Effect of Various Nutrient Levels of Soil and Foliar Spray Applications on Sugar Beet Yields

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Experimental data tend to indicate that to secure maximum sugar beet yields a balance of plant nutrients is required. A greenhouse experiment was set up in 1949 to determine this balance and the quantities of each nutrient necessary.

This greenhouse experiment consisted of four levels of nitrogen, phosphorus and potassium in the soil. With these levels occurring in all possible combinations the growth of sugar beet plants indicated the best balance ol nutrients. These levels were then applied to a field in an effort to produce maximum yields of beets in the eastern area. The field selected was tiled and had two cuttings of alfalfa plowed under the year previous.

Field Experimental Methods

In work previously reported (l)[2], applications of three rates of phosphorus, potassium and nitrogen were made in an effort to achieve, under field conditions, the levels producing the best growth of sugar beets. The levels were 5, 10 and 15 ppm. for phosphorus and 15, 30 and 45 ppm. for potassium. Soil tests in 1951 indicated that the active phosphorus levels were 6, 12 and 18 ppm. and the potassium levels were 18, 42 and 41 ppm. Nitrogen was applied at 250 pounds and 500 pounds for the higher levels. The plowdown served as the check levels.

All soil tests were by the Spurway active soil testing methods. Spurway green tissue testing methods were used to determine the nitrates, phosphorus and potassium in the green petioles.

These plots were planted to beets again in 1951 and supplemental irrigation was used on one-half of the plots.

Results in 1950 and 1951

The plots which were irrigated twice appear to have outyielded the non-irrigated. Further data will be required to substantiate this.

Soil tests indicate that the sugar beet plant takes up all available nitrogen. Green tissue tests indicate that greater quantities than the plant requires accummulate in the tissues. Yield results show that a heavy application of nitrogen increased yields, but the sucrose percent and gross sugar per acre are lowered as shown in Table 1, all to a statistically significant level of 1 percent. This is true even when available phosphorus and potassium levels are high.

Table 1.—Effect of Heavy Nitrogen Applications on Yields and Sucrose Percent.

		0 lbs. N	250 lbs. N	500 lbs. N
Yield Tons/A		15.5	17.8	17.3
Sucrose %		18.8	15.1	14.3
Gross	Sugar	5,837	5,347	4,920

No nitrogen was applied in 1951. The carryover of nitrogen was sufficient to be very evident in top growth. Yield increased significantly and sucrose percent decreased significantly but gross sugar was raised slightly.

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[2] Numbers in parentheses refer to literature cited.

Green tissue tests for potassium indicated no variation in the plant tissue irrespective of the quantity or concentration available in the soil. Tissue tests were equal for soil tests of .5 ppm. to the highest tested level.

The heavier applications of potassium significantly lowered gross sugar as shown in Table 2. The combination of the heavy nitrogen application and the heavy potassium application resulted in a slight increase in yields as indicated in Table 2.

Neither the potassium nor the nitrate concentration of the petioles, as shown by green tissue tests, could account for this.

Table 2.—Effect of Heavy Potassium Applications on Sugar Beet Yields and the Offsetting Effect of a Heavy Potassium Application and a Heavy Nitrogen Application. (500 lbs./A of N.)

	0 lbs. N		500 lbs. N	
	1,785 lbs. KCL	4,725 lbs. KCL	1,785 lbs. KCL	4,725 lbs. KCL
Yield Tons/A	17.2	16.6	17.1	18.1
Sucrose %	16.2	16.0	14.4	14.3
Gross Sugar	5,565	5,223	4.910	5.170

In 1951 soil tests were the same for potassium as in 1950. Yields were increased slightly but percent sucrose was decreased significantly.

Phosphorus levels produced no significant benefit or detriment on beet yields in either year. However, some 1950 data gave indications of lines requiring further investigation. It was found that where no nitrogen was applied the phosphate increased the sucrose percent on 54 plots to 18.9 compared with 18.3 for the check plot. Also, the green tissue tests showed these same plots averaged 10.2 ppm. of phosphorus while the rest of the plots averaged 6.5 and the check plots averaged 5.5. Where both potassium and nitrogen were low, the sucrose percent for 18 plots was 19.2 compared with 18.3 for the check plots. The average phosphorus of the green tissue on these plots was 11.1 ppm. compared with 6.5 ppm. for the other plots and 5.5 ppm. for the check plots.

Therefore, to investigate the role of phosphorus more fully, a set of plots were designed to determine whether phosphorus in the plant tissue could be raised, thereby increasing percent sucrose. Research by other workers has indicated that phosphate in the tissue could be increased by making foliar spray applications of a soluble phosphate.

This experiment was designed with six treatments: 1. check, 2. 60 pounds P_2O_5, 3. 120 pounds P_20_5, 4. 120 pounds P_2G_5 plus sprayings every week with a saturated superphosphate solution, 5. 120 pounds P_20_5 plus sprayings every other week with a saturated superphosphate solution, 6. 120 pounds P_20_5 plus two sprayings with urea. These treatments were used on field check, 50 pounds nitrogen sidedressed and 100 pounds nitrogen sidedressed and a basic application of 60 pounds of K_20 on all plots.

Green tissue tests were made for phosphorus prior to harvesting on four sets of plots: 1. 120 pounds P_20_5 plus saturated superphosphate sprays every other week, 2. 120 pounds P_20_5 plus two sprayings of urea, 3. check, 4. 120 pounds P_2O_5, each on 50 pounds of nitrogen, 0 pounds of nitrogen, and 100 pounds of nitrogen. These results shown in Table 3 indicate that the application of phosphate fertilizer increased the phosphorus in the plant but subsequent sprayings with soluble phosphate had no effect.

Table 3.—Parts Per Million of Phosphorus in Green Tissue Under Various Phosphorus Applications. *

Quantity applied	ppm. of Phosphorus in Green Tissue
No phosphorus	6.8
120 lbs. P_2O_5	19.4
120 lbs. P_2O_5 plus 5 P_2O_5 sprayings	19.3
120 lbs. P_2O_5 plus 2 urea sprayings	17.5

Table 4 shows that the application of nitrogen lowered the phosphate in the plant tissue in direct relationship to the quantity of nitrogen applied.

Table 4.—The Phosphorus Content of the Green Tissue as Affected by Increasing Nitrogen Applications.

Pounds of Nitrogen	Phosphorus ppm.
0	18.3
50	15.8
100	13.2

This is evident even when urea was applied as a spray as shown by Table 3. The application of urea gave no visible effect on the top growth either in color or in size. Chloroyphyll determinations on the same tissue also indicated that the urea sprays did not affect the green pigments even though the phosphorus in the tissue was decreased.

The determination of the green pigments was made to check on the theory that possibly the concentration of photosynthetic material present as evidenced by the green pigments would correlate with sucrose percent. These tests indicate virtually no correlation of chlorophyll with percent sucrose. A definite correlation of chlorophyll exists with nitrogen. As nitrogen is increased, leaf size is increased and Table 5 shows that the concentration of chlorophyll in that larger leaf is increased.

Table 5.—Relationship of Chlorophyll Concentration to Nitrogen Applications.

Pounds of Nitrogen	Chlorophyll mg/gm
0	.35
50	.55
100	.59

The plant phosphate was not correlated with sucrose percent in this experiment even though high phosphate concentrations were found in some petioles.

It is of interest to note in Table 6 that benefit from 10 weekly phosphate sprays is indicated by the averages of six plots.

Table 6.—Average Yields of Each Treatment.

	Tons/A	% Sucrose	Gross Sugar
Check	13.3	16.5	4,423
60 lbs. P_2O_5	16.3	17.0	5,562
120 lbs. P_2O_5	16.7	17.3	5,725
120 lbs. P_2O_5 + 10 P_2O_5, Sprayings	18.7	17.3	6,462
120 lbs. P_2O_5 + 5 P_2O_5 Sprayings	17.7	16.6	5,845
120 lbs. P_2O_5 + urea sprayings	17.8	17.2	6,068

These averages indicate increases of a ton/A of beets above any other treatment and 400 pounds gross sugar/A and possibly some increase in sucrose percent. Furthermore, there are indications that the weekly phos-

phate spray was of even greater benefit at the 100 pounds application rate of nitrogen.

Summary

Heavy applications of phosphate fertilizer raised the active phosphate level of the soil and maintained it for two years.

Heavy potassium applications increased active soil potassium to a certain level, then no further increase was found.

Heavy nitrogen applications had a marked carry-over to the following year.

Irrigation may have been beneficial in the eastern area.

Yields are increased by heavy nitrogen applications but percent sucrose is lowered. Potassium has similar effects but not so extreme. The combination of heavy potassium and heavy nitrogen applications raised gross sugar slightly.

Phosphorus fertilizer application had no effect except where nitrogen was low. Under low nitrogen conditions phosphorus in the tissue was increased and percent sucrose was increased.

Foliar spray applications of a soluble phosphate every two weeks did not increase phosphate *in* the tissue.

As nitrogen applications increased, phosphate in the tissue decreased.

No relation was found of chlorophyll concentration and percent sucrose but concentration of chlorophyll was directly related to rates of nitrogen applications.

Weekly foliar sprayings of a soluble phosphate indicates some benefit, especially with the heavier nitrogen application rates.

Literature Cited

(1)_____.
1951. Proc. Am. Soc. Sugar Beet Tech. Eastern United States and Canada. P. 95.