Potato Nutrition in Southwestern Indiana[1]

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The potatoes in southwestern Indiana are produced for the potato chip market and are harvested in late July or early August. Since they are to be matured in as short a growing season as possible, their growth must be stimulated at all stages. This means that at no time should any factor, that can be controlled, be limiting. The potatoes must be grown to be of highest possible specific gravity and chipping quality.

Soil and fertilizers supply the nutrient needs of the potato plant for its growth and development. The amount of fertilizer to apply depends on level of available nutrients in the soil and the yield response that is obtained from the fertilizer application. The response is also regulated by the absence or presence of other growth limiting factors in the potato production area.

This experiment was carried out for the purpose of determining the fertilizer requirement of the potato crop on a soil of known fertility level.

Materials and Methods

This experiment was carried out on the Paul Klein farm near Vincennes, Indiana. The soil type was a Genessee sandy loam, an alluvial terrace soil underlain with gravel. Potassium levels 0, 75, 150, 225 and nitrogen levels 32, 65, 97 and 164 pounds per acre were applied broadcast in a randomized block with four replications. Three levels of P, O, 96 and 192 pounds were applied in bands at planting in a randomized block arrangement with two replications.

Kennebac potatoes were planted 9 inches apart in the row on March 24, 1959 and April 6, 1960. The individual plots were 12 feet wide and 36 feet long. Four rows were planted on each plot and 26 feet of the two center rows were harvested for yield and tuber sampling.

The initial soil test values averaged 70 pounds per acre for phosphorus and 161 pounds per acre for potassium as determined by the Purdue Soil Testing Laboratory. In the laboratory, available phosphorus and potassium are extracted by shaking 5 g. of soil with 15 ml. of 0.75 N. HCl on a shaker 2 minutes. The values are expressed in terms of pounds P_2O_5 and K_2O per 2 million pounds soil. The soil pH was 6.1.

Plant samples were collected as recently matured leaves on ten plants in the two center rows of each plot. In 1959, the sample date was May 26 at the bud stage. In 1960, samples were collected June 1 at bud stage when tubers were just beginning to set and June 15 when the tubers were developing rapidly. The samples were dried at 70° C. in a forced air oven and ground to pass a 20 mesh sieve. The tissue was analyzed for P, Ca, Mg and K according to the methods described by Jackson (1).

The potatoes were harvested on July 26, 1950 and July 25, 1960. Four tubers from each treatment were chipped two days after harvest at the Chesty Potato Chip factory in Terre Haute, Indiana. The vat

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temperature was 325° F. The chip samples were prepared for color determination by grinding in a Waring blender 20 g. chips and 100 ml. H_2O. The slurry was poured into a cell and read on a Hunter color-difference meter that was standardized against a white standard.

Results

Nitrogen effect: The nitrogen test results were obtained from the 1959 crop only. Growth of the potatoes in the spring of 1959 was vigorous and by May 26 the vine growth on the high nitrogen rates nearly covered the middles of the rows. Response to nitrogen could be observed by the amount of vine growth and the color of the vines. The vines on the plots that had received only 32 pounds of nitrogen were light green and had less growth than that on the plots that received the higher rates. In figure 1 the open middle of the row of the low nitrogen treatment illustrated

Figure 1. Potato vine growth influenced by nitrogen treatment. Open middles of rows in center of picture result when only 32 pounds of N applied at planting as compared to closed middles in forefront and rear of same rows from effect of 96 pounds per acre of N.

the relative amount of growth obtained. However, even though color and growth response was obtained to nitrogen there was no measureable effect on tuber yield or tuber and chip quality.

Potassium effect: In 1959, no vine growth or yield responses to potassium fertilization were apparent. However, in 1960 severe potassium deficiency on the vines was developed at the 0 potassium rate. The leaves showed an interveinal bronzing over much of the vine and the entire growth was only about two-thirds that obtained at the 75 pound rate. The potassium in the most recent mature leaves at the June 1 sample dates, table 1, was increased from 2.14% to 4.26% by the application of 225

Table 1. Potato recently matured leaf composition at two sample dates from various K fertilizer rates. 1960.

Treatment *	Composition							
Rate K_2O Application	P		K		Ca		Mg	
	6/1	6/15	6/1	6/15	6/1	6/15	6/1	6/15
Lbs./A				%				
0	.33	.23	2.14	1.8	1.21	2.05	.48	.78
75	.31	.21	2.75	2.3	1.08	1.94	.42	.63
150	.32	.18	3.23	2.3	.90	1.77	.37	.52
225	.32	.18	4.26	3.0	.94	1.75	.37	.50
LSD 5% level	NS	.03	0.74	0.36	0.21	0.24	0.045	0.09

* All plots received 44-192-0 in bands at planting and 66 pounds per acre of N broadcast preplant.

pounds of K_2O and on June 15 the K composition was changed from 1.8% at the zero rate to 3.0% at the 225 pound rate. The composition was increased in rather uniform amounts by the 75 pound increments of K_2O fertilizer applied. As the rate of potassium fertilizer was increased the Ca and Mg in the tissue was decreased. At the June 15 sample date, P in the tissue was decreased by the higher rates of K. This could have been due to anion competition as a result of the anion carrier in the K fertilizer. The yield of tubers, table 2, was increased from 245 cwt. to 310 cwt.

Table 2. Potato yield, specific gravity and chip color from potassium fertilization.

Treatment *	Yield		Specific Gravity		Chip Color White L=85.3	
Rate K_2O Applied	1959	1960	1959	1960	1959	1960
Lbs/A	Cwt/A				L	
0	225	245	1.090	1.074	60.4	52.1
75	227	280	91	74	63.3	61.5
150	244	299	90	73	61.1	63.7
225	224	310	88	74	63.3	67.1
LSD 10% level	NS	24.3	NS	NS		

* All plots received 44-192-0 in bands at planting and 66 pounds per acre of N broadcast preplant.

per acres in 1960 over the 0-225 pound K range tested. The response to K was highest for the first 75 pound increment and fell off at the higher rates. Over the range of K rates tested there was no influence on specific gravity of the tubers. In 1960, the potatoes from the zero potassium plots produced very inferior chips. The color of the chips was much darker than those from tubers grown on the plots that received higher K fertilizer rates. An L reading of above 60 is a very acceptable chip color. The read-

ing of 52.1 for the chips from the zero K treatment represents a dark brown, burnt-looking chip.

The soil from the respective plots was sampled in the fall of 1960 to determine the influence of the potassium treatments on the amount of exchangeable K_2O in the soil after two crops of potatoes have been grown. It was found that the exchangeable K_2O level was 102 pounds per acre on the zero potassium plots and 138, 140 and 158 pounds per acre respectively for the 75, 150 and 225 pound K_2O rates. Thus, at this sampling date an annual application of 225 pounds of K_2O was required to maintain the K level in the soil.

Phosphorus effects: In the plant, the effect of P fertilization showed up mainly as an increased amount of P in the tissue, table 3. The P

Table 3. Potato recently matured leaf composition at two sample dates from various P fertilizer rates. 1960.

Treatment *	Composition							
Rate P_2O_5 Application	P		K		Ca		Mg	
	6/1	6/15	6/1	6/15	6/1	6/15	6/1	6/15
Lbs./A				%				
0	.20	.17	2.6	2.6	.87	1.40	.32	.43
96	.26	.18	3.2	2.6	.82	1.54	.32	.44
192	.30	.20	2.6	1.8	.97	1.63	.39	.51
LSD 5% level	.05	.03	NS	0.5	NS	NS	.06	NS

* P applied in bands at planting along with 44 pounds of N. In addition all plots received 180 pounds per acre K_2O broadcast preplant and 66 pounds of N sidedressed.

composition was increased most at the early sampling date. The application of P increased the tissue composition from .198 at the zero rate to .300 at the 192 pound rate at the June 1 sample date and from .173 to .200 at the June 15 sample date.

The potato yield, table 4, was increased from 244 cwt. to 319 cwt. per acre by the first 96 pound P_2O_5 increment and from 319 cwt. to 348 cwt.

Table 4. Yield and specific gravity of tubers from various phosphorus treatments.

Treatment * Rate P_2O_5 Applied	Yield	Specific Gravity
	Cwt.	
0	244	1.074
96	319	1.076
192	348	1.078
LSD 10% level	32.6	.003

* P applied in bands at planting along with 44 pounds of N. In addition all plots received 180 pounds per acre K_2O broadcast preplant and 66 pounds of N sidedressed.

per acre by the second 96 pound P_2O_5 increment. The specific gravity of the tubers was increased significantly by the P fertilization, from 1.074 at the zero rate to 1.078 at the 192 pound P_2O_5 rate.

Discussion

The lack of yield response in 1959 to applications of nitrogen, even though vine growth response was observed, and potassium may have been due to shortage of water. During the period of rapid tuber development in June most of the water had to be supplied through irrigation which could not keep up with the demand. Thus, the yield ceiling in 1959 was approximately 240 cwt. per acre and at this point nutrients were not limiting.

In 1960, the level of exchangeable potassium on the O K plot had been reduced by the previous crop to a point that it was very limiting to potato growth and yield. The reduction of exchangeable K in the acre plow layer after two years of production was about 60 pounds of K. A total application of 450 pounds per acre K_2O was necessary to maintain the 160 pounds per acre plow layer level of exchangeable K under potato production practices in this area.

The detrimental effect of potassium deficiency on chip color was very significant and when potatoes are produced solely for chip production it is very important that the potassium nutrition be optimum.

The yield response to P fertilization was equal to or greater than for K. Also the specific gravity of the tubers was higher at the highest P rate than at the deficient level of P. Apparently, when phosphorus is limiting for plant growth the rate of development of the tubers is delayed so that at harvest they contain less dry matter than tubers developed under more optimum fertility conditions.

Summary

Kennebac potatoes grown on a Genessee sandy loam soil that contained 161 pounds exchangeable K_2O per acre did not respond to potassium fertilization in 1959. Two years of protato production decreased the level of exchangeable potassium in the soil to about 100 pounds per acre. Potatoes responded to potassium fertilization the second year when the yield was increased from 245 to 310 cwt. per acre by the application of 225 pounds K_2O. Potato chips from the zero K plots were dark brown and of inferior quality. The highest quality potatoes were produced at the higher fertilizer rates.

Nitrogen rates over the range of 32 to 164 pounds per acre did not affect either the yield or the quality of the potatoes.

The soil contained 80 pounds available P_2O_5 per acre and yield was increased from 244 cwt. to 348 cwt. per acre by the addition of 192 pounds P_2O_5 per acre.

Literature Cited

1. Jackson, M. L. 1958. Soil Chemical Aanalysis. Prentice-Hall, Inc.