

Optimal Nutrient Levels Required For High-yielding Potatoes

Achieving optimal goals requires an efficient nutrient management program, using the most effective nutrient sources, application timings, and methods of placement.

Summary: Potatoes require optimal levels of essential nutrients throughout the growing season to ensure rapid, steady tuber growth and normal tuber development. Seasonal nutrient requirements vary widely, with crops yielding from 400 to 500 ctw/A taking up nitrogen (N) at the rate of 180 to 240 lbs/A, phosphorus (P) at 25 to 35 lbs/A, potassium (K) at 260 to 320 lbs/A, and S at 18 to 24 lbs/A during the growing season. Daily nutrient uptake rates during tuber growth also vary greatly, ranging from 2.5 to 4 lbs/A/day for N, 0.30 to 0.40 lb/A/day for P, 4.0 to 6.0 lbs/A/day for K and 0.10 to 0.15 lbs/A/day for S. Potatoes have a relatively shallow root system and are commonly grown in very intensively managed cropping systems on coarse-textured soils. Consequently, it is important for crop managers to develop an efficient nutrient management program, using the most effective nutrient sources, application timings, and methods of placement.

Crop managers should adopt potato fertilizer practices consistent with the characteristics of the cropping system that efficiently use available equipment, fertilizer materials, and other resources to provide flexibility in responding to changing nutrient requirements. Fertilizer application methods commonly used for potatoes include 1) preplant broadcasting followed by incorporation,

2) banding at markout or planting, 3) sidedressing after planting, 4) applying foliar nutrient sprays, and 5) injecting liquid fertilizer through the sprinkler system.

Nitrogen management

Efficient N management is an essential part of any potato fertilization program. About 60 percent of the seasonal N requirement is taken up in the first 75 days after planting. Consequently, adequate N must be available to the crop early in the season to allow for sufficient canopy development. Research shows that about 150 to 180 lbs/A from soil and fertilizer N is required to affect the canopy closure needed to provide for optimum plant development and yield.

Total seasonal N fertilizer recommendations are presented in Table 1. The recommended rates are based on the total N requirement adjusted for yield potential, soil test NO₃-N, and NH₄-N in the top 12 inches, plus the previous crop. The recommendations assume an average N rate of 60 lbs/A of mineralized N that is accounted for in the table.

Split N. The most efficient N management systems for potatoes use split N management with onehalf to three-fourths of the total seasonal N topdressed and/or applied through the irrigation system in several small applications during tuber growth. Several liquid N sources such as urea ammonium nitrate (28 to 32% N) and

ammonium polyphosphate (10-34-0) can be applied by this method. N is also a component of many other liquid fertilizers containing P, K, and S that can be injected through sprinklers. When properly used, split N can significantly increase N-use efficiency and reduce N leaching potential, while improving potato yield and quality.

Monitoring N status. Relationships between tuber bulking rates and daily or weekly N requirements can be used to initially estimate in-season N applications. However, weekly petiole NO₃-N concentrations should be used to monitor actual plant N status. Petiole NO₃-N should be maintained above 15,000 ppm during tuber growth for optimal yield. NO₃-N concentrations in the top 18 inches of soil also can be used to monitor N availability.

Phosphorus management

P recommendations for potatoes are presented in Table 2. The primary factors used in determining potato P recommendations are the soil test P concentration (STPC) and the amount of free or excess soil lime. The rates presented in the table represent the amounts of P₂O₅ that should be broadcast in the fall or spring to raise the STPC to adequate levels. In addition to the broadcast P recommendation, an additional 40 to 80 lbs/A should be applied in a starter or markout band to improve early P availability. When high rates of P are applied, it is important to make sure that zinc availability is

Table 1. Total N recommendations for Russet Burbank potatoes.

Soil Test NO ₃ -N (0 to 12 inches)	Potential yield--cwt/A				
	300	400	500	600	
ppm		lbs/A of N			
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	

Table 2. Total P recommendations for Russet Burbank potatoes.

Soil Test P (0 to 12 inches)	Percent soil free lime				
	0	4	8	12	
ppm		lbs/A of P₂O₅			
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	

Table 3. Total K recommendations for Russet Burbank potatoes.

Soil Test K (0 to 12 inches)	Potential yield--cwt/A				
	300	400	500	600	
ppm		lbs/A of K₂O			
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	

adequate to avoid P-induced zinc deficiencies.

In-season P. Sprinkler application of fluid P fertilizer is effective for correcting inseason potato P deficiencies as long as active roots are near the soil surface. Potato root density increases near the soil surface once the canopy starts to shade the hill. This is important since P applied by sprinklers only moves about 1 to 2 inches into the soil. Petiole P concentrations should be maintained

above 0.22 percent and usually respond within about 10 to 14 days after application. Consequently, fluid P fertilizer should be applied through the sprinkler system before P deficiencies develop.

Potassium management

K fertilizer recommendations are presented in Table 3.

Research shows that a soil test K concentration (STKC) of 175 ppm in the top 12 inches of soil is required to

produce maximum potato yield and quality. In general, K source has relatively little effect on total yield, although potassium sulfate or potassium magnesium sulfate tends to produce slightly higher percentages of large No. 1 tubers and higher specific gravities than KCl, particularly when K is applied at high rates shortly before planting.

In-season K. Applying all K preplant is usually more effective than applying most or all of the seasonal K supply via fertigation. Petiole K should be maintained above 7.5 percent using fertigation supplemental K if necessary.

Sulfur management

Application of S fertilizer is usually needed in areas where soil S levels at the 0 to 12-inch depth are below 15 ppm and S concentrations in the irrigation water are below 5 ppm. A sulfate-S preplant application of 30 to 40 lbs/A as ammonium sulfate, potassium sulfate, or urea-sulfuric acid should satisfy the crop's S requirement.

Dr. Stark is a research agronomist and Dr. Hopkins is a potato cropping systems specialist in the Plant, Soil and Entomological Sciences Department at the University of Idaho. □