HOW MUCH POTASSIUM FERTILIZER IS NEEDED FOR TOP POTATO YIELDS?

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Introduction

The research results to be discussed here are closely related to the 1963 results which were reported at this conference one year ago.[1/] An introduction to the 1964 experimental work will be given by way of a brief review of last year's report.

In 1963 an experiment was conducted at Columbia Basin Research Unit No. 1 (Othello) which was designed to show the effect of soil potassium availability on the growth and production of potatoes. The correlation obtained for potassium (K) in the petiole versus soil test K was about .95 for two samplings taken in late June and late July. The petiole K in the second sampling increased from 2% to 10% over the soil test K range 150 to 750. The yield of tubers increased from about 480 cwt/A at the 150 soil test level to about 680 cwt/A at 350 soil test level. Soil test K levels beyond 350 had no further effect on yield of tubers. The two main conclusions drawn from the 1963 results were (1) the soil test is a very reliable tool for estimating the availability of potassium in the soil to potatoes,[2/] and (2) when the K soil test index is less than about 350, potassium fertilizer must be added to eliminate the possibility of yield reduction due to potassium dificiency.

It should be re-emphasized at this time that although the 1963 results showed how the soil test could be used to predict the need for potassium fertilizer, there was nothing in the data to indicate how much fertilizer would be needed to obtain the best results. The 1964 experimental program was especially designed to help answer the latter question.

1964 Experiments and Results

The field plots used in 1963 were replanted to Russet potatoes on April 17, 1964. Phosphorus (as treblesuper) and nitrogen (as ammonium nitrate) were sidedressed after emergence at uniform rates of 25 [3/] and 300 pounds per acre, respectively. The main experimental variable was soil test level of K, as in the previous season. In addition, potassium (in muriate of potash form) was applied to certain plots along with the N and P. The potassium

1/D. W. James. Potassium availability versus potato production in central Washington soils. Proceedings, 3rd Annual Washington State Potato and Vegetable Conference, Moses Lake, Washington February 6-7, 1964.

2/This assumes that a reliable soil sample is obtained. The problem of obtaining soil samples from highly variable fields was discussed in last year's report. It is discussed again at this conference by Mr. A. I. Dow.

3/Note that phosphorus (P) and potassium(K) fertilizers are discussed throughout this report in terms of the elements. Factors for changing from elemental to oxide forms are given in the addendum.

treatments provided for a combination of fertilizer K rates with different levels of soil K availability.

The potatoes were sampled for tissue analysis on July 8 and August 5. The sample consisted of petioles taken from the 4th node down from the terminal bud. About 20 petioles were composited from each plot.

Harvest measurements were made on October 15 after which K content of the tubers was determined.

The relationship between soil test K and K content of the petiole is illustrated in figure 1. The correlation coefficients of .95 again indicate that soil test K is a very good indicator of soil K availability. These results are in complete agreement with those obtained in 1963. The effect of soil test on K in the tuber is shown in figure 2. Apparently, 75 pounds of K will be removed in each ton of potato tubers harvested where the soil test is above 350.

The effect of potassium fertilizer on the potassium content of the plant is of special interest. The results of the second petiole sampling are given again in figure 3 except in this case, instead of showing the results for individual plots, the plots are grouped into soil test categories. Succeedingly higher categories differ by approximately 50 on the soil test scale. Along with the direct effect of soil test, figure 3 includes the effect of superimposing fertilizer K at the rate of 150 lbs. K/A[3/] on the soil test. The indication is that 150 lbs. K/A at a soil test of 125 is as effective as a soil test of about 300 in putting K into the plant. It will be noted that the effect of fertilizer K decreases as the soil test increases. For example, 150 pounds K/A increases the K content of the petiole by 3% at soil test 125, but the petiole K increases only by about 2% at soil test 325. It is expected that at very high levels of soil test, fertilizer K would have a very small effect on K uptake. There were not enough field plots available to measure the fertilizer K effect across the full range of soil test K.

Figure 4 provides another measure of the effect of fertilizer K. In this case rates of K from zero to 300 lbs. K/A were applied on plots that were all in the same soil test category. These plots were uniformly low at approximately 175 on the soil test scale. It is apparent from figure 4 that the most pronounced effect of fertilizer K occurs with the 75 and 150 pound rates. The practical significance of the change in petiole K between 225 and 300 lbs. K/A is not too clear. It would have been desirable to extend the fertilizer K range to higher levels but space was too limited to permit an extension of this comparison.

The yield response to increasing levels of soil potassium availability is shown in figure 5. The soil test categories are the same as those shown for figure 3. The total yield of tubers ranged from 390 cwt/A at 70% to 558 cwt/A at the highest or 100% level. Each solid point (no added K) in the figure is the average of from one to six plots. Each open point (150 lbs. K/A added) is the average of two plots. Although the overall yield was lower than in 1963, the break in the yield curve occurs at about the same place, i.e. about 350 on the soil test scale. The effect of fertilizer K on yield, as shown in figure 5 is analogous to the effect on K uptake by the plants. Fertilizer at 150 lbs. K/A increases yield from 70% to 85% of maximum at the 125 soil test level, but at the 325 soil level of K this amount of fertilizer only increases yield from 94% to 97% of maximum.

Figure 6 shows the effect of potassium rates on yield at the uniform soil test of about 175. Yield increases sharply from 70% to 85% of maximum with 75 lbs.

K/A but greater amounts of fertilizer K have very little added effect. This is not clearly understood since there was a considerably broader effect of K rates on absorption of K as indicated in figure 4.

Disease factors had a generally poor effect on yield from all plots in 1964. Due to a mild winter there was a large crop of volunteer potatoes from the previous season. It was impossible to rogue out the volunteers and leaf roll virus and verticillium wilt took a toll. In addition, the potatoes suffered from ammonium toxicity early in the season from the fertilizer nitrogen which was banded after mergence. Since cold dry weather extended till very late in the spring, the conversion of ammonium to nitrates was delayed considerably. Under the circumstances the fertilizer was obviously placed too closely to the plants. Despite the effects of diseases, the data on K uptake and relative yield are in good agreement with the results from the previous season. Straight-forward conclusions on the K nutrition of the potatoes are justified.

A comment should be made on grade of potatoes. In 1963 the percent of number one potatoes decreased below a soil test of about 200. In 1964 no particular effect of either soil availability of K or fertilizer K on percent number one potatoes was noted. Actually, the overall grade-cut was poorer in 1964 probably because of the effect of nitrogen fertilizer becoming highly available about June 1 when the soil finally warmed up.

Discussion and Conclusions

The relationships between soil-fertilizer K and K in the plant demonstrated in the foregoing results may differ somewhat under other circumstances. For example, the level of available nitrogen creates different demands by the crop for potassium and other nutrient elements. Where plant diseases are severe it may be necessary to have very high levels of available potassium in the soil to help counteract the effects of the disease. It is believed that the results referred to here from 1963 and 1964 are generally applicable since the 300 pound per acre rate nitrogen is not untypical of rates in commercial fields. Although disease effects were present to some extent in 1964 there were no disease effects in 1963 and the two years' results complement each other in terms of K nutrition.

At the present time the W.S.U. Extension Service is making recommendations for potassium on potatoes when the soil test gets below 400. Evidently this provides a fair margin of safety for averting potassium dificiencies in potatoes. It is believed that if good soil sampling techniques are used and the recommendations from the soil test are followed, potassium deficiencies in potatoes in central Washington can be avoided.

The results of the two years' field experiments lead to the following conclusions:

(1) The potassium soil test is a good indicator of soil potassium availability for potato production.
(2) Yield of potatoes may be reduced due to potassium deficiency where the soil test K index is below about 350.
(3) The 1964 results strongly support the recommendations now being made for potassium fertilization of potatoes. These recommendations are based on soil test as follows:

Soil Test K Index	Fertilizer Needed lbs. K/A
Above 400	None
400-300	100
300-200	200
200-100	300
Below 100	400

Addendum

The factor for changing from P to P_2O_5 in fertilizer terminology is 2.32. The factor for changing from K to K_2O is 1.2. Thus, the 25 pounds of P per acre used in this experiment was equivalent to 58 pounds of P_2O_5 per acre. The rates of K used in the experiments are related to K_2O as follows:

K Applied Pounds per acre	K_2O Equivalent Pounds per acre
75	90
150	180
225	270
300	360

Experiment Station personnel throughout the country are moving away from the custom of referring to P and K in fertilizers in terms of the oxides. This is because the oxides as such do not exist in fertilizer, neither do they exist in soils or plants. Soil tests and plant nutrient contents are always discussed in terms of the elements, so dropping the oxide designation in fertilizer is actually simplifying fertilizer and plant nutrient terminology.

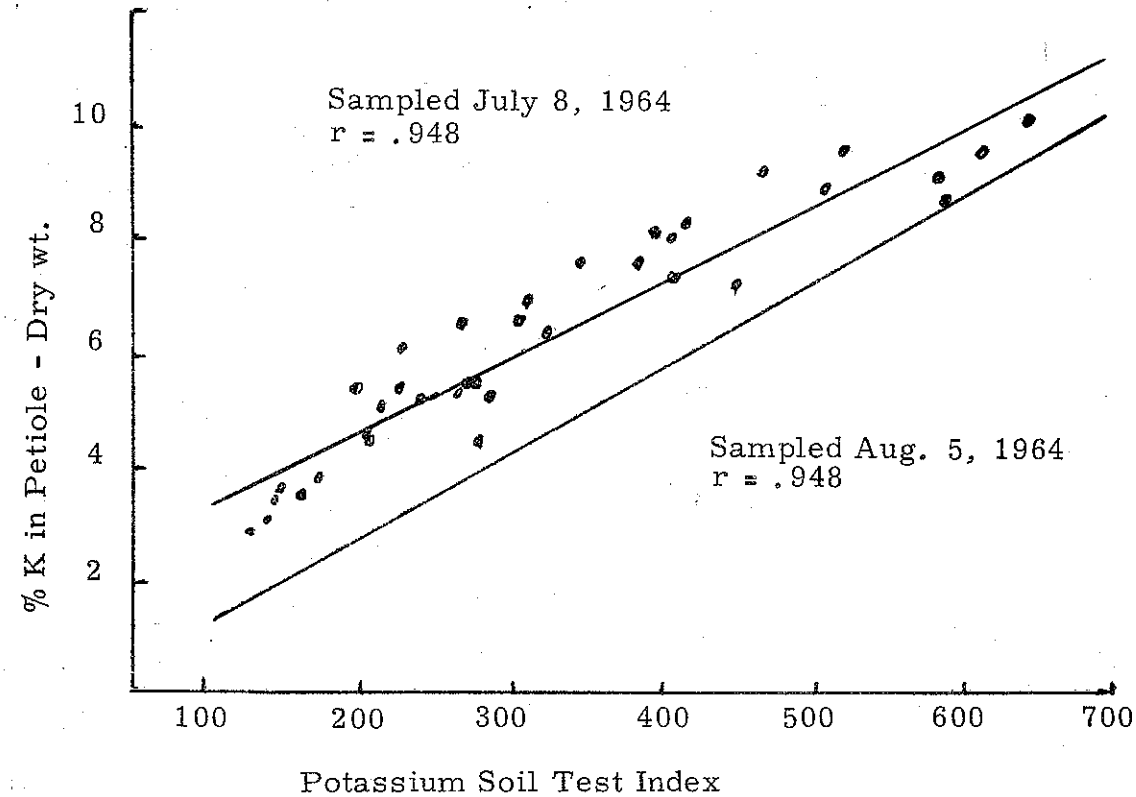

Figure 1. Relationship between potassium soil test and potassium in the potato petiole at two sampling times. Each point represents one plot. Since points over-lap for the two samplings, data for second sampling not shown.

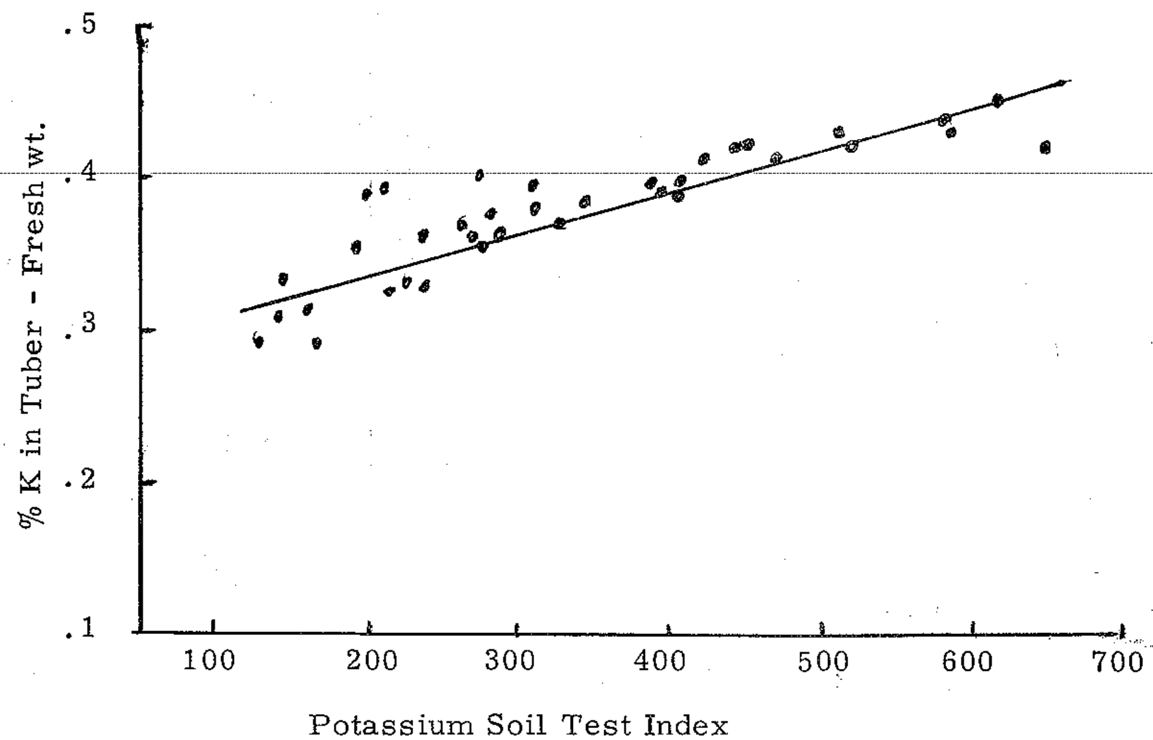

Figure 2. Relationship between potassium soil test and potassium content of potato tubers at harvest time.

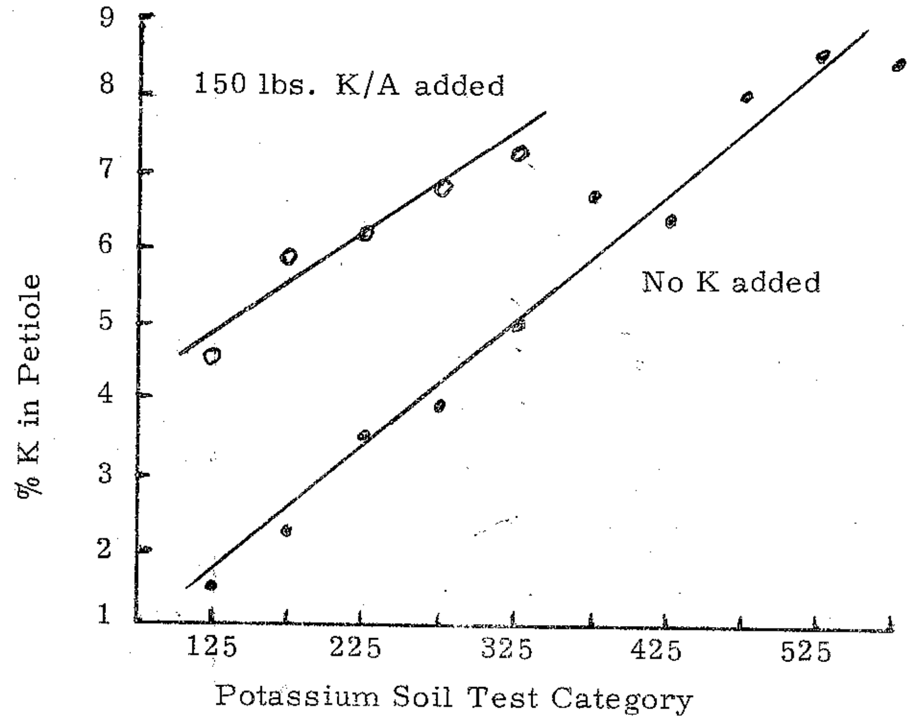

Figure 3. Effect of soil potassium availability and added fertilizer on the K content of the petiole. The plots were grouped into soil test categories. The soil test numbers shown are the centers of the respective categories. Each solid point is the average of from one to six plots. Eash open point is the average of two plots.

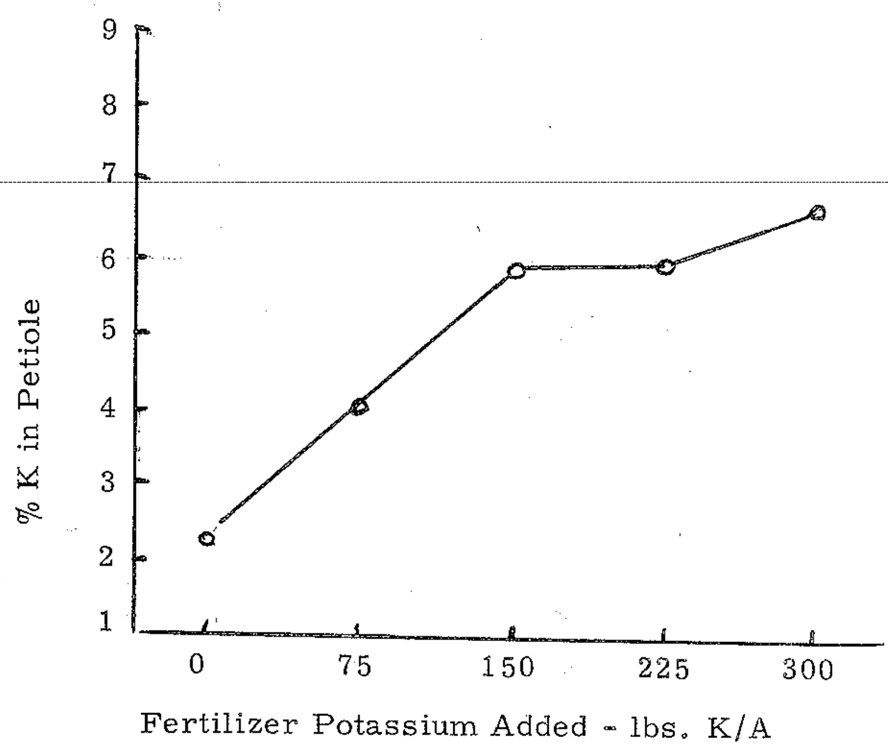

Figure 4. Effect of increasingly higher levels of fertilization on the K content of the petiole. Each point is the average of four plots, each plot being near 175 soil test K.

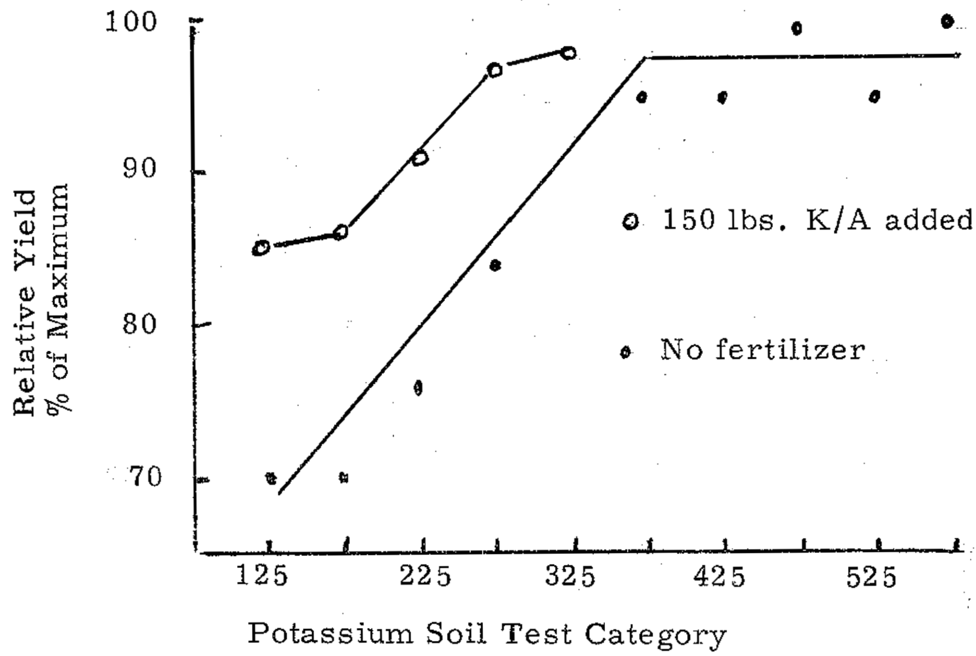

Figure 5. The yield response of potatoes to increasing levels of soil potassium availability with and without fertilizer. 100% or maximum yield was 558 cwt/A. Soil test categories and the number of plots at each level are the same as those indicated for Figure 3.

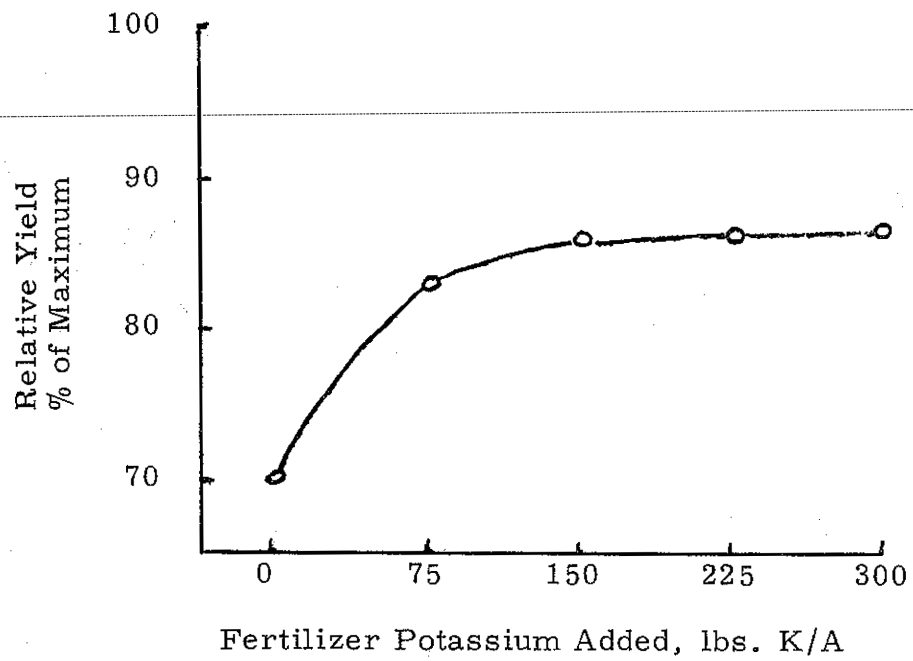

Figure 6. Effect of increasingly higher levels of fertilization on the yield of potatoes. Same plots as shown in Figure 4.