EFFECTS OF FERTILITY ON POTATO PLANTS AND TUBERS

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Rather than discuss the potato fertilizer problem in general, I would like to direct your thinking to a specific part of the fertilizer problem which is becoming more prevalent throughout the Columbia Basin. The need for nitrogen, phosphorus and zinc for potatoes is well recognized, but the need for potash is relatively new. Most soils in the Columbia Basin are well supplied with potash, but each year for the last three years there has been an increasing acreage of leveled land and cut spots which are low in potash by both soil and tissue tests. In simple terms, it means that crops are removing potash faster than the parent material is decomposing, and in greater quantities than is being supplied by fertilization. Not only is the low potash level reflected in yields, but also in tuber quality. Potatoes are heavy users of potash. It requires about 0.9 lbs. of K_2O to grow one CWT of potatoes and 0.4 lbs. of K_2O is removed from the soil with each CWT of potatoes removed.

Potash deficiency symptoms:

The symptoms of the deficiency are of two kinds, those which develop under conditions of low general fertility and those which develop under conditions of high general fertility.

If nitrogen and phosphorus are low enough so that the plants are dwarfed, almost no symptoms of a potash deficiency will develop. If nitrogen is limited and phosphorus is adequate, the plants may attain almost normal size, but the leaves will be yellowish in color, typical of a nitrogen shortage. The leaf surfaces will nevertheless be cupped downward at the edges, have a wrinkly appearing surface, and the interveinal necrotic areas will be a light tan to brown in color. The necrotic areas begin as a small spot which is quite different from the yellowing due to *Verticillium* wilt, which frequently affects only half of a leaflet. Leaves affected with *Verticillium* are yellowish, and potash deficient leaves are more bronze in color.

If nitrogen and phosphorus are high, the plants will seem to be normal but will have a deep green, almost bluish-green color. If an entire field were uniformly deficient under these conditions, it would be considered to be in a good state of health and growth. The differences described are strikingly apparent only where normal and abnormal plants can be compared side by side, as is possible in split plot experiments or in soil spots which occur in fields not otherwise adequately fertilized with potash. The leaves on affected plants are cupped downward at the margins, have a wrinkled surface, and the necrotic tissue is almost a dark chocolate brown in color. Under certain light conditions the necrotic areas take on a purplish sheen.

Plants well fertilized with nitrogen and phosphate, but deficient in potash, will grow well for 90 to 100 days after planting. By this time the wrinkled leaf surfaces are well developed, and the necrotic spots are beginning to show in the top leaves. The differences in plant growth make the soil spots appear as relatively small areas in the field. The spots usually enlarge as the season progresses. Death of the plant occurs within two to four weeks after the necrotic areas begin to appear.

Two attempts have been made to correct the potash deficiency after the symptoms were present. Neither soil injection of a potash solution nor water infiltration of potash directly over the root zone was successful in saving the plants once deficiency symptoms were present. This indicates that potash should be applied at the time fertilizing usually is done, which is prior to or at the time of planting.

Use of the Soil Test:

The best laboratory indicator of the phosphorus and potash status of a soil is a chemical analysis of the soil. This test is reliable on uniform soils, but is no better than the soil sample taken from areas which are not uniform. This is illustrated in Table 1. The area surveyed was in conjunction with a fertilizer experiment which included 1.4 acres of land. The experimental area was divided into rectangles 24 feet wide by 40 feet long. A number of examples of soil variability of this kind have been found, and demonstrate the fact that Columbia Basin soils are variable.

Table 1. The problem of obtaining an adequate soil sample on which to base a potato fertilizer recommendation.

1.	Size of area surveyed	1.4 acres
2.	Average phosphorus test	14.2
	(a) Range in samples obtained	6 to 20
	(b) Per cent of area testing low in phosphorus	49
	(c) Per cent of area testing between low and high	23
	(d) Per cent of area testing high in phosphorus	28
3.	Average potassium test	320
	(a) Range in samples obtained	114 to 741
	(b) Per cent of area testing low in potassium	24
	(c) Per cent of area testing between low and high	44
	(d) Per cent of area testing high in potassium	32

The analysis for phosphorus in the soil samples taken from the experimental area shows (1) that the soil is very variable, (2) the truly composite soil samples gave a low test (14.2) indicating that a response in yield could be expected if phosphorus were applied. However, 28 per cent of the area would not have responded to additional phosphorus because the test was high, and (3) a phosphorus recommendation based on a test of 14.2 would not be adequate for 49 per cent of the area.

The analysis for potassium in the soil samples shows (1) that the soil is extremely variable in potassium content, (2) the truly composite soil sample gave a test of high (320) indicating that no response in yield would be expected if additional potash were applied in the fertilizer. However, 24 per cent of the area would have responded to applications of potash. It should now be apparent that almost any level of phosphorus or potassium can be obtained from the same field, depending on where in the field the sample was taken and what sub-samples went into the composite sample.

Limited space prevents a discussion of sampling procedures, but the following is suggested: (1) Obtain a leveling map of your field, locate the cuts and treat them separately with both phsophorus and potassium. (2) Divide your field into a grid, take composite soil samples from each grid, keep each sample separate and have it analyzed separately, and treat each respective area according to the soil analysis, (3) Use a blanket fertilizer application and apply rates high enough to supply the most deficient areas adequately.

Experimental results with potash on potash-deficient areas:

In the experiment the results of which are reported in tables 2, 3 and 4, the plots were fertilized with 160 pounds of nitrogen and 80 pounds of P_2O_5.

Table 2. Effect of rates and placement of potash on the yield and grade of Russet Burbank potatoes.

	Total Yield, CWT/Acre		Per cent No. 1 grade	
Pounds K_2O/Acre	all banded	1/2 ba, 1/2 br.	all banded	1/2 ba, 1/2 br.
0	311	282	58	53
200	363	326	60	54
400	343	298	56	53

It can be seen that the addition of potash to the fertilizer increased the yield without greatly affecting the percentage grade-out. It can also be seen that banding all of the fertilizer produced a higher yield than broadcasting and plowing under half the fertilizer and banding the other half of the fertilizer at planting time.

Table 3. Effect of rate and placement of potash on specific gravity and potato chip color.

Pounds	Specific gravity		Potato Chip color	
K_2O/Acre	all banded	1/2 ba, 1/2 br.	all banded	1/2 ba. 1/2 br.
0	1.093	1.093	7.1	7.1
200	1.088	1.088	6.8	7.0
400	1.084	1.086	6.8	6.9

The method of applying the fertilizer had little influence on either specific gravity of the potatoes or on the color of the potato chips. Increasing the amount of potash in the fertilizer had a marked effect on the specific gravity. The higher the rate of potash, the lower the specific gravity. This could be undesirable if the potatoes were to be processed, but desirable if they were sold on the fresh market (Table 3). In another experiment the high rates of potash in the fertilizer did not reduce yield or specific gravity appreciably when nitrogen and phosphorus also were applied at high rates.

The 1962 potato marketing season was one with considerable blackspot in the potatoes. The amount of potash in the soil, in the fertilizer and in the tissue has been correlated with the amount of blackspot. The effect of potash on blackspot is shown in Table 4.

Table 4. The effect of rate and placement of potash on the potassium in the petiole and the susceptibility of the tubers to blackspot when bruised.

Pounds K_2O/A	Per cent potassium in the petiole all banded	Per cent potassium in the petiole 1/2 ba, 1/2 br	Blackspot index all banded	Blackspot index 1/2 ba, 1/2 br	Mean per cent decrease in blackspot index
0	3.7	3.6	3.4	3.0	0
200	7.8	7.0	2.2	2.4	28
400	8.8	7.8	1.9	1.9	41

The results in Table 4 indicate that more potash was taken into the plant when the fertilizer was banded than when only half of it was banded. The results also indicate that the greater the level of potassium in the petiole, the lower was the blackspot index.

All of the potash effects mentioned indicate that more attention to the soil spot problem will be needed in the future if maximum yeilds of high quality potatoes are to be produced.