I D A H O

Potatoes and Potassium for Irrigated Southern Idaho Soils

By Terry A. Tindall and Dale T. Westermann

A 4-year study of potassium (K) requirements of potatoes in southern Idaho indicates that current soil test critical levels suggested by the University of Idaho are appropriate, but that the rate of fertilizer K within each category should be increased. Potassium fertilization can benefit both total yield and the percent of large tubers (>10 oz). Potassium sulfate (K_2SO_4) produced tubers with higher specific gravity. There appeared to be no advantage from splitting K applications compared to all K preplant unless the rate was high and salt damage became a possibility.

Potatoes, a culinary mainstay for many Americans, are at the heart of Idaho agriculture. Historical soil test information in southern Idaho is showing a general decline in available K concentrations from >400 parts per million (ppm) in the 1960s to 100 to 200 ppm today, suggesting growers are under-fertilizing for present production levels. Potatoes utilize and remove several hundred pounds of K/A at desired yield levels. Information on K fertilizer management needs to be re-evaluated to increase use efficiency and maximize potential benefits.

The University of Idaho presently sets the K soil test critical value for potato production at about 150 ppm ($NaHCO_3$ extraction). Relatively high potato yields (over 500 cwt/A) are being achieved by many of Idaho's potato growers. At this production level, the equivalent of over 250 lb/A of K_2O can be removed in the tubers. These tremendous requirements of K necessitate a relatively abundant supply of available K to the growing plant throughout the growing season.

Idaho growers typically monitor K and other nutrients weekly through petiole analysis. Many fields fall below suggested K petiole critical ranges during mid- and late-season tuber growth. To alleviate the concerns of potential K deficiency, growers are applying in-season K by solution injection in irrigation water (fertigation). Very little information is available to direct these in-season applications or to indicate how late during tuber growth K can be applied without detrimentally affecting tuber quality. A study was initiated to determine (a) K fertilizer requirements for Russet Burbank potatoes, (b) effectiveness of K solutions applied during tuber growth, (c) the relative effectiveness of K sources, and (d) the K dynamics in the potato plant as related to petiole K concentrations. This article focuses on tuber yield and quality responses obtained with K fertilizer applications.

Idaho Studies

A series of experiments on growers' irrigated fields has been conducted over a four-year period. All experiments evaluated K fertilizer application rates, sources, broadcast versus banding and preseason versus split applications. Sources included potassium chloride (KCl) and K_2SO_4. Potassium fertigation was simulated by

TABLE 1. *Overall effect of K on tuber yields and specific gravity.*

Yield parameter	1992 -K	1992 +K	1993 -K	1993 +K	1994 -K	1994 +K
Total, cwt	416	440	330	357	408	419
US #1, cwt	254	254	124	134	296	302
Large US #1, cwt[a]	73	106 *	–	–	82	103 *
>10 oz, %	17.5	26.9 *	_	_	29	33 *
Specific gravity	1.083	1.082	1.088	1.088	1.082	1.080
Available soil K[b]	102		85		131	

*** Significant difference, P≤0.05.**
[a] Large US #1 refers to US #1 potatoes over 10 oz.
[b] Sodium bicarbonate extraction, 0-12 inch samples.

application of K during sprinkler events.

The K status of each treatment was monitored by sampling the fourth mature petiole from the growing point as well as vines, roots and tubers every 21 days, beginning at early tuber growth and continuing until vine kill. Tuber yields, grades, and internal quality measurements were determined for each plot.

Soil-Applied K Effects

The overall tendency was for K applications to increase both total yields as well as yield and percent of >10 oz. tubers for all studies in which exchangeable soil K ranged from 85 to 131 ppm (**Table 1**). Potash applications slightly decreased specific gravity in two of three studies. However, slightly higher gravity usually occurred where K_2SO_4 was the K source (averaged across all other treatments) which is consistent with previous research by the authors in Utah. Potato tuber yields were comparable for both K sources. The highest tuber yields in 1992 were recorded at the highest K rate (480 lb K_2O/A), while the highest K rate (720 lb K_2O/A) in 1994 tended to decrease yield (**Table 2**). Growers who apply such high rates of K should consider a split application to help eliminate the possibility of detrimental salt effects. A portion of the material could be applied in the fall with the remainder in the spring.

Fertigation K Effects

Growers who are concerned with adequacy of K fertilization should plan ahead so they can apply all of their K on a preplant basis (**Table 3**). There was no evidence that in-season fertilizer K benefited production or tuber quality over a preplant program. Rates of either 30 or 60 lb K_2O/A or different sources of K made no difference to plant response for in-season K applications (data not shown).

Petiole K Concentrations

Petiole K concentrations decreased with time after tuber initiation. Concentrations were initially higher with broadcast K applications compared to either banding or fertigation treatments. Concentrations for split applications were moderate and K_2SO_4 applications tended to produce higher petiole K concentrations than other sources. Petiole K concentration response to fertigation application was slow...15 to 20 days after application. The relationship between the petiole

TABLE 2. *Effect of preplant broadcast KCl and K_2SO_4 on tuber yields and specific gravity.*[a]

K Source	K_2O, lb/A	Yield parameters, cwt/A			>10 oz, %	Specific gravity
		Total	US #1	Large US #1		
				1992		
	0	416a	324a	73a	19.9a	1.083b
KCl	120	429ab	351ab	101ab	25.9b	1.083b
KCl	240	429ab	337a	105ab	28.4b	1.081ab
K_2SO_4	240	451b	374b	115b	27.7b	1.082ab
KCl	480	445b	373b	118b	29.8b	1.080a
				1994		
	0	408ab	296bc	82	29.8a	1.082b
KCl	180	421b	310c	91	29.6a	1.079a
K_2SO_4	180	401a	282b	94	33.0ab	1.081ab
KCl	360	419b	285b	100	35.1b	1.082b
K_2SO_4	360	450c	312c	102	32.9ab	1.078a
KCl	720	389a	256a	93	35.9b	1.077a

[a] **Means within the same column and experiment followed by different letters are significant at $P \leq 0.05$.**

K concentration and K uptake rate balance (total plant uptake/tuber uptake) showed average K concentrations of 6.4 percent when the K balance was "1". This balance tended to range from 5.5 to 7.2 percent K depending on tuber growth rate. Growers can use this range as a guide to K sufficiency for irrigated Russet Burbank production in southern Idaho. However, to avoid any potential in-season K deficiency during tuber bulking, growers should not allow the fourth mature petiole to drop below 7.2 percent K.

Summary

These studies support the current soil test K critical levels provided by the University of Idaho. However, recommended K fertilization rates for potatoes should be increased over what is presently considered adequate. This is particularly true on coarse, sandy textured soils.

Potassium fertilization increases large tubers as well as total tuber production in

IDAHO *researchers are showing that rates of fertilizer K for potatoes may need to be increased for better yields and quality.*

most years when soil test K levels fall below established critical levels. Potassium sources have little effect on total tuber yields, but K_2SO_4 applications produced a higher percentage of larger tubers and a trend towards higher specific gravity. Growers should apply the total K fertilizer requirements on a preplant basis where possible. Higher rates of K should be split into a fall and spring application. Growers who monitor K petiole concentrations should fertigate with K if concentrations drop below 7.2 percent in the fourth mature petiole. The total rate per individual injection should not exceed 30 lb K_2O/A during tuber growth. Late season (30 days prior to vine kill) K fertigation applications are probably not effective. BC

TABLE 3. *Effect of K application method on tuber yields and specific gravity averaged across K sources.*[a]

Yield parameter	1992 240 lb K_2O/A Preplant	1992 240 lb K_2O/A Split	1994 360 lb K_2O/A Preplant	1994 360 lb K_2O/A Split
Total, cwt	429b	388a	434	412
US #1, cwt	337b	298a	298a	315b
Large US #1, cwt[a]	105b	72a	101b	82a
>10 oz, %	28.4b	21.9a	34.0b	26.9a
Specific gravity	1.081	1.081	1.079	1.079

[a] **Means within the same row and experiment followed with different letters are significant at P≤0.05.**

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North Central Soil Fertility Conference Proceedings Available

Papers of the 1995 North Central Extension-Industry Soil Fertility Conference are available for interested individuals. The Conference, held in St. Louis, MO, November 15-16, was the 25th annual opportunity for agriculturalists from the North Central region of the U.S. and Canada to be updated on the latest developments in soil fertility research and education. The North Central region includes the states of North Dakota, South Dakota, Nebraska, Kansas, Missouri, Iowa, Minnesota, Wisconsin, Illinois, Kentucky, Indiana, Michigan, Ohio, Pennsylvania and the province of Ontario.

The proceedings of the Conference include presentations on site-specific crop management, improved fertilizer recommendations for nitrogen, phosphorus, potassium, sulfur and zinc, the importance of starter fertilizers for reduced tillage crops, residue interactions with starter fertilizer needs, corn hybrid interactions with starter fertilizer applications, management considerations for returning conservation reserve program (CRP) land to production, systems research for higher yields, efficiency and profits in corn-wheat-doublecropped soybean rotations plus a number of other important topics and reports.

The Conference also encourages graduate student participation and recognition. 1996 Graduate Student Awards were presented to Rogerio Borges, Iowa State University; Jon Charlesworth, Purdue University; Jason Goesch, University of Nebraska; Marcus Jones, Michigan State University; Luiz A. C. Lucchesi, Ohio State University; Karl Ritchie, University of Illinois; Kevin Schoessow, University of Wisconsin; Michael Smith, North Dakota State University; Tad Wesley, Kansas State University; and Terry Wilkerson, Southern Illinois University.

Dates for the 1996 North Central Extension-Industry Soil Fertility Conference are November 20-21 at the Westport Holiday Inn in St. Louis, MO.

Copies of the Conference proceedings are available at a price of $15 in U.S. funds from the Potash & Phosphate Institute, 2805 Claflin Road, Suite 200, Manhattan, KS 66502, phone 913-776-0273. BC