

SOIL SCIENCE

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Row Fertilization Effects on Potato Growth on Sandy and Organic Soils¹

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A certain optimum concentration of nutrients in the soil is required for maximum potato yields. An adjustment of the concentration of nutrients in soil must often be made by the application of fertilizer. This adjustment offers problems in both rate and placement of fertilizer for the best response. Lucas et al. (7) found that the application of 300 lbs of potassium on organic soil resulted in the highest yield of potato tubers, however, a treatment of 100 lbs of K₂O resulted in the highest yield of starch. Yield of starch should be of importance in determining proper fertilization methods.

Decreasing amounts of potassium in the band results in increased dry matter. Findlen (5) found that nitrogen, phosphorus and potassium fertilizer applications in bands at planting time of 0 and 60 pounds in factorial combinations had no important effect on chip color. However, the high rate of nitrogen and potassium application reduced chip yield. Most soils used for potato production need applications of N, P and K to maintain optimum growth and yields. Black and Cairns (2) reported that broadcast applications of nitrogen, phosphorus and potassium showed economic gains in yield without loss of quality. Lorenz, et al. (6) has reported the need for potassium fertilization in reducing black spot damage. Though potassium plays a significant role in potato nutrition and must be applied, it appears that it should not be present in high concentrations in the band application at planting time. Berger, et al. (1) found that phosphorus uptake was increased when potassium was broadcast in comparison to row application. Dunn & Rost (4) reported similar effects of potassium fertilization.

In this experiment the effect of potassium rates and materials on potato growth and quality was measured on sandy soils and organic soils.

Materials and Methods

The experiments were conducted in 1958 near Vincennes on Buckner sandy loam and Fox sandy and in 1960 and 1961 on Houghton muck at the Northern Indiana Muck Experiment Farm near Walkerton. Cultural practices for weed control and insect control were applied to all experiments during the growing season.

1. Journal Paper No. 2246 Purdue University Agricultural Experiment Station, Lafayette, Indiana.

The Buckner sand loam was pH 5.8 and contained 120 pounds per acre P_2O_5 and 191 pounds per acre exchangeable K_2O while the Fox sand was pH 6.4 and contained 650 pounds per acre available P_2O_5 and 349 pounds per acre exchangeable K_2O as determined by the Purdue soil testing laboratory. Fertilizer treatments applied in 1958 are listed in table 1. Plots 12 x 36 feet, were replicated three times in a randomized

TABLE 1. Potato yields and specific gravity from various broadcast and row fertilizer treatments on sandy soils. 1958.

Treatments			Rate 5-10-15S in row			
Broadcast Pounds Per Acre			600 lbs/A		1200 lbs/A	
N	P	K	Yield	Sp. Gr.	Yield	Sp. Gr.
			bu/A		bu/A	
Buckner Sand Loam						
65	40	200	608	1.068	624	1.063
130	80	100	606	1.066	605	1.065
97.5	60	150	593	1.067	612	1.061
97.5	95	150	650	1.066	611	1.063
65	80	200	585	1.066	598	1.062
152	95	235	596	1.068	592	1.064
Fox Sand			584	1.064	598	1.059

block design. Thirty feet of the two center rows were harvested for yield. The broadcast fertilizer treatments, formulated from ammonium nitrate, treble super phosphate and muriate of potash, were applied before planting. Commercial 5-10-15, with the potassium derived from potassium sulfate, was used in the row. This was applied with an Iron Age planter at time of planting. Kennebec potatoes were planted the last week in March. The soil was irrigated on a regular schedule during June and July to provide sufficient moisture. The potatoes were harvested the last week in July.

The Muck soil was a well decomposed, finely divided, dark organic soil in which little or no organic matter could be identified as to origin. In 1960 the soil from the plot area tested pH 5.3 and contained 405 pounds per acre available P_2O_5 and 1260 pounds per acre exchangeable K_2O . Five treatments, as listed in table 2, were applied to Katahdin potatoes May 13, 1960. The yield and specific gravity of tubers were recorded when the potatoes were harvested October 14.

The 1961 experiment was conducted on a soil which tested pH 5.6, and contained 570 pounds per acre available P_2O_5 and 680 pounds per acre exchangeable K_2O . The treatments, listed in table 3, were placed in bands by an Iron Age planter. The plot was of a split plot design with six replications. Russet Burbank potatoes were planted May 5, 1961 and harvested October 10, 1961. Tissue samples of petiole and fully expanded leaves below the growing point on the main stem were collected on June 12. The samples were dried at 70° C, ground and analyzed for P, K, Ca and Mg.

Results

The fertility levels of the soils in all experiments were such that no significant yield response to fertilizer treatment was obtained.

In all cases (table 1) the increase from 600 to 1200 pounds per acre of 5-10-15 fertilizer in the row reduced the specific gravity of potatoes in 1958.

The effects of K rates and materials on specific gravity of potatoes produced on organic soils in 1960 are presented in table 2.

TABLE 2. Potato yield and specific gravity from various row fertilizer treatments on organic soil. 1960.

Rate/A N	Treatment Row Fertilizer Application		Yield Per Acre	Specific Gravity
	P	K		
	lbs		bu	
60	135	85 ^a	730	1.067
72	125	120 ^b	757	1.062
72	125	120 ^c	758	1.065
72	0	120 ^c	745	1.065
36	47	270 ^b	751	1.060
LSD p = .05			N.S.	.0024
^a K as KH_2PO_4				
^b K as KCl				
^c K as K_2SO_4				

TABLE 3. Potato leaf composition and tuber yield and specific gravity from various K treatments on organic soil. 1961.

Treatment ^a		Leaf 6/12/61 Ca	Tuber Yield/A.	Specific Gravity
K per acre row rate	Source			
lbs		%	cwt	
0		.716	338	1.064
75	Cl	.875	299	1.064
	SO_4	.633	330	1.064
150	Cl	.833	316	1.062
	SO_4	.742	333	1.062
225	Cl	.950	298	1.062
	SO_4	.633	314	1.065
300	Cl	.842	288	1.062
	SO_4	.675	327	1.064
LSD p = .05		.138	21	.0014

^a All plots received 44-104-0 in addition to the K treatments in the row.

Potatoes with a specific gravity of 1.067 were obtained from the application of 85 pounds K per acre as KH_2PO_4 . The specific gravity of potatoes fertilized with 120 pounds per acre K as K_2SO_4 was 1.065. Specific gravity was significantly reduced by the application of 120 and 270 pounds K per acre as KCl. These treatments resulted in tubers with specific gravity of 1.062 and 1.060 respectively.

The results of the 1961 experiment are presented in table 3. Increasing the rate of K as KCl in the row decreased specific gravity .002 units at the 150 pound per acre rate. There was no further reduction as the K rate increased to 300 pounds per acre. K as K_2SO_4 applied in the row affected specific gravity only at the 150 pound per acre rate. The Ca composition of the leaves at the June 12 sample date was significantly higher for the KCl treatments than for the K_2SO_4 treatments.

Discussion

The fertilizer treatments did not visibly affect the growth characteristics of the plants during the growing season. The fertilizer effect on tuber specific gravity was greatest with the coarse textured soils, which are of lowest water holding capacities. The greater effect of the high rate of potassium in the row on specific gravity of potatoes grown on sandy soils was evidently due to effect on the growth rates of the potatoes which although not visible in the top growth had a measurable effect on dry matter production in the tubers.

At comparable K rates KCl had a greater effect on reduction of specific gravity than did K_2SO_4 . The katahdin potato grown on organic soils was markedly affected by the potassium in the row at rates of 120 lbs and 270 lbs K in 1960 when applied as KCl. However, in 1961 the magnitude of effect of the potassium in the row on specific gravity of Russet Burbank potatoes was not great, although significant. Even at rates as high as 300 lbs K per acre in the row there was little reduction in specific gravity of the tubers.

The fact that the Ca composition of the tissue of the young potato plant was affected by the K salt applied suggests the possibility of a direct effect in the plant or in indirect effect due to changes in equilibrium composition of the soil solution around the fertilizer band. If the composition and the salt concentration in the soil solution about the band does not greatly affect the growth rate of potatoes on organic soil, the roots can evidently feed in other areas and not depend on the nutrition from the vicinity of the band. It may be anticipated that the seed piece-fertilizer band relationship would be a problem of greater magnitude in soils where a high proportion of the nutrition is derived from the fertilizer band.

Summary

Applications of fertilizers to high fertility soils did not give yield response but did affect quality. An increase in rate of 5-10-15 fertilizer row from 600 to 1200 pounds per acre reduced specific gravity an average of .004 units on sandy soils. This is equivalent to a reduction in about one per cent dry matter.

At comparable K rates in bands KCl reduced specific gravity of tubers more than the K_2SO_4 on organic soil.

Increasing amounts of K up to 300 lbs/acre applied to organic soils in band affected specific gravity slightly for Russet Burbank potatoes. The effect was greater for Katahdin potatoes.

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