SOIL FERTILITY, PLANT NUTRITION, AND PLANT DISEASE INTERACTIONS AFFECTING POTATOES

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ABSTRACT

An experiment was established at Powell Butte, Oregon, to evaluate the effect of different rates and sources of potash (K) on yield, nutrient concentration of potato petioles and tuber quality (size, hollow heart, and processing quality), and the relationships between fertilizer treatments applied and nutrient concentrations in petiole and tuber samples and yield and quality effects.

Yield and quality (grade) were good; yields of 25.5 T/A were produced. Application of K fertilizers increased yield (total) as well as increasing the percent of 6+ oz. tubers and reduced the amount of hollow heart.

Potassium chloride was more efficient than K sulfate in increasing K concentration in petiole samples, in increasing yield and in reducing hollow heart. Yield increases and quality effects resulting from potash applications have been associated with a wide range in petiole K concentrations (for example, petiole K was increased from 6 to 10% in the 1983 Central Oregon Experiment and from 9 to 14% in previous Central Oregon Experiments).

It is becoming evident that yield, quality, and disease responses following an application of potassium chloride fertilizers must be associated with the chloride present in the fertilizer as well as from the potassium. Relationships among K, Ca, and Mg are being evaluated.

These results leave some growers in a dilemma concerning sources of K. Potassium sulfate has increased specific gravity when compared with potassium chloride. Also, potassium sulfate is an excellent K source to band with N, P, and S near the seed at planting. We need a better understanding of the total effects of chloride in this production system.

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Table 1. Nitrogen rate, and potash rate and source effects on potato yield, grade, and hollow heart, Powell Butte, Oregon, 1983

	Treatments*			Yield T/A			In 10 Largest		In 20 Largest	
	5/18	7/7	7/27	Total	6+oz	4oz	%HH	%HH+BC	%HH	%HH+BC
1	K_0	N_2		18.3	6.0	4.3	27.5	37.5	15.0	20.0
2	K_1Cl	N_2		22.7	9.1	4.3	2.5	10.0	1.25	6.25
3	K_1S	N_2		21.2	7.4	4.4	10.0	12.5	5.0	10.0
4	K_3Cl	N_2		25.2	12.2	4.4	5.0	10.0	2.5	6.25
5	K_3S	N_2		23.2	8.8	5.4	5.0	17.5	2.5	12.5
6	K_1Cl	N_2K	K_1	24.2	9.8	4.5	5.0	5.0	2.5	5.0
7	K_1S	N_2K_1	K_1	23.4	9.8	4.7	10.0	22.5	5.0	12.5
8	K_1Cl	N_2K_2	K_2	25.7	11.9	4.7	0.0	10.0	0.0	10.0
9	K_3Cl	N_2K_2	K_2	24.5	12.6	3.8	5.0	5.0	2.5	4.0

TIME AND RATE OF NITROGEN APPLICATION EFFECTS

	Treatments			Yield T/A			In 10 Largest		In 20 Largest	
	5/18	7/7	7/27	Total	6+oz	4oz	%HH	%HH+BC	%HH	%HH+BC
10		N_1		23.8	10.7	4.3	0.0	2.5	0.0	2.5
11		N_2		25.2	12.2	4.4	5.0	10.0	2.5	6.25
12	N_2			25.5	12.9	3.6	0.0	2.5	0.0	2.5
13		N_1	N_1	25.4	11.3	4.6	0.0	0.0	0.0	0.0
14		N_2	N_2	24.9	10.8	4.6	2.5	5.0	1.25	2.5
15		N_4		25.0	11.0	4.6	5.0	10.0	3.75	7.5
16	N_2K_0			21.5	8.6	4.3	5.0	12.5	2.5	8.75

* All plots: 40-150-0-32 (N-P_2O_5-K_2O-S)/A banded at planting on May 18.

Trts. 1 thru 9 had 120 lbs. N added on 7/7.

Trts. 10 thru 15 had K_3Cl broadcast before planting.

N_1, N_2, N_4 = 60, 120, 240 lbs. N/A added on dates shown.

K_1, K_2, K_3 = 100, 200, 300 lbs. K_2O/A, Cl as Chloride, S as sulfate.

K on 7/7 and 7/27 added as KCl.

STATISTICAL ANALYSES OF YIELD DATA:

LSD	(0.05)	Total	2.5	6+oz.	2.3
	(0.10)	Total	2.1	6+oz.	1.9
		P = .0000		P .0000	

RESULTS AND DISCUSSION

Soil analysis for Powell Butte experiment:

pH	P	K	Ca	Mg
	-----ppm-----		--Meq/100g---	
5.9	28	130	7.0	3.0

Effects of potash and nitrogen fertilizer treatments on yield, size distribution and hollow heart are given in Table 1.

Potash fertilizer increased total yields from 18.3 to 25.2 T/A (Treatment 4) and the yield of 6+ oz. tubers from 6.0 to 12.2 T/A, a doubling of yield of larger sized tubers. There was no advantage from split applications of K (Treatment 6 or 7 vs 4 or 5).

There was a marked decrease in hollow heart (HH) and brown center (BC) when potash was added, 27.5% (Treatment 1) down to 5 or 1%. The decrease in hollow heart was greater when K chloride was applied than when K sulfate was applied.

Those treatments receiving 160 pounds of N, 40 at plant + 120 later, produced maximum yield with essentially no effect from varying the time of application. However, when the effects of time and rate of nitrogen application on hollow heart are considered, it was evident that more than 60 pounds N/A on July 7 increased hollow heart dramatically (Treatment 10 vs 11 or 15). Those treatments with only 40 pounds N at planting had "run out" of nitrogen by July 7, therefore, the accelerated increase in growth from the higher N rates on July 7 apparently resulted in growth stress that increased hollow heart and brown center.

The effects of treatments on K, Ca, Mg concentration in petioles are given in Table 2 for July 7 and 27. Potash (K) increased K concentrations and decreased Ca (calcium) and Mg (magnesium) concentrations with K chloride being more effective in increasing K uptake than a comparable rate of K sulfate.

It is probably logical to assume that the higher rates of potash fertilization reduced the susceptibility of potato plants to stress. The higher total salt concentration presumably increases osmotic concentration of plant cell sap, thus reducing the susceptibility of plants to stress.

The N (nitrogen) fertilizer effects are interesting and support the idea that factors associated with "growth stress" "trigger" or cause hollow heart. Forty pounds N at planting plus an added 120 (160 pounds N total), resulted in optimum yield. It was evident that different times of application for the supplemental 120 pounds N (Treatment 11-15), all produced comparable yield of both total and 6+ oz. tubers. However, when all of the 120 or 240 pounds of N application was applied July 7, when first tubers set were 0.75 to 1.0-inch diameter, the growth stimulation increased hollow heart. Note that applying all of the N at planting (May 18) or

splitting an added 120 pounds N application had lower levels of hollow heart and brown center.

Increasing the N rate from 40 lb/A at planting to the 160 pounds total also increased the K level in potato petioles (Table 2 Treatment 10 vs 12). We assume these petiole samples will have higher levels of chloride and nitrate-N which should increase total uptake of K+Ca+Mg.

Table 2. Nitrogen rate and potash rate and source effects on K, Ca, and Mg concentrations in petioles on July 7 and July 27, 1983, Powell Butte, Oregon

Treatments*			July 7			July 27		
5/18	7/7	7/27	% K	% Ca	% Mg	% K	% Ca	% Mg
1 K_0	N_2		6.5	1.94	1.65	4.1	2.07	2.33
2 K_1Cl	N_2		9.6	1.73	1.25	6.4	1.78	1.86
3 K_1S	N_2		8.4	1.76	1.39	5.4	1.66	2.00
4 K_3Cl	N_2		10.8	1.82	1.31	8.3	1.79	1.72
5 K_3S	N_2		9.6	1.54	1.28	8.3	1.39	1.58
8 K_1	N_2	K_2				8.2	1.77	1.80
10 K_3	N_1		9.8	1.66	1.46			
12 N_2K_3			11.1	1.66	1.53			
16 N_2K_0			7.2	1.94	1.73			

* K_1, K_2, K_3 = 100, 200, 300 lb K_2O/A; Cl as chloride, S as sulfate.

All plots: 40-150-0-32 banded at planting plus N_1 or N_2 at 60 or 120 lbs N/A at planting on May 18.