EFFECTS OF POTASSIUM SOURCE AND SECONDARY NUTRIENTS ON POTATO YIELD AND QUALITY IN SOUTHCENTRAL ALASKA

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INTRODUCTION

Calcium (Ca), magnesium (Mg), and sulfur (S) are required for the growth and development of all higher plants. They are commonly referred to as secondary nutrients because they are less often limiting to plant growth than the primary nutrients nitrogen (N), phosphorus (P), and potassium (K), although secondary nutrients are as critical for crop growth and development as the primary nutrients. There is limited information available concerning secondary nutrient requirements of potatoes grown in southcentral Alaska.

Laughlin (1966) conducted studies between 1961 and 1963 comparing potassium chloride (KCl) and potassium sulfate (K_2SO_4) as potassium sources for Green Mountain potatoes, and determined the effects of varying rates of magnesium sulfate ($MgSO_4$) and K_2SO_4 on Kennebec potatoes. Since these studies were conducted without irrigation and at production levels about one-half those obtained by top producers in the Matanuska Valley today, it was considered appropriate to expand upon the previous work using current production practices.

Potassium was supplied as KCl and K_2SO_4 to explore the need for additional S under local potato production conditions and to determine the effects of the chloride (Cl) and sulfate (SO_4) anions on production and quality of potato tubers. In addition, Mg and Ca were added to determine whether the background levels of these nutrients were adequate for optimum production.

MATERIALS AND METHODS

In the spring of 1989 field plots were established on a Knik silt loam (Typic Cryorthent) at the University of Alaska Agricultural and Forestry Experiment Station Matanuska Farm. The soil was sampled to a depth of about 6 inches one week before planting. Initial nutrient levels were determined using Mehlich 3 extractant (Mehlich, 1982), organic matter by combustion,

Table 1. *Soil pH, organic matter, and Mehlich 3 soil test levels prior to fertilization.*

pH	Organic Matter (%)	P	K	Ca	Mg
		ppm			
5.96	5.0	66	59	1593	150

Table 2. *Fertilizer treatments applied prior to planting. Rates refer to weight of nutrients, not weight of material, applied.*

Treatment	Materials	K	Ca	Mg	S
		lbs/acre			
1	KCl	200	0	0	0
2	K_2SO_4	200	0	0	87
3	KCl, $MgSO_4$	200	0	62	87
4	KCl, $CaSO_4$	200	113	0	87
5	NONE	0	0	0	0

and pH was measured in a 1:1 soil:water suspension. Results of these analyses are shown in Table 1.

Forty plots, each measuring 9 by 40 feet, were arranged in a randomized complete block design with 5 fertilizer treatments in four replications (Table 2). All plots received 120 lbs N/a as NH_4NO_3 (ammonium nitrate) and 105 lbs P/a (240 lbs P_2O_5/a) as triple super phosphate. The plot area was chisel-plowed on May 10. Fertilizer treatments were broadcast over the soil surface and mechanically tilled to a depth of approximately eight inches with a tractor-mounted rototiller on May 12. Potato seed-pieces (var. Bake-King) were planted on May 18 with a single row Iron Age assist-feed planter. Seed pieces were spaced approximately 11 inches apart in rows three feet apart and covered with 2 to 3 inches of packed soil.

Plots were irrigated as needed through the growing season. Petiole samples were collected August 3 for nutrient status determination and analyzed for nitrate (NO_3), total N, P, K, Ca, Mg, S, chlorine (Cl), manganese (Mn), copper (Cu), zinc (Zn), and boron (B). On September 13, 35 feet of row from each plot was harvested with a mechanical lifter which dug the tubers and dropped them on the soil surface. Tubers were then collected by hand, washed, graded by USDA specifications, and weighed. Specific gravity of tubers was measured with a hydrometer.

RESULTS AND DISCUSSION

Foliar K deficiency symptoms were visually apparent in the control plots which received

Table 3. *Effect of fertilizer treatments on tuber yield and quality.*

		Tuber Yield				
	Treatment	**Total**	**US#1**	**Shatter cracked**	**Under sized**	**Specific Gravity**
		cwt/a				
1	KCl	335.5	308.4	5.3	21.8	1.079
2	K_2SO_4	302.6	278.1	1.8	21.4	1.092
3	KCl + $MgSO_4$	332.8	297.7	9.8	22.1	1.085
4	KCl + $CaSO_4$	332.1	295.8	10.9	24.7	1.088
5	Control	293.5	248.3	14.3	30.9	1.089
	5% LSD	NS	NS	11.4	7.4	0.005
	10% LSD	NS	55.0	9.4	6.1	0.004

NS - not statistically significant.

Table 4. *Effect of anions on tuber specific gravity.*

Anions Added	Specific Gravity
Cl	1.079
Cl + SO_4	1.086
SO_4	1.092
5% LSD	0.005

no K fertilizer. This was not surprising considering the soil K levels at planting. However, the extent of yield increase, both of total and US No.1 tubers, upon addition of K was smaller than expected (Table 3). Total yields of all treatments were statistically identical. The difference between the US No.1 yield of the check and the KCl treatment was significant at the 10% level. In both categories the yield obtained with K_2SO_4 was slightly less than that obtained when KCl was the K source, although the difference was not statistically significant. In previous studies, yield differences between KCl and K_2SO_4 were generally very small (Laughlin, 1966; McDole, 1978). The untreated check had a greater yield of undersized tubers than any other treatment. The use of K_2SO_4 reduced the weight of shatter cracked tubers when compared to the untreated check. This treatment also had less shatter cracked tubers than any of the KCl treatments, although these differences were not statistically significant.

Tuber specific gravity was clearly affected by the experimental treatments. The tubers produced with KCl had the lowest specific gravity, followed by those which received KCl with either $MgSO_4$ or $CaSO_4$, and those which received no fertilizer. Specific gravity was highest where K_2SO_4 was applied. When the applied anions are considered alone (Cl or SO_4, Table 4), Cl significantly reduced specific gravity compared to that obtained when SO_4 alone was applied. When SO_4 was applied to plots which also received Cl, the reduction in specific gravity was diminished. These preliminary results suggest that specific gravity may be affected by Cl:SO_4 balance rather than simply by the level of Cl available to the plant. Previous studies have indicated that KCl reduced specific gravity, although rarely to the degree found here (Laughlin, 1966; McDole, 1978; Timm and Merkle, 1963).

Nutrient concentrations found in potato petioles are presented in Table 5. With the exception of K, the nutrient levels are within accepted sufficiency ranges indicating that supply was adequate for optimum plant growth (Dow, 1980; Kelling, 1981). Petioles from plants in the control plots had the greatest concentrations of N, P, Ca, Mg, and S, and the lowest concentration of K, confirming that K was limiting to yield when none was added to the soil. The K_2SO_4 treatment had significantly lower P than the KCl treatment, and significantly lower Mn than any other treatment. The reasons for this are unknown. The plants which received KCl had higher petiole K than those from other treatments. The petioles from plants receiving K_2SO_4 had significantly less K than those from plants receiving KCl, although all plants except those from the unfertilized check had K concentrations exceeding published critical concentrations (about 8.0%). Addition of $CaSO_4$

Table 5. *Effects of fertility treatments on petiole nutrient levels.*

Treatment	N	P	K	Ca	Mg	S	Cl	Mn	Zn	B	Fe	Cu
	%							ppm				
KCl	2.62	0.41	11.93	1.59	0.93	0.20	3.98	97	45	21	96	19
K_2SO_4	2.37	0.30	10.18	1.54	0.75	0.22	1.31	44	41	21	111	16
KCl+$MgSO_4$	2.68	0.36	10.50	1.44	1.07	0.23	2.72	87	48	22	115	20
KCl+$CaSO_4$	2.32	0.24	9.43	1.70	0.86	0.17	2.78	123	37	21	94	15
Control 2.87	2.87	0.49	6.78	1.99	1.38	0.24	0.94	88	38	21	106	24
5% LSD	0.29	0.08	1.54	0.44	0.31	0.06	0.96	28	NS	NS	NS	8

NS - not statistically significant.

or $MgSO_4$ also tended to reduce petiole K. Petiole Ca and Mg concentrations were increased (although not significantly) by additions of $CaSO_4$ and $MgSO_4$, respectively. The addition of SO_4 containing fertilizers did not significantly raise the S level in the petiole tissue. However, the use of SO_4 containing materials in conjunction with KCl reduced the Cl concentration below that found when KCl was used alone, again suggesting that Cl/SO_4 balance may be important. Zinc, B, and Fe levels were unaffected by fertilizer treatments.

SUMMARY

In the low K soil at the site selected for this experiment, application of K in either Cl or SO_4 forms increased yield. There was a trend toward slightly higher total and US No.1 tuber yields when KCl was used compared to K_2SO_4.

Yield was not increased by application of Mg, Ca, or S, indicating that these nutrients were not yield-limiting. Petiole analyses confirm this conclusion.

Applied Cl and SO_4 had a significant impact on tuber specific gravity. Application of Cl containing fertilizer reduced specific gravity, while addition of SO_4 did not. The use of K_2SO_4 decreased petiole P and Mn relative to that observed with KCl. The reason(s) for this are not clear.

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