.2	449.8	1.7	2.8	16.3	20.9	470.7	22.1	492.8
	144	33.1	91.5	312.8	437.4	1.8	2.9	28.6	33.3	470.7	19.2	489.9
	204	26.3	78.7	348.4	453.4	1.3	4.3	37.5	43.1	496.4	16.1	512.5
	Average	32.8	88.4	317.9	439.0	1.3	3.0	21.9	26.2	465.3	18.7	483.9
F. Russet	0	90.0	176.7	168.5	435.2	1.2	3.3	16.8	21.3	456.5	56.6	513.0
	84	76.9	137.5	223.3	437.7	2.0	2.1	18.7	22.7	460.5	63.1	523.6
	144	72.8	137.5	191.0	401.3	2.0	5.5	24.1	31.6	432.8	52.5	485.3
	204	71.2	115.2	199.2	385.6	2.7	7.2	23.3	33.1	418.7	59.5	478.2
	Average	77.7	141.7	195.5	414.9	2.0	4.5	20.7	27.2	442.1	57.9	500.0
R. Russet	0	49.2	142.7	181.6	373.5	3.0	6.8	19.7	29.6	403.1	30.2	433.2
	84	41.0	123.6	284.8	449.3	2.7	5.5	24.1	32.3	481.7	26.4	508.1
	144	42.4	110.3	271.5	424.3	1.2	7.6	25.0	33.8	458.1	27.2	485.3
	204	40.1	83.7	269.0	392.7	3.1	10.0	34.5	47.6	440.3	32.0	472.3
	Average	43.1	115.1	251.7	409.9	2.5	7.5	25.8	35.8	445.8	29.0	474.7
AO 82611-7	0	81.4	191.2	166.1	438.8	1.0	3.6	12.7	17.3	456.1	49.0	505.1
	84	61.5	158.5	240.1	460.2	1.6	6.1	20.3	28.0	488.2	38.5	526.7
	144	63.2	147.8	266.2	477.1	1.4	6.4	23.7	31.5	508.6	43.6	552.2
	204	59.7	145.2	299.0	504.0	2.3	5.8	19.3	27.5	531.4	43.3	574.8
	Average	66.5	160.7	242.9	470.0	1.6	5.5	19.0	26.1	496.1	43.6	539.7
COO 83008-1	0	40.2	128.8	220.0	389.0	1.1	6.7	24.1	31.9	421.0	19.2	440.2
	84	30.4	94.0	324.7	449.2	1.5	8.4	39.9	49.7	498.9	13.9	512.7
	144	39.6	135.3	270.2	445.0	1.5	8.9	21.8	32.2	477.2	20.6	497.8
	204	27.3	111.5	311.7	450.5	1.1	4.7	33.2	39.0	489.5	21.2	510.7
	Average	34.4	117.4	281.6	433.4	1.3	7.2	29.7	38.2	471.6	18.7	490.4
NDTX 8-731-1R	0	59.1	144.8	198.0	401.9	0.0	0.0	0.0	0.0	401.9	42.4	444.3
	84	68.4	146.2	240.2	454.8	0.0	0.0	0.0	0.0	454.8	45.4	500.2
	144	68.9	145.6	205.2	419.6	0.0	0.0	0.0	0.0	419.6	40.4	460.1
	204	59.2	142.0	197.6	398.8	0.0	0.0	0.0	0.0	398.8	42.3	441.1
	Average	63.9	144.6	210.2	418.8	0.0	0.0	0.0	0.0	418.8	42.6	461.4
All varieties	0	69.3	151.0	190.6	410.9	1.3	4.4	14.2	20.0	430.9	44.1	475.0
	84	61.5	131.4	254.8	447.6	2.2	5.3	21.4	28.9	476.5	42.3	518.8
	144	60.9	134.0	238.4	433.4	2.0	6.6	22.0	30.6	464.0	40.6	504.6
	204	53.7	117.9	253.6	425.2	1.9	6.5	25.3	33.8	459.0	42.6	501.7
LSD (0.05) Trt		6.5	9.3	23.7	21.5	ns	ns	6.6	8.5	21.5	ns	20.8
LSD (0.05) Variety		8.9	15.2	29.4	28.3	1.2	3.0	8.0	9.8	29.2	6.1	29.2
LSD (0.05) Trt X Var		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 4. Tuber market grade response of seven potato cultivars to four nitrogen fertilizer treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Nitrogen fertilizer rate	Potato market grade distribution									
		US Number One				US Number Two				Marketable	Undersize
		4-6 oz	6-10 oz	>10 oz	total	4-6 oz	6-10 oz	>10 oz	total		
	lb N/ac	%									
R. Burbank	0	22.8	31.5	22.8	77.1	0.5	1.6	3.8	5.9	83.0	17.0
	84	21.0	30.8	24.3	76.1	1.0	2.2	5.4	8.6	84.7	15.3
	144	19.3	30.4	26.5	76.2	1.2	2.6	5.4	9.2	85.4	14.6
	204	17.5	28.3	29.5	75.3	0.6	2.6	5.6	8.8	84.0	16.0
	Average	20.2	30.2	25.7	76.2	0.8	2.3	5.1	8.1	84.3	15.7
Shepody	0	9.0	22.8	62.6	94.4	0.1	0.4	1.2	1.6	96.0	4.0
	84	6.9	17.3	67.3	91.4	0.3	0.6	3.2	4.0	95.4	4.6
	144	6.8	18.8	63.7	89.3	0.4	0.6	5.8	6.7	96.0	4.0
	204	5.1	15.4	68.3	88.9	0.2	0.8	6.9	8.0	96.9	3.1
	Average	6.9	18.6	65.5	91.0	0.3	0.6	4.3	5.1	96.1	3.9
F. Russet	0	17.3	34.3	33.0	84.6	0.2	0.6	3.4	4.2	88.9	11.1
	84	14.9	26.3	42.3	83.5	0.4	0.4	3.5	4.3	87.8	12.2
	144	15.0	28.4	39.1	82.5	0.4	1.2	5.0	6.6	89.1	10.9
	204	15.0	23.9	41.6	80.5	0.6	1.5	4.9	6.9	87.5	12.5
	Average	15.6	28.3	39.0	82.8	0.4	0.9	4.2	5.5	88.3	11.7
R. Russet	0	11.4	33.3	41.6	86.3	0.7	1.5	4.4	6.7	93.0	7.0
	84	8.0	24.4	56.0	88.4	0.5	1.1	4.8	6.4	94.8	5.2
	144	8.9	22.7	55.8	87.3	0.2	1.5	5.2	7.0	94.3	5.7
	204	8.6	17.8	56.9	83.4	0.6	2.1	7.0	9.7	93.1	6.9
	Average	9.2	24.5	52.6	86.3	0.5	1.6	5.4	7.5	93.8	6.2
AO 82611-7	0	16.3	37.9	32.6	86.8	0.2	0.7	2.5	3.4	90.2	9.8
	84	11.7	30.1	45.4	87.2	0.3	1.2	4.0	5.4	92.6	7.4
	144	11.4	26.9	48.2	86.5	0.2	1.1	4.3	5.6	92.1	7.9
	204	10.6	25.7	51.3	87.5	0.4	1.0	3.3	4.7	92.3	7.7
	Average	12.5	30.1	44.4	87.0	0.3	1.0	3.5	4.8	91.8	8.2
COO 83008-1	0	9.2	28.9	50.1	88.2	0.2	1.6	5.5	7.3	95.5	4.5
	84	6.1	18.5	62.7	87.4	0.3	1.6	8.0	9.9	97.3	2.7
	144	8.0	27.2	54.2	89.3	0.3	1.8	4.4	6.5	95.8	4.2
	204	5.4	22.1	60.6	88.1	0.2	0.9	6.6	7.7	95.8	4.2
	Average	7.2	24.2	56.9	88.3	0.3	1.5	6.1	7.9	96.1	3.9
NDTX 8-731-1R	0	13.2	33.3	43.9	90.4	0.0	0.0	0.0	0.0	90.4	9.6
	84	13.8	29.3	47.8	90.9	0.0	0.0	0.0	0.0	90.9	9.1
	144	15.0	31.9	44.3	91.1	0.0	0.0	0.0	0.0	91.1	8.9
	204	13.4	32.2	44.8	90.4	0.0	0.0	0.0	0.0	90.4	9.6
	Average	13.9	31.7	45.2	90.7	0.0	0.0	0.0	0.0	90.7	9.3
All varieties	0	14.2	31.7	40.9	86.8	0.3	0.9	3.0	0.2	91.0	9.0
	84	11.8	25.2	49.4	86.4	0.4	1.0	4.1	5.5	91.9	8.1
	144	12.1	26.6	47.4	86.0	0.4	1.3	4.3	6.0	92.0	8.0
	204	10.8	23.6	50.4	84.9	0.4	1.3	4.9	6.6	91.4	8.6
LSD (0.05) Trt		1.7	1.9	3.8	ns	ns	ns	1.3	1.6	ns	ns
LSD (0.05) Variety		1.7	2.9	4.6	2.2	0.2	0.6	5.6	1.9	1.2	1.2
LSD (0.05) Trt X Var.		ns	5.8	ns	ns	ns	ns	ns	ns	ns	ns

Table 5. Tuber stem-end fry color and specific gravity response of six potato cultivars to four nitrogen fertilizer treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Variety	Nitrogen fertilizer rate	Stem-end fry color	Specific gravity	Variety	Nitrogen fertilizer rate	Stem-end fry color	Specific gravity
	lb N/ac	% reflectance			lb N/ac	% reflectance	
R. Burbank	0	32.5	1.094	R. Russet	0	44.7	1.159
	84	33.8	1.092		84	45.2	1.102
	144	33.2	1.088		144	45.5	1.100
	204	33.4	1.087		204	44.4	1.098
	Average	33.2	1.090		Average	44.9	1.115
Shepody	0	46.5	1.094	AO 82611-7	0	45.6	1.095
	84	47.6	1.093		84	46.5	1.094
	144	46.4	1.087		144	46.3	1.093
	204	44.9	1.089		204	45.9	1.094
	Average	46.3	1.091		Average	46.1	1.094
F. Russet	0	35.6	1.097	COO 83008-1	0	48.3	1.097
	84	34.0	1.088		84	47.2	1.095
	144	32.9	1.088		144	50.3	1.096
	204	30.1	1.083		204	49.1	1.092
	Average	33.1	1.089		Average	48.7	1.095
All varieties	0	42.2	1.106				
	84	42.4	1.094				
	144	42.4	1.092				
	204	41.3	1.090				
LSD (0.05) Trt		ns	ns				
LSD (0.05) Variety		19.7	0.016				
LSD (0.05) Trt X Var		ns	ns				

Figure 1. Nitrogen fertilizer was shanked into the bed between the furrow and seed piece. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

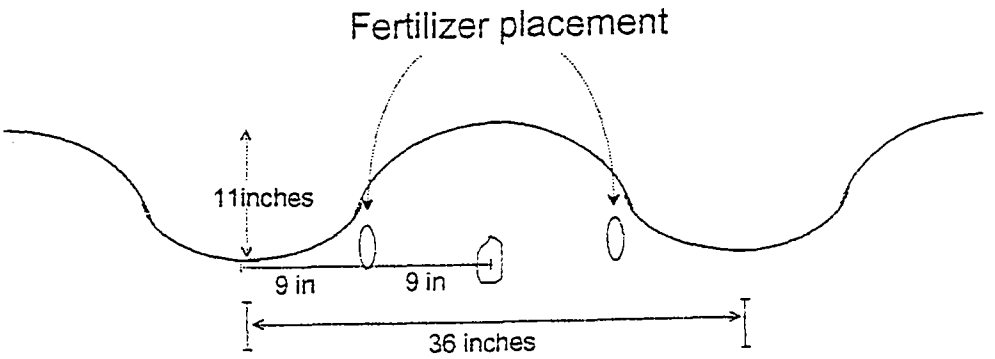

Figure 2. Soil water potential over time for furrow-irrigated potatoes. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

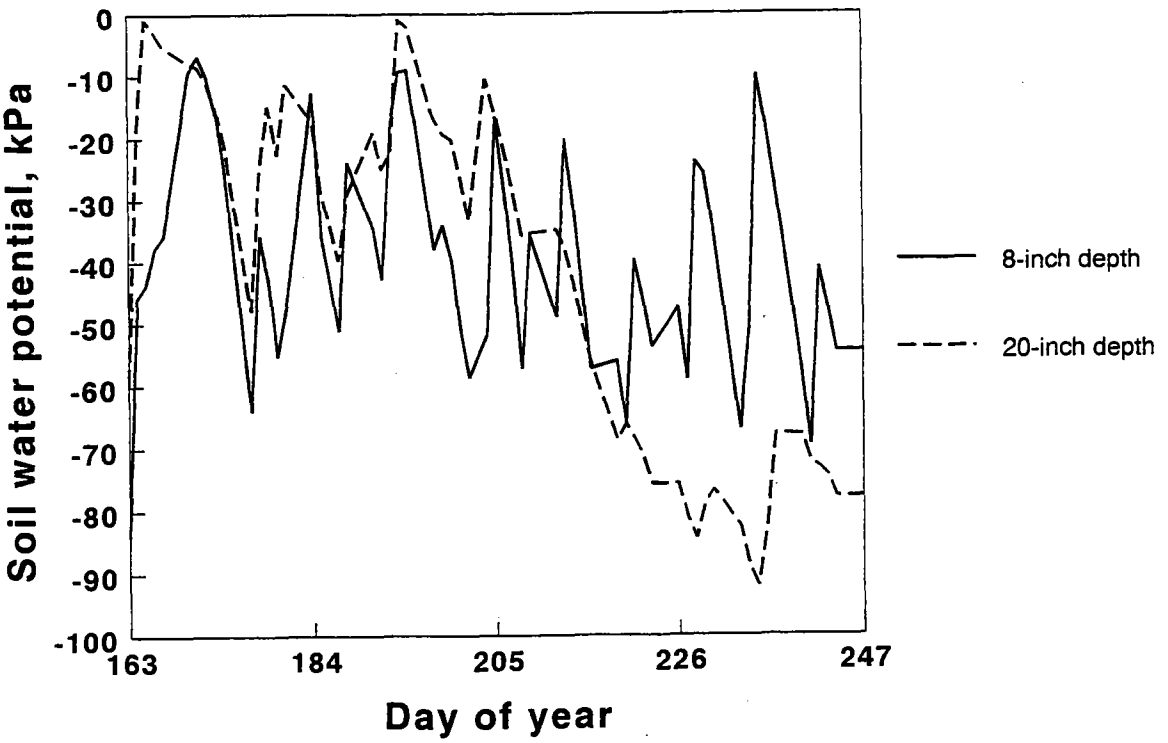

Figure 3. Available soil N in the first and second foot of soil released through organic matter mineralization as estimated by the buried-bag method. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

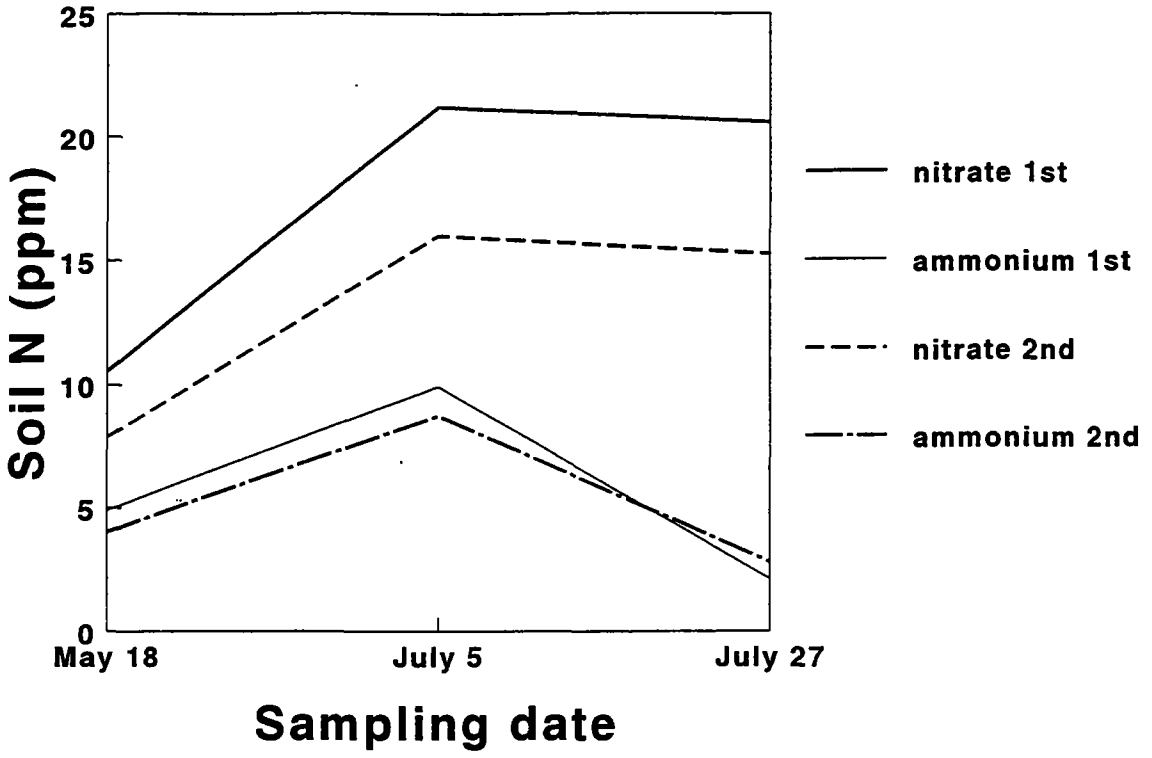

Figure 4. Russet Burbank petiole nitrate over time for furrow-irrigated potatoes receiving different N treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

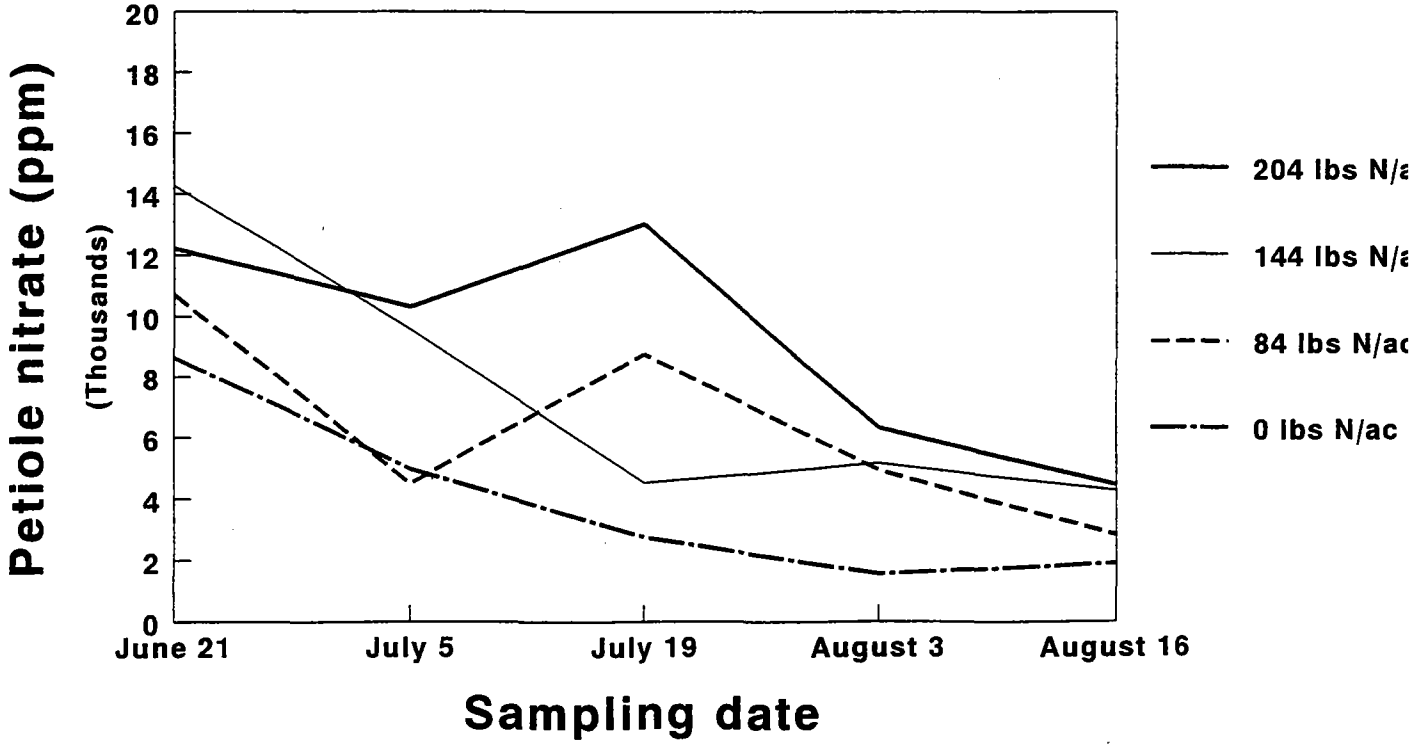

Figure 5. Shepody petiole nitrate over time for furrow-irrigated potatoes receiving different N treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

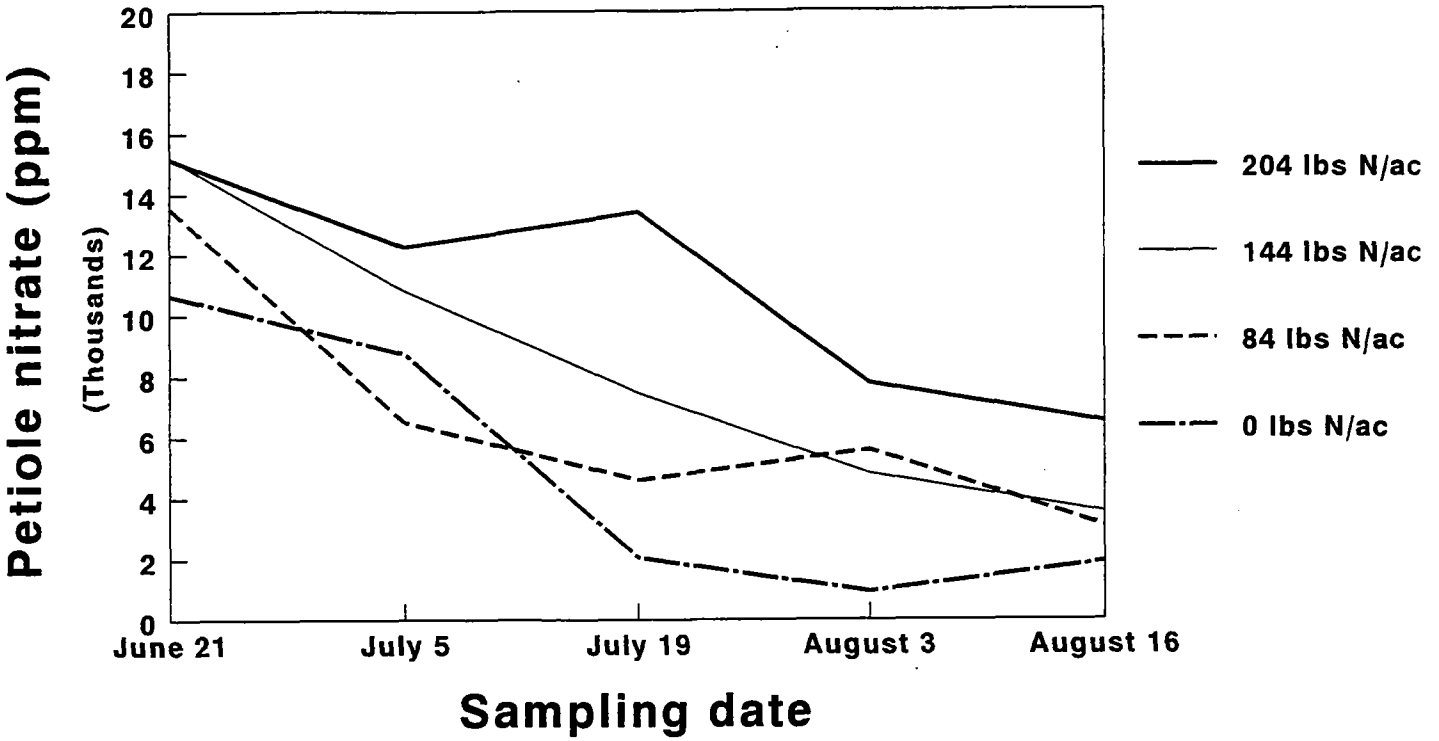

Figure 6. Frontier Russet petiole nitrate over time for furrow-irrigated potatoes receiving different N treatments. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.