ADVANCES IN NITROGEN MANAGEMENT FOR RUSSET BURBANK POTATOES [1]

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There have been many studies reporting on nitrogen (N) fertilization of potatoes with the required fertilizer applied at planting time. When fertilizer was labeled with ^{15}N tracer, just over half of the N applied at planting was recovered in harvested tubers (Tyler, Broadbent, and Bishop, 1983). The pattern of N uptake is less certain with split application of fertilizer. Split application of N on sandy soil helps minimize N loss by wind erosion and leaching (Vomocil and Ramig, 1976). This report covers the effects of ^{15}N labeled fertilizer on yield and N utilization by potatoes where varied rates, methods and time of treatment were used. Some background on the ^{15}N tracer technique was discussed previously (Cheng and Roberts, 1982).

Our experimental results for the last three years were obtained on sprinkler-irrigated, sandy soil with low N fertility at a site five miles west of Plymouth, Washington. Russet Burbank potatoes were planted about April 20 each year. The primary treatments consisted of N rates with 50, 100, or 200 lb/a as NH_4NO_3 starter applied early in May. The starter was followed by supplemental addition of NH_4NO_3 every week or 10 days from June to August for a season total of 200, 300 or 500 lb N/a. Other nutrients were adequate according to soil test or were added as fertilizers.

Eight or more mini-plots (number varied each year) were set up within replicated blocks in the field with each mini-plot three rows wide by 4 to 6 ft long. Each time a split application treatment called for an addition of N, a different mini-plot received an equivalent amount of ^{15}N labeled fertilizer. The fertilizer was applied as a spray, followed immediately by sprinkler irrigation.

Fig. 1 illustrates the accumulated fertilizer for the 300 N standard treatment and the 300 N variable treatment. At the first stages the accumulated N for the standard treatment with 100 lb N/a as starter exceeded the amount accumulated for the variable treatment.

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The 300 N variable treatment had only 50 lb N/a as starter followed by some supplemental additions up to 40 lb N/a the first part of the season and as little as 10 lb N/a in each application toward the end of the season.

Samples of whole plants were collected each month to assess N uptake and distribution in plant tops and tubers. Petiole samples were collected for NO_3-N analysis, but these results were not reported here.

Nitrogen Requirement for Potatoes

The amount of N needed for potato production usually depends upon the yield potential and the yield goal of the grower. Our results on low N sandy soil (Table 1) and related results in the same area (Lauer, 1985) indicate that a rate of 300 lb N/a is sufficient to produce 30 t/a of potatoes. In another experiment the 200 lb N rate produced 31 t/a (Table 2). The 200 lb N rate is likely a sub-optimal level in some cases because tubers from a crop this size may remove that much N or more. The unexpected yield with 200 N is probably related to the low amount of crop residue with little tie-up of N fertilizer on this land which had not been cropped for several years. Potatoes planted in substantial amounts of crop residue usually require extra N to compensate for N tie-up or immobilization during residue decomposition. Growers planting potatoes on land with a substantial carry-over of NO_3-N as shown by soil test may scale down the N fertilization rate proportionately.

There was no advantage in applying 500 lb N/a as this high rate actually decreased yield slightly (Table 1,2). The treatment with 500 lb N/a promoted vine growth at the expense of tuber yield as compared with 300 lb N/a (Table 1). It has been suggested that at an optimum N level, tubers show dominance of N uptake over vines at an early development stage with vines reaching peak N uptake before mid-season (Lauer, 1985).

Split Application of Nitrogen

It has been demonstrated that split application of N, with a portion of N applied around planting time and the rest later, is desirable on Russet Burbank potato, because it enhances the early bulking rate of tubers (Roberts, Weaver, and Phelps, 1982). Besides this, splitting the N application minimizes the risk of losing N by early season wind erosion or leaching. An earlier report on potatoes demonstrated N leaching on a sandy soil treated with excessive irrigation early in the season (Middleton et al., 1975). In this case, leaching reduced yield unless corrective action was taken to apply N to compensate for what was lost.

Scheduling Starter and Incremental Nitrogen Applications

Results indicate that for a season total of 300 lb N/a, it is appropriate to apply about one-third (100 lb/a) of the total as starter fertilizer (standard treatment). Other treatments with 300 and 500 lb N/a with respective starter rates of 50 and 200 lb N/a yielded slightly less than this standard treatment (Table 1,2).

The versatility of the ^{15}N tracer technique enabled us to evaluate the percent ^{15}N recovered in the potato crop at various times of sampling from each supplemental N applied. The average accumulated percent ^{15}N in tubers at harvest was greater for the 300 standard treatment than for the variable treatment (Fig. 2). The percentages of applied ^{15}N recovered at different times in samples of plant tops and tubers are shown in Fig. 3 and 4. The first samples of plant tops taken after treatment usually contained 30 to 40% of the ^{15}N applied. The first samples of tubers after any given treatment showed much less ^{15}N uptake. The treatment applied in August (Fig. 4) resulted in less ^{15}N in tubers at final harvest than the earlier ^{15}N treatments. The August treatment allowed only a limited time before harvest for metabolizing and translocating ^{15}N into the tubers. This indicates that N applied in August was used less efficiently for tuber production than N applied earlier.

The tuber yields were nearly the same for both the standard and variable treatments with 300 lb N/a (Table 3), which substantiated results reported previously (Roberts and Cheng, 1984). The substantial additions of N in mid-season in the variable treatment induced second growth and low grade-out of tubers (Table 3). Consequently there is probably no advantage in trying to refine N applications to the point of adjusting daily or weekly N rates up or down during the season. For N injected in sprinkler water, the additions should begin soon after starting the post-planting irrigation. The amount of N needed to supplement the starter fertilizer may be pro-rated on a daily or weekly basis and applied on a fixed schedule at least through July. The addition of N may be continued into August although this fertilizer may be used less efficiently than N applied earlier.

Broadcasting Versus Sidedressing Starter Fertilizer

Yield results in Table 4 showed little difference between surface broadcasting N starter fertilizer or sidedressing at 7 inches on each side of the row. Likewise, starter fertilizer sidedressed at emergence was also equivalent to broadcasting at planting. Tentative conclusions from these results indicate that sidedressing starter fertilizer at planting is not important. This would make it much easier to plant having applied the starter fertilizer ahead of time.

References

Cheng, H. H. and Steve Roberts. 1982. ^{15}N tracer studies on nitrogen uptake by Russet Burbank Potatoes. Proc. 21st Ann. Washington State Potato Conf., p. 69-73.

Lauer, D. A. 1985. Nitrogen uptake patterns of potatoes with high frequency sprinkler applied nitrogen fertilizer. Agron. J. (In press).

Middleton, J. E., S. Roberts, D. W. James, T.A. Cline, B. L. McNeal, and B. L. Carlile. 1975. Irrigation and fertilizer management for efficient crop production on a sandy soil. Washington State Univ., College of Agric. Res. Ctr. Bull. 811.

Roberts, Steve, and H. H. Cheng. 1983. Additional results from ^{15}N tracer studies on nitrogen uptake by Russet Burbank potatoes. Proc. 22nd Ann. Washington State Potato Conf., p. 69-72.

Roberts, Steve, and H. H. Cheng. 1984. Implications from "spoon-feeding" potato plants with ^{15}N fertilizer. Proc. 23rd Ann. Washington State Potato Conf., p. 29-33.

Roberts, S., W. H. Weaver, and J. P. Phelps. 1982. Effect of rate and time of fertilization on nitrogen and yield of Russet Burbank potatoes under center pivot irrigation. Am. Potato J. 59:77-86.

Tyler, K. B., F. E. Broadbent and J. C. Bishop. 1983. Efficiency of nitrogen uptake by potatoes. Am. Potato J. 60:261-269.

Vomocil, J. A. and R. E. Ramig. 1976. Wind erosion control on irrigated Columbia Basin land. Oregon State Univ. Special Report 466.

Table 1. N Rates on Potatoes, 1982.

Sampling date	Dry tops, lb/a		Fresh tubers, T/a	
	300N	500N	300N	500N
22 June	1630	1890	0.54	0.93
20 July	4610	5260	12.3	8.7
17 Aug	4470	5640	23.9	15.6
28 Sep	-	-	31.0	28.9

Table 2. N Rates on Potatoes, 1984.

N	Tuber yield	Grade #1
lb/a	T/a	%
200	31.1	55
300	31.4	64
500	26.2	57

Table 3. Timing of N application.

N, lb/a		Method	Yield, T/a	% #1
300 Std	(100)	Broadcast at planting	31.4	64
300 Var.	(50)	Broadcast at planting	28.8	43

Table 4. N Response, 1984.

N applied, lb/a	Method and timing	Yield T/a	% #1
200	(100) Band at planting	31.4	71
200	(100) Band at emergence	29.8	52
200	(100) Broadcast at planting	31.1	55
200	(100) Broadcast at emergence	29.0	60

Fig. 1. Accumulation of N through the season for standard (equal increments) and variable (unequal increments) N treatments.

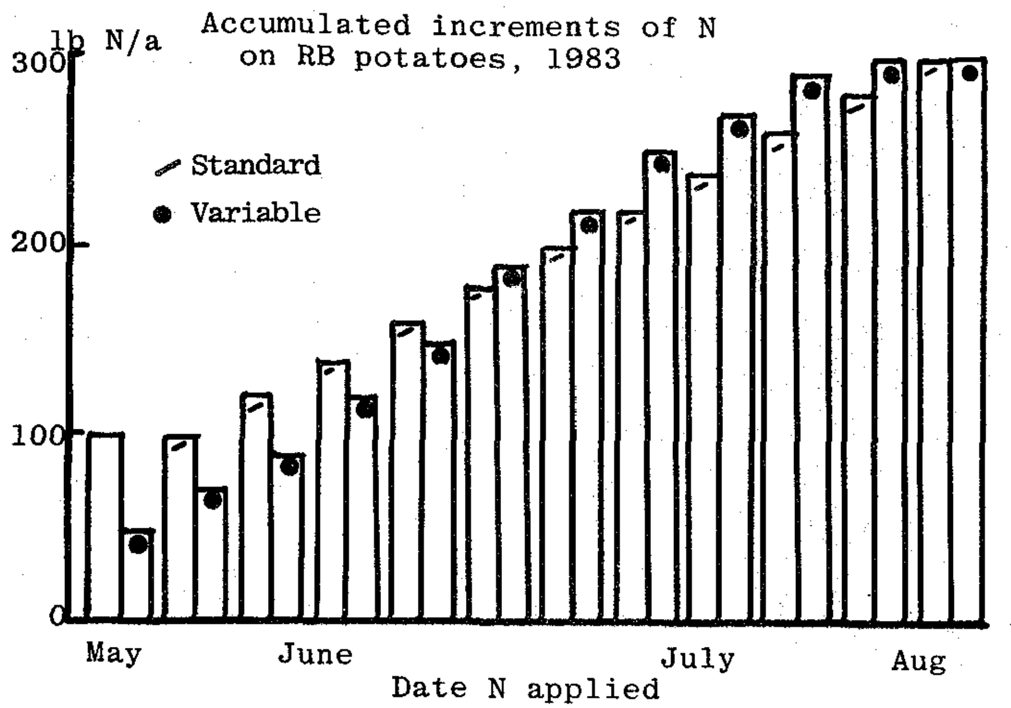

Fig. 2. Average percent ^{15}N accumulated in tubers at harvest for 300N standard and variable treatments applied at times indicated through the season.

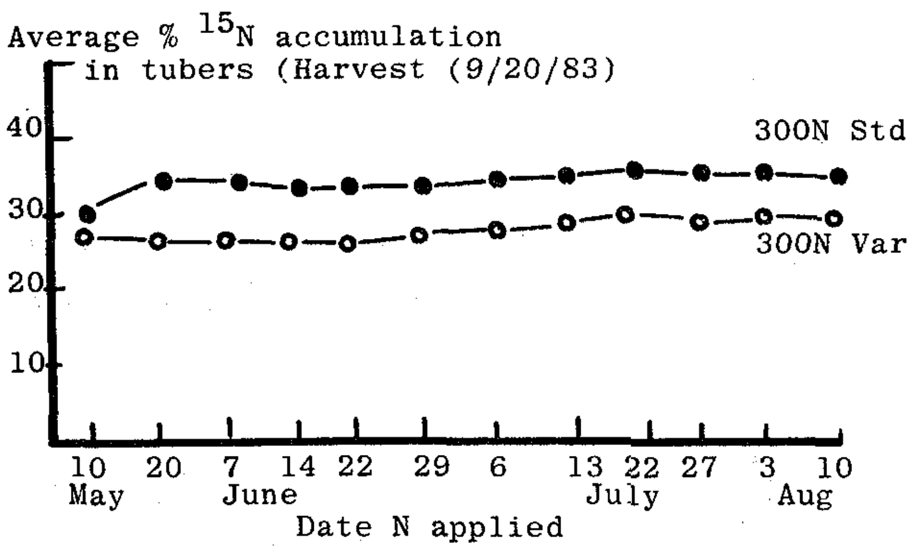

Fig. 3. Percent ^{15}N recovered in potato tops on different sampling dates following incremental N applications for a total of 300 lb N/a.

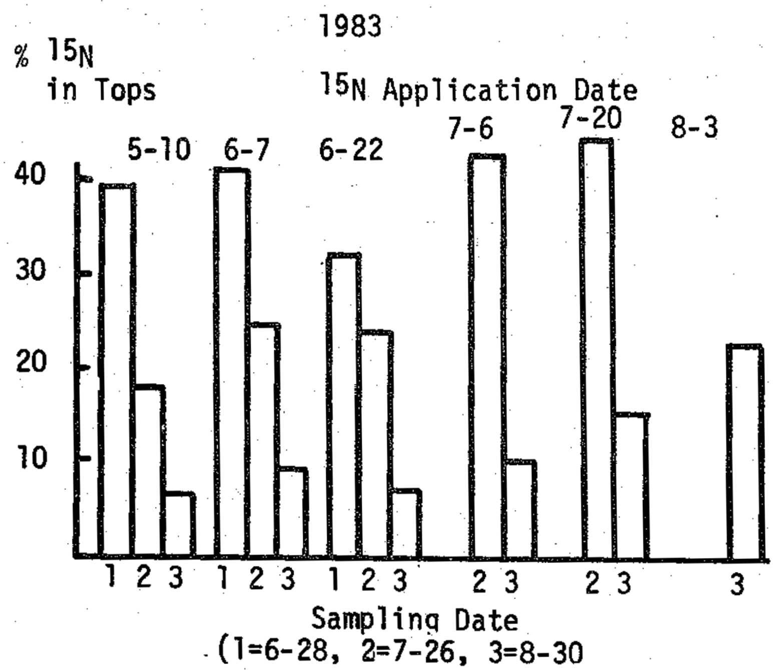

Fig. 4. Percent ^{15}N recovered in tubers on different sampling dates following incremental N applications for a total of 300 lb N/a.