Plant Tissue Testing as a Guide to Side-Dressing Sugar Beets[1]

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The testing of green plant tissue is recognized as a reliable method for determining the nutrient status of plants (3, 5)[3]. In view of the fact that tissue testing kits are now widely available and easy to use, it is possible for sugar beet growers to make a much more efficient use of commercial fertilizer. This is particularly true where fertilizer is applied as a side-dressing. Such delayed applications are for the purpose of supplying nutrients as they are needed during the growing season and should be considered as supplementary to the planting time application.

From a theoretical point of view, side-dressing may be practical if: (1) inadequate applications of fertilizer have been made at planting time; (2) if growth characteristics and (or) plant tissue tests indicate a low plant nutrient status; (3) if the soil has a high nutrient fixing power; (4) or if there occurs a low efficiency in fertilizer consumption by a crop.

The purpose of this investigation was to determine the practicality of using rapid tissue test information as a guide for the application of supplemental fertilizer as a side dressing.

Methods and Procedures

Plant tissue tests were made with a Simplex Soil and Plant Tissue Testing Kit[4]. These tests measure the unassimilated nutrients, thus indicating whether or not the plant is obtaining sufficient nutrients at the time the tests are made. The results of tests in the field were recorded as H (high), M (medium) , L (low) , and B (blank) .

For the most part side-dressings were made in fields where the beet leaves tested low or blank for a given nutrient. The fertilizer was applied with an experimental garden type of side-dresser[5] which treats two rows at a time. For the elements other than nitrogen, the fertilizer was placed as close to the row as possible without physical injury to the plants and from one to two inches deep. The ammonium sulfate, in some cases, was placed as just described. In other experiments it was placed on the surface of the soil within two inches of the plants. Unless one is careful it is possible when applying fertilizer as a side-dressing to injure the beet roots so seriously that the fertilizer application may fail to increase yields. Sugar beet planters have been used successfully for placing fertilizer to the side of the row.

Results and Discussion

The results of these experiments are shown in Tables 1 through 4. For

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[3] Numbers in parentheses refer to literature cited.

[4] Kits may be obtained from Soil Science Department, Michigan State College, East Lansing, Michigan.

[5] Cooperative project between USDA Agricultural Engineers and Soil Science Department.

the most part these data are the results of tissue tests and yields on individual farms and are intended to illustrate certain points in regard to side-dressing.

If tissue tests indicate a "high" amount of the nutrients nitrogen, potassium and phosphorus, there is no reason to expect that supplemental applications of these elements would increase sugar beet yields. The data presented in Table 1 show that in a field where tissue tests for nitrogen, phosphorus and potassium were high fertilizers applied as a side-dressing did not increase yields or percentages of sugar. No exceptions to this have been observed. These plots were located on a Brookston clay loam soil and were all fer-

Table 1.—The effect of side-dressing with ammonium sulfate and 0-20-20 fertilizer upon sugar beet yields.

Date of Side-Dressing	Pounds Per Acre Ammonium Sulfate	0-20-20	Tissue Test N	P	K	Yield[1] T/A	Percent[1] Sugar
July 18	200	0	H	H	H	11.8	17.5
July 18	500	400	H	H	H	12.4	16.9
July 18	200	400	H	H	H	11.8	16.9
July 18	500	0	H	H	H	11.8	16.8
July 18 and Aug. 7	200	0	H	H	H	11.1	17.1
July 18 and Aug. 7	500	0	H	H	H	12.3	16.9
July 18 and Aug. 7	200	400	H	H	H	12.3	17.3
July 18 and Aug. 7	500	400	H	H	H	11.4	17.2
No side-dressing			H	H	H	11.6	17.2

[1] No significant difference at 5 per cent level.

tilized uniformly at planting time. The crop previous to sugar beets was two-year-old alfalfa.

The data reported in Table 2 show that nitrogen side-dressing did increase yields in fields where the tissue test for nitrogen was low or blank, but they did not cause an increase in yield in a third field where the test

Table 2.—The effect of ammonium sulfate on the yield of sugar beets which varied in their content of nitrate nitrogen at the time of side-dressing[1]

Pounds Per Acre of Ammonium Sulfate Side-dressed	Ferden Farm[2] Test for Nitrogen	Yield Tons/A	% Sucrose	Rader Farm Test for Nitrogen	Yield Tons/A	% Sucrose	Talladay Farm Test for Nitrogen	Yield Tons/A	% Sucrose
0	B	9.10	19.2	L	7.35	15.0	M	16.6	16.1
200		12.39	19.0						
250								15.3	16.4
375					8.45	15.7			
500								17.7	15.5
L.S.D.—5% level		1.1	N.S.[3]		1.0	N.S.		N.S.	N.S.

[1] Tests for phosphorus and potassium were high.
[2] Crop sequence data—sugar beets after timothy.
[3] N. S.—not significant at 5 per cent level.

was medium at the time the fertilizer was applied. There is a possibility, of course, that a medium test could be followed with a beneficial response to applied nitrogen. If previous tests in the same field were high the medium test could be an indication that the beets were using nitrogen more rapidly than it was being made available in the soil. If this were the case the beets

might later need supplemental nitrogen for optimum growth.

The data shown in Figure 1 indicate the relationship between plant tissue tests and response to side-dressing with nitrogen. These were obtained from the crop sequence results on the Ferden farm in 1948 (6). Various

Table 3.—Sugar beet yields as affected by side-dressings of manganese and potassium and a manganese spray.

	Tons per acre	% Sucrose
Wauseon sandy loam[1]		
Not side-dressed	17.8	18.15
100 pounds $MnSO_4$ side-dressed	22.1	17.8
100 pounds KCl side-dressed	21.0	18.2
Berrien loamy fine sand[2]		
Not side-dressed	10.8	
100 pounds $MnSO_4$ side-dressed	17.8	Not
5 pounds $MnSO_4$ sprayed	16.8	Determined

[1] Side-dressed June 11.
[2] Side-dressed and sprayed August 4.

preceding legumes, legume-grass mixtures, grasses and grains supplied different amounts of nitrogen for the sugar beets. These were reflected in the tissue tests, side-dressing responses and sugar beet yields. Higher tissue tests for nitrogen were accompanied by lower response from side-dressings.

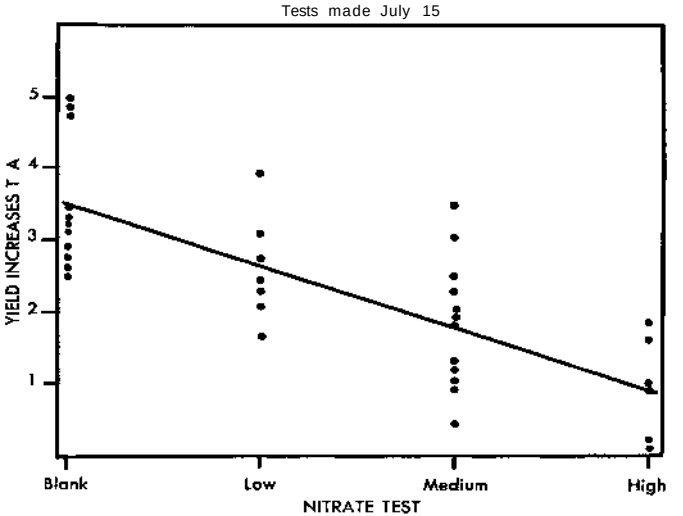
A few instances have been noted in which beets which tested low in nitrate did not respond favorably to an application of nitrogen as a side-dressing. In such cases, the soil had not been managed properly and was not in a desirable physical state. Tissue tests do not indicate this condition and unfortunately there are no dependable rapid tests for the measurement of soil tilth.

Theoretically, nitrogen side-dressings should increase sugar beet yields in many fields, because tissue tests indicate the need for more nitrogen early enough in the season so that it could be supplied. Side-dressing is a more economical way of supplying nitrogen than applying it all at planting time, because a higher percentage of the nitrogen enters the plant when it is supplied at several times during the growing season. Cook and Millar (2) found that only 41 percent of the nitrogen applied at planting time was recovered by the beet, but where the same amount of nitrogen was applied at three times during the growing season 70 percent of the applied nitrogen was recovered. Another factor which shows that side-dressing with nitrogen may be a desirable practice is brought out by the data of Brown and Irving (1). They show that only 15 percent of the total nitrogen used by a sugar beet is required during the first two months of growth.

While no data are reported here to demonstrate that phosphorus applied as a side-dressing to phosphorus-deficient beets will increase yields, Jones (4) has reported success in the northwest. It has been observed, however, that much of the yellowing or "maturing" of the beet leaves after the middle of September is associated with a low tissue test for phosphorus. It could be that higher planting-time rates or side-dressed fertilizer would correct this situation and be reflected in increased sugar beet yields with a higher content of sugar.

Sugar beets are grown largely on the heavier soils in the state and a small amount of potassium in the planting-time fertilizer is usually sufficient. However, where beet tissue tests were low in potassium, a side-dressing of potassium has increased yields, as is shown in Table 3. These beets showed manganese deficiency symptoms and tissue tests showed the beets to be low in

Figure 1-TISSUE TESTS AS RELATED TO INCREASES IN SUGAR BEET YIELDS RESULTING FROM SIDE-DRESSED NITROGEN



potassium. As a result, the beets were side-dressed. Alternate pairs of rows received manganese sulfate and potassium chloride. Each treatment increased the yields significantly.

It is possible to test green leaves for manganese, but the method requires laboratory facilities. There is no rapid field tissue test for this element. By the process of elimination (by testing for other nutrients), and from symptoms of manganese deficiency which are rather specific and easily distinguished, it is usually possible to avoid the necessity of testing for this element.

The fact that manganese sulfate can be applied successfully as a side-dressing or as a spray is shown in Table 3. Such applications, however, should be considered as emergency treatments, as it is better where it is known that manganese is needed to make the application as manganese sulfate in the planting-time fertilizer.

Boron is another nutrient recommended for sugar beets, although there is no satisfactory tissue test to show when this element is needed. For best results this element should be mixed into the planting-time fertilizer. However, this nutrient can be side-dressed as an emergency treatment with success as is shown in Table 4. Unfortunately it was not possible to obtain yields from this field but stand counts on incidence of heart rot demonstrated clearly the effectiveness of side-dressing with borax. Since the demonstration, that particular farmer always includes borax in his sugar beet fertilizer.

Table 4.—The effect of borax side-dressings on incidence of heart rot[1]

Pounds of Borax per Acre	Number of beets Having heart rot per 500 feet of row
0	37.5
7.5	8.7
15.0	0.0
20.0	1.0

[1] Vader farm—Wisner loam—Side-dressed July 11—Counts were made September 15.

Summary

Rapid plant tissue tests can be made in the field to determine the nutrient status of a plant in regard to nitrogen, phosphorus and potassium. With the aid of these tests it is possible to determine with a reasonable degree of accuracy when a crop could use some supplemental plant food.

Plant tissue tests have been used on sugar beets, and where tests have been "high" throughout the growing season no response to side-dressing was indicated by sugar beet yields. On the other hand, when tissue tests were "low" or "blank" for a specific nutrient, side-dressing with the deficient nutrient has invariably increased sugar beet yields, providing all other growth factors affecting sugar beets were near optimum. Nitrogen, potassium, manganese and boron have been side-dressed to sugar beets and the yields have been increased materially with no consistent decrease in sugar content.

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