DEFICIENCY SUMPTOMS AND TISSUE TESTS AS AIDS IN THE PRODUCTION OF SUGAR BEETS

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For some time now the medical world has realized that animals, including man, maintain a normal healthy appearance only as long as the diet contains all of the essential foods. A lack of some essential ingredient causes the animal to develop an abnormal characteristic or appearance. The physician and veterinarian have learned through experimentation that certain appearances are symptoms of nutrient deficiencies. Sometimes it is necessary to perform some physiological test on the patient before the diagnosis is certain.

In like manner those who are dealing with rations for higher plants have come to realize that specific abnormal appearances indicate starvation for certain nutrients. Sometimes to confirm some symptom, it is necessary to make tests on the green tissue. The tests are simple and can be made with the Spurway Simplex Soil Testing Outfit. Instructions for making the tests may be obtained from the Soil Science Department, Michigan State College.

Healthy sugar beets retain their normal green color right up until harvest time or until the foliage is frozen down in the fall. When leaves develop an abnormal color or shape or when the outside, older leaves die, one may be almost sure that the condition is the result of some nutrient deficiency and not just the result of unfavorable weather conditions. It is true that certain moisture and temperature conditions may affect rate of growth and rate of availability of soil nutrients and may thus hasten or delay the appearance of deficiency symptoms, but the sumptoms themselves are not due to the weather. The yellowing of sugar beet leaves, for instance, is almost always the result of starvation for nitrogen, potassium, or manganese. Ther may be instances of yellowing caused by a lack of magnesium but such cases have not as yet been observed in the field. Since the patterns of yellowing vary for the different nutrient elements, it is relatively easy, with a little experience, to tell which one is lacking.

Nitrogen - When sugar beets are grown on soil containing insufficient available nitrogen, they become very light green in color, sometimes almost yellow. There is also a tendency for the leaves to spread out in a direction horizontal with the ground, instead of standing up almost straight as leaves of normal beets should do. Yellowing caused by a deficiency of nitrogen does not develop in any characteristic pattern on the leaves but is simply a gradual fading of the green color from the entire leaf surface.

The green tissue test for nitrate nitrogen is very easy to perform and is a positive measure of the nitrate level in the plant. When a beet is growing in a soil where there is plenty of available nitrogen it takes in more than it really needs. In other words it takes the nitrogen in faster than it can build it into sugar beet tissue. The test measures this excess. If the quantity of available nitrogen in the soil is so limited that the plant is being starved, the plant uses the nitrogen as fast as it

enters the roots and thus the test is blank. The reagent used in the test detects only the nitrogen in the soluble form in which it enters the plant.

It is only necessary to place a drop of the nitrate reagent (Number 2 in the Simplex kit) on a freshly cut surface of the leaf petiole. If a blue color developes, nitrate is present. If the solution turns brown, nitrate is absent and one concludes that the plant was that day starving for nitrogen. The tissue tests measure only the conditions existing at the time the test is made.

Nitrogen may be purchased as commercial fertilizer or may be obtained by the growing of such leguminous crops as alfalfa, clover, or sweet clover. Alfalfa is the best soil building legume. The writer has made it a practice, while traveling in sugar beet growing areas during the late summer, to observe the color of sugar beet foliage and make tissue tests for nitrogen. Invariably, yellow or light green leaves have been found to test low in nitrate nitrogen. In most cases, information from the farmers revealed the fact that alfalfa had not been grown on those fields for several years. It was generally found that dark green beets testing high in nitrogen were separated from an alfalfa crop by a period of not more than one year.

At the Ferden experimental farm in Saginaw County and in pots in the greenhouse it has been shown repeatedly, year after year, that sugar beets following alfalfa resemble, in color and in content of soluble nitrogen, those which receive large quantities of soluble nitrogen fertilizer.

Phosphorus - When sugar beets are lacking in phosphorus they present in early growth a striking contrast to those which are starved for nitrogen. Phosphorus deficient beets have small leaves which during the early stages of growth stand very erect and are very dark green in color. If the deficiency is very severe the edges of the leaves may be fringed with purple. The dark green color is due to excess nitrogen which accumulates in the leaves when the growth is depressed from lack of phosphorus. Thus if the beets in a certain field seem to be growing slowly but the color is good, phosphorus deficiency should be the first consideration. This is especially true if the field seems spotted with scattered beets larger and lighter in color. In the case of such beets the phosphorus test on the green tissue should be low and the nitrate test should be high. The potassium test is generally high in such cases, but it isn't necessarily so.

Where the supply of available nitrogen in the soil is excessive and phosphorus is plentiful enough to carry the beets along until mid-season, the final exhaustion of the phosphorus may be indicated by a yellowing of the beet leaves. This results in an appearance very similar to nitrogen starvation but confusion may be avoided by use of the tissue test for nitrate nitrogen.

Potassium - This element is used by sugar beets in rather large quantities. A deficiency shows up first as a yellowing of the tips and edges of the older leaves, those at the outer edge of the crown. As the deficiency develops the inner leaves become affected and the older leaves become almost completely yellow while the tips and edges turn brown. After that

the leaves soon die. It is not uncommon to find dead leaves around the edges of sugar beets during late summer and early fall. A lack of potassium may be the cause of such a condition. Maximum yields are not obtained where such conditions exist.

Manganese - A shortage of this so called, minor element may also cause yellowing of sugar beet leaves. The deficiency occurs on soils which are neutral to alkaline in reaction, and is seldom observed on soils more acid than pH 6.5. Most of the sugar beets are grown on soils having a pH above 6.5.

Manganese deficiency of sugar beets becomes most noticeable in mid-summer, after the beets have made considerable growth. The leaves turn yellow between the veins, with the veins remaining green. A mottled appearance is the result. Sometimes the mottling is not apparent. In that case the deficiency very closely resembles that of nitrogen and it is necessary to resort to the tissue test to avoid confusion.

A deficiency of manganese may be avoided by applying a fertilizer containing manganese sulfate or by spraying the beets with manganese sulfate in solution in water at the time the symptom first appears. An application of 5 pounds per acre as a spray is probably sufficient, whereas it is advisable to use 25 to 50 pounds per acre if applied in the fertilizer.

Boron - Sugar beets are very sensitive to a deficiency of boron. A lack of this element results in the breakdown and death of the growth tissue in the center of the crown. The resulting condition has been called heart rot. In fact it was called heart rot disease long before anyone realized the cause to be a lack of boron rather than the work of some disease organism.

There are several very distinct boron deficiency symptoms but they do not all occur on the same plants. The most commonly observed, perhaps, is the dead heart. There appears to be a tendency for the beet to try to cover up the dead heart with new leaves and secondary crowns which develop around the edge of the old crown. These new leaves remain small and are often abnormal in shape. They seem to grow faster on one side than on the other which causes them to bend toward the side of slowest growth. The upper, concave side of the petioles sometimes develop cross cracks, a sure sign of boron starvation, but not evident in all cases. There is a tendency for the leaves to be darker green than normal and to spread out horizontal with the ground, in a manner similar to that already discussed as a symptom of nitorgen deficiency. The color, however, is dark green rather than light green.

The roots of boron deficient beets gradually disintegrate and turn black. The breakdown of the tissue develops from within and may occur in beets which have not disintegrated at the heart and which do not show leaf symptoms. In such cases boron deficiency is not suspected until the beet is lifted. The broken down tissue may extend out through the epidermis to form an external canker or it may develop only within the flesh of the beet and not be visible until the beet is sliced.

Boron deficiency is most serious on soils which are alkaline in reaction. However the crop is so sensitive to a deficiency that one should play safe and include borax in the fertilizer for all sugar beets. Where the fertilizer is applied in bands beside the seed, the rate of application should be 10 pounds of borax per acre. If the fertilizer is placed directly

with the seed there is a possibility of injury so it is advisable in that case to hold the application down to 7 or 8 pounds per acre. As is the case also with manganese sulfate, fertilizers may be purchased, upon special order, with borax already mixed in.

Calcium - Greenhouse experiments have shown that sugar beets need a constant and plentiful supply of calcium. A deficiency results in the death of the new leaves. While positive evidence of this deficiency is lacking in the field, it is known that beets do not thrive on acid soils. Perhaps calcium starvation, which is possible on such soils, may be one of the reasons.

Summary

Sugar beets should retain their normal green color and all their leaves until harvest time or until the tops are frozen down. When the leaves develop abnormal colors and shapes and the older leaves die, there is a strong possibility that the condition is due to a deficiency of one or more nutrients.

Deficiencies of the various nutrients affect the beets in different ways. The symptoms are so distinct and definite for different elements that it is possible to tell from the appearance what element is most seriously lacking. Tests on the green tissue are sometimes necessary to confirm the conclusion drawn from the symptom.

One thing is certain, yellowing of sugar beet leaves, in various shades and patterns, is not "just due to the weather" but is due to a lack of one or more nutrient elements in the soil. The aim of the agronomist and the farmer is to be able to tell which elements are lacking in order that the condition may be corrected. By so doing a healthy and heavy yielding crop may be grown.