POTATO RESPONSE TO RATE, TIME AND METHOD OF NITROGEN APPLICATION [1]

by
Steve Roberts and H. H. Cheng [2]
Department of Agronomy and Soils
Washington State University

A primary goal in potato production is to obtain high yields of salable potatoes with effective use of fertilizer, water and energy. Our earlier work showed that applying adequate, but not excessive N as starter fertilizer at the beginning of the season stimulated plant growth and gave early tuber development. When the amount of starter fertilizer is restricted, it increases the need for incremental or seasonal N applications to carry the crop through the season.

Many growers apply a portion of the required fertilizer as starter and then follow with daily or weekly increments of seasonal N. Studies were conducted with Russet Burbank potatoes on sandy soil to learn more about the starter and seasonal fertilizer requirements. The N use efficiency of potatoes with variations in rate, time and method of fertilization was of special interest in the study.

PROCEDURE

The experimental site was near the Columbia River, 5 miles west of Plymouth on Quincy loamy sand. The pre-treatment soil test N (NH_4^+-N + NO_3-N) averaged 5 ppm in the surface 2-ft layer. Fertilizers were incorporated before planting to supply adequate P, K, S and Zn. Treatments consisted of 200, 300 and 500 lb N/a as split applications of NH_4NO_3 with part of the N applied as starter fertilizer at planting and with the rest sprayed on and sprinkled in at weekly intervals through the season from June to August (Table 1). The N treatments were replicated three times in a randomized complete block experiment.

---

1 Paper presented at 25th Annual Washington State Potato Conference and Trade Fair, Big Bend Community College, Moses Lake, Feb. 4-6, 1986. Research was partially supported by a grant from the Washington State Potato Commission. Our thanks to F. O. Farrow, Agric. Res. Tech. III, Washington State University, Pullman, for performing the analytical part of the study.

2 Soil Scientists at Irrigated Agriculture Research and Extension Center, Prosser, Wa. and Washington State University, Pullman, Wa. respectively.

This Presentation is part of the Proceedings of the 1986 Washington State Potato Conference & Trade Fair.

Selected treatments had ^{15}N labeled NH_4^+ or NO_3^- added as tracer to the standard NH_4NO_3 fertilizer which is primarily ^{14}N. This enables one to follow the extent of the uptake of ^{15}N labeled fertilizer by the potato crop. The dry matter accumulation in whole plants was determined monthly and the yield of tubers was recorded at harvest. Plant samples were analyzed for total N and the percent ^{15}N tracer was determined in the total N taken up by the plants.

RESULTS

Increasing the season total N rate from 300 to 500 lb N/a in 1982 (Fig. 1,a) and from 200 to 300N in 1983 (Fig. 1,b) had increased the yield of dry plant tops and decreased tuber yield by the time whole plants were sampled in August. At final harvest in September of 1982 and '83, 300 N (100 starter plus 200 N as seasonal increments) usually gave the highest tuber yield. High N fertility up to 500 N favored growth of plant tops at the expense of tuber production.

In 1984 and '85, potato yield and grade-out tended to be higher for treatments with 100 N as starter (200 to 300 N as season total) then where starter was higher or lower than this amount (Table 2,3). Starter applied at 200 lb N/a (500 season total N) gave the highest percent by weight of under-sized tubers which was attributed to delayed tuber development with high fertility (Table 4).

The method of applying starter N whether broadcast as top-dressing or side-dressed along the row had no effect on yield (Table 5). Delaying starter fertilization from planting until emergence, tended to lower the yield in some cases (Table 5). The specific gravity of tubers seemed to vary more from one year to the next (1.081 in 1983 to 1.073 in 1983) with constant rate of 300 lb N/a than it did with different N rates (Table 6). Some have the impression that maintaining high N fertility with late season N applications may result in low specific gravity. In this study, N application was discontinued the second week of August which may have been early enough to avoid any adverse effect on specific gravity. The percent recovery of ^{15}N in whole plants was higher where increments of ^{15}N-labeled fertilizer were sprayed on during June and July than where ^{15}N was applied in May as pre-emergence starter (Fig. 2). Over 50% of the ^{15}N-labeled fertilizer applied during June and July was recovered by whole plants sampled in August of 1982 and by mature tubers harvested in September (results not shown) for the 300 N treatment. Generally the percent recovery was much lower for ^{15}N-labeled fertilizer applied in August than at any other time (Fig. 2). There was some apparent difference in recovery for $^{15}NH_4^+$ (A) versus $^{15}NO_3^-$-labeled (N) fertilizer (Fig. 2). The implications of these results are not considered here. Other results not included here showed nearly the same N use efficiency for treatments with 200 and 300 lb N/a, but the efficiency of 300 N was much higher as compared with an excessive rate up to 500 N.

CONCLUSIONS

N rates: Tuber yield was usually highest for 200 and 300 N, with 300 ^{15}N producing top-growth that was intermediate between 200 and 500 N. The % ^{15}N recovered in tubers at harvest was nearly the same for 200 and 300 N, and % ^{15}N recovery for 500 N was much lower.

Time: Yield was slightly higher with starter N applied at planting than at emergence. The highest % ^{15}N recovered in tubers at harvest was from seasonal N applied in late June and in July; the lowest ^{15}N recovery was generally from increments of fertilizer applied in August.

Method: There was no difference in yield or % ^{15}N recovered when top-dressed starter N was compared with side-dressing at this sandy site.

Table 1. Nitrogen fertilizer treatments on Russet Burbank potatoes, 1982-85.

Season total N rate, lb/a	Starter N lb/a	Seasonal N applied in† 10 weekly increments, lb/a
200	100	10
300	0	30
300	50	10-40 (Variable)
300	100	20
500	200	30

†Increments applied June to August.

Table 2. Effect of starter nitrogen at planting on potato yield.

Starter N lb/a	Seasonal N lb/a	1984 Yield, T/a	1985 Yield, T/a
0	300	--	28.9 bc
50	250	27.7 bc	--
100	100	31.1 ab	32.3 a
100	200	31.4 a	31.1 ab
200	300	26.2 c	27.8 c

Table 3. Grade of Potatoes with rates of starter nitrogen at planting.

Starter N lb/a	Seasonal N lb/a	1984 % 1's	1985 % 1's
0	300	--	63 a
50	250	55	--
100	100†	64	68 a
100	200	71	72 a
200	300	52	39 b

†10 weekly increments

Table 4. Undersized Russet Burbank potatoes produced with rates of starter nitrogen at planting, 1985.

Starter N lb/a	Seasonal N lb/a	<4 oz %
0	(300)†	13 b
100	(100)†	12 b
100	(200)	12 b
200	(500)	21 a

†10 weekly increments

Table 5. Effect of rate, method and time of applying nitrogen on yield of potatoes.

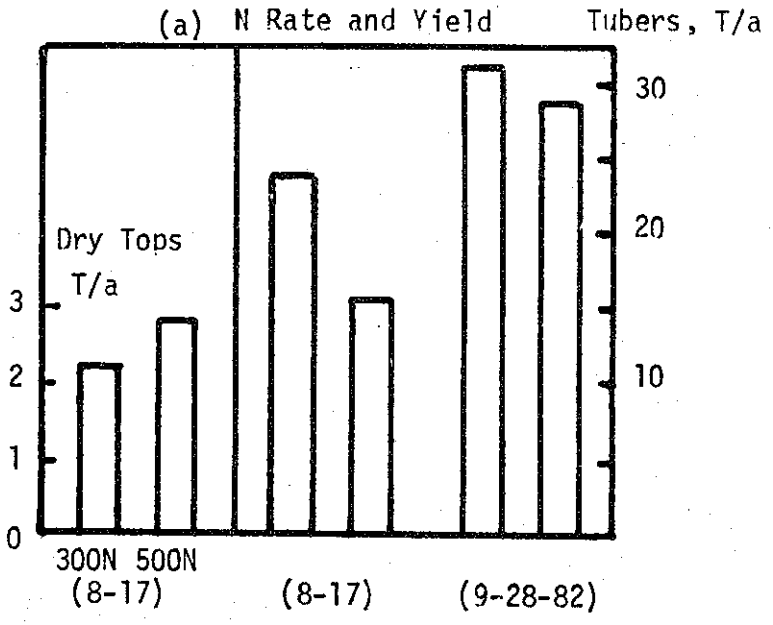
Rate - Method - Time lb/a	Seasonal N lb/a	1984 Yield, T/a	1985 Yield, T/a
100 Bc at planting†	100	31.1 ab	32.3
100 Sd at planting	100	31.4 a	30.9
100 Bc at emergence	100	29.0 b	30.0
100 Sd at emergence	100	29.8 b	--

†Bc = Broadcast; Sd = Sidedress

Table 6. Yield, specific gravity and grade of potatoes with different nitrogen rates.

N Rate lb/a	Tuber Yield, T/a	Sp. G.	% 1's
200 ('83)	29.5	1.074	77
300 ('82)	31.0	1.081	--
('83)	35.6	1.073	66
500 ('32)	28.9	1.085	--

Figure 1. Effect of nitrogen rate on dry matter accumulation of whole plants and on potato yield (a) 1982 and (b) 1983.



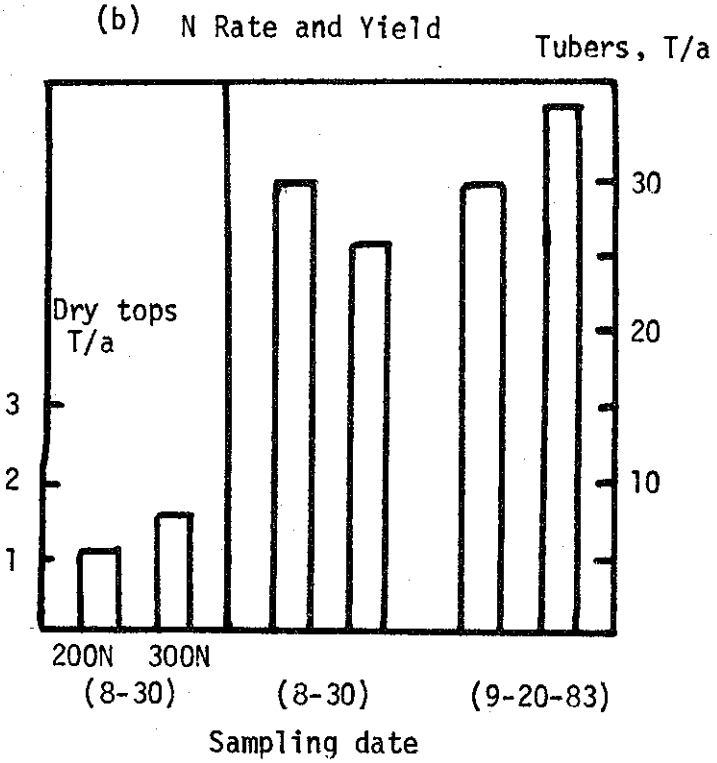


Figure 2. The % ^{15}N recovered in whole plants (complete bars) and in tubers (lower segment of bar) from pre-emergence starter fertilizer in May and seasonal increments of N from June to August equal to 300 lb N/a where A is $^{15}NH_4$ and N is $^{15}NO_3$-labeled fertilizer.