

DEVELOPING POTATO FERTILIZER RECOMMENDATIONS FROM SMALL PLOT AND ON-FARM RESEARCH

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INTRODUCTION

Recent revisions in the University of Idaho fertilizer recommendations for potatoes are based on data from a wide variety of sources including multi-location small plot research conducted by the University of Idaho and USDA-ARS, large scale strip trials conducted on growers' fields, and on-farm and experiment station studies of site-specific relationships between nutrient management and potato yield and quality. Many of the on-farm research trials involved the cooperative efforts of university and ARS scientists, growers, crop advisers, and consultants. This broad approach to building a crop nutrient management database has provided several key advantages including (1) comparisons of small plot and field-scale research results, (2) an assessment of the effects of soil spatial variability on potato nutrient response, (3) increased ownership and support of the database by growers and crop advisers, and (4) a more realistic appraisal of potato nutrient responses in commercial production systems.

Nitrogen

The revised N recommendations are based on data obtained from small plot research studies conducted at university experiment stations during 1991-98, and from over 120 on-farm studies examining commercial N management practices. Data collected in these studies included site-specific relationships between N management and potato yield and quality, N uptake patterns, changes in soil inorganic N concentrations and apparent N losses. Data typically were collected at 3 to 4 sites per field. Plant N uptake patterns at each site were determined by collecting whole plant samples at 2-week intervals throughout the growing season. Soil NO₃-N and NH₄-N concentrations at each site were determined at the beginning and end of the growing season. Nitrogen mineralization potential was determined for about half of the sites using anaerobic incubation. Relationships between irrigation and N management were also evaluated.

An example of some of the on-farm data comparing potato yield and post-harvest soil N to total N application is presented in Figure 1. These data represent average results from 44 potato fields in 1994. These and other data sets show that maximum yield of potatoes is obtained when total N availability (inorganic N + mineralized N + fertilizer N) approaches 300 lb N/acre. Although highly variable, N mineralization at these sites averaged 60-70 lb N/acre. Applying greater amounts substantially increased post-harvest soil NO₃-N levels and reduced potato yield and economic return. Total N uptake from these fields averaged 175 to 225 lb N/acre, indicating an N use efficiency range of 60 to 75%. Additional research studies were used to refine and validate the total season N recommendations which are presented in Table 1. The recommended rates are adjusted based on soil test NO₃-N and NH₄-N, yield potential, and previous crop.

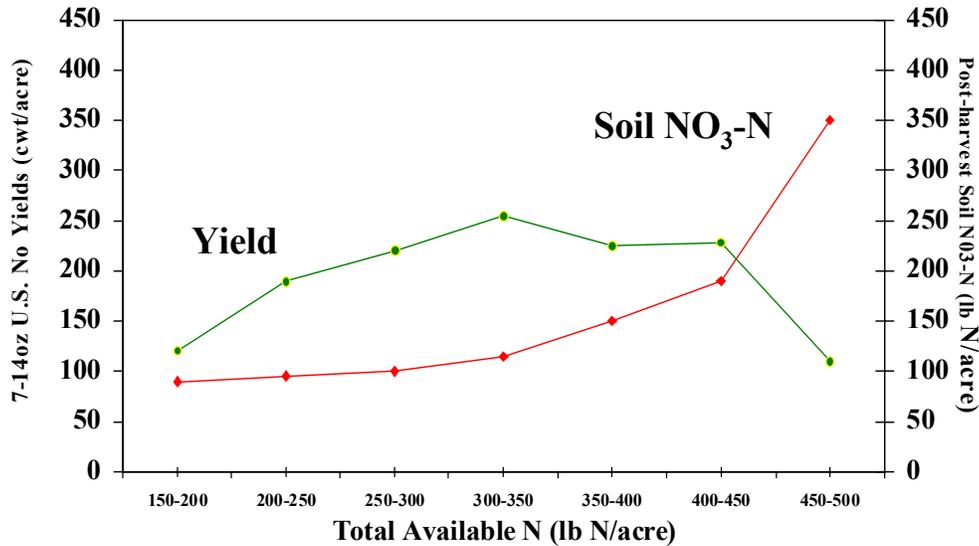


Figure 1. Relationship between potato yield, post-harvest soil NO₃-N, and total available soil N for 44 commercial potato fields in southeastern Idaho in 1994.

Table 1. Total season N application recommendations for Russet Burbank potatoes.

Soil Test NO ₃ -N = NH ₄ -N (0-12 inch depth)	Potential Yield (cwt/acre)			
	300	400	500	600
ppm	----- (lb N/acre) -----			
0	200	240	280	320
5	180	220	260	300
10	160	200	240	280
15	140	180	220	260
20	120	160	200	240
25	100	140	180	220

Add 15 lb N/acre for each ton of previous grain crop residue up to 60 lb N/acre.

Some additional guidelines for potato N management are as follows:

(1) The proportion of the seasonal N requirement applied prior to planting should be adjusted according to soil texture:

- Sands 25 to 30%
- Sandy loams 30 to 40%
- Silt loams 50 to 50%

(2) In-season N applications should begin after tuber initiation and should be adjusted according to tuber bulking rates and changes in weekly petiole N concentrations.

(3) N applications should be cut off 3 to 4 weeks before vine kill to avoid reductions in specific gravity and skin-set.

Phosphorus

Changes in the potato P recommendations are based on small plot research results, site specific P responses in precision fertilization studies, and results of large scale strip trials conducted in cooperation with growers and crop advisers as part of the Cooperative Fertilizer Evaluation Program (Tindall and Stark, 1997). The revised recommendations (Table 2) are based on three factors (1) a soil test P (NaHCO₃ extractable) sufficiency concentration of 20 ppm with no excess lime, (2) an adjustment of 10 lb P/acre for each 1% increase in excess lime, and (3) an adjustment for differences in crop P removal based on yield. Results from the on-farm strip trials and site-specific P response studies were used to validate the new recommendations.

Table 2. Preplant P fertilizer recommendations for Russet Burbank potatoes.

Soil Test P (0-12 inch depth) ppm	Percent Free Lime			
	0	4	8	12
	----- (lb P ₂ O ₅ /acre) -----			
0	320	360	400	440
5	240	280	320	360
10	160	200	240	280
15	80	120	160	200
20	0	40	80	120
25	0	0	0	40
30	0	0	0	0

Apply an additional 40 to 80 of P₂O₅/acre as a starter at planting for soil test P levels below 30 ppm. Add 25 lb P₂O₅/acre for each additional 100 cwt/acre above 400 cwt/acre.

The P rates presented in Table 2 represent preplant broadcast recommendations designed to bring soil test P concentrations up to sufficient levels. At soil test P concentrations less than 30 ppm, an additional 40 to 80 lb P/acre applied in a starter band is recommended to promote early season P availability. In-season P applications should be applied if needed to maintain petiole P concentrations above 0.22% (Tindall et al., 1991).

Potassium

Revisions in K recommendations for potatoes were based on a series of experiments established in grower fields between 1992 and 1994 (Westermann and Tindall, 1995). The

experiments included selected K management variables such as K rate, source and timing, as well as comparisons of broadcast vs. banding and preplant applications vs. fertigation.

Tuber yield, size, and quality data from these studies indicated that the critical soil test K concentration (STKC) using NaHCO₃ extraction, should be increased from 150 to 175 ppm in the top 12 inches of soil (Westermann and Tindall, 1997). In addition to the change in the critical STKC, the K fertilization rates necessary to achieve maximum yields (Table 3) were increased substantially from the previous guide (McDole et al., 1987). For example, the optimum K fertilization rate for a 400 cwt/acre yield at a STKC of 100 ppm increased from 100 lb K₂O/acre in the previous guide, to 300 lb K₂O/acre in the new recommendation. The results of these experiments show that preplant K fertilization is more effective than K fertigation and broadcasting K is better than banding. The data also show that K rates greater than 300 lb K₂O/acre should be split between fall and spring applications. Evaluations of the relationships between the K uptake by tubers and total plant K show that petiole K concentrations should be maintained above 7.0 to 7.5% until 30 days before vine kill.

Table 3. Potassium fertilizer recommendations for Russet Burbank potatoes.

Soil Test K (0-12 inch depth) ppm	Yield Goal (cwt/acre)			
	300	400	500	600
	----- (lb K ₂ O/acre) -----			
25	550	600	650	700
50	450	500	550	600
75	350	400	450	500
100	250	300	350	400
125	150	200	250	300
150	50	100	150	200
175	0	0	50	100

REFERENCES

- McDole, R.E., D.T. Westermann, G.D. Kleinschmidt, G.E. Kleinkopf, and J.C. Ojala. 1987. Idaho Fertilizer Guide: Potatoes. CIS No. 261. Univ. of Idaho, Moscow, ID. 4 p.
- Tindall, T.A. and J.C. Stark. 1997. Cooperative fertilizer evaluation program seeks appropriate recommendations. *Better Crops* Vol. 81:4-7.
- Westermann, D.T. and T.A. Tindall. 1995. Potassium management of Russet Burbank potatoes in southern Idaho. P. 94-100. Western Nutrient Management Conference, Proceedings, Vol. 1. Salt Lake City, UT, March 9-10, 1995.
- Westermann, D.T. and T.A. Tindall. 1997. Potassium considerations for southern Idaho soils. P. 172-181. Western Nutrient Management Conference Proceedings, Vol. 2. Salt Lake City, UT, March 6-7, 1997.