Sugar Beet Leaf Analysis Survey in Five Western States

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During the past 25 years plant analysis has become increasingly important in the study of nutritional problems. The present day approach to plant analysis is concerned with the nutritional status of the plant itself, while the earlier concept of its use as a biological method of soil analysis has been virtually abandoned. Soil tests, whether biological or chemical, attempt to simulate the ability of the plant roots to utilize the nutrient elements in the soil. The value of soil analysis should not be minimized, but it would seem logical to believe that the plant itself is the best judge of what is, or is not, available. The nutrient concentration in the plant is an integrated value of all outside influences, including the supplying power of the soil.

Time does not permit a discussion of the fundamentals involved in the use of foliar diagnosis, but a few elementary considerations should be mentioned. Sampling techniques, such as the portion of the plant, and the stage, or stages, of growth which most clearly reflect the nutrient level in the plant can be determined by means of controlled pot tests. A preliminary estimate of the "critical nutrient level" for any given element and crop may also be obtained by this method. The "critical nutrient level" might be defined as the concentration of the nutrient in the plant at which growth is restricted as compared to plants of a higher concentration. The establishment of "critical levels" for the various elements applicable to field conditions will result only from field fertilizer trials.

Numerous practical applications of plant analysis techniques have been made by research workers in the study of soil fertility problems. Some of these applications include:

1. Nutrient absorption in fertilizer test plots.

Fertilizer test plots have often shown "no response" due to the use of inadequate amounts, or improper placement of the materials being tested, and reflect the inability of the plant to utilize these elements, rather than the lack of a deficiency or deficiencies. A study of the nutrient levels in the plant will indicate whether or not the materials applied are being absorbed by the plant.

2. Identification of visual deficiency or toxicity symptoms.

Symptoms now associated with potassium deficiency of plums, grapes, tung, tomatoes, etc., were first suggested by analysis of plant material. This method was also used in identifying sodium excess symptoms on a number of deciduous fruits in California. Analysis of plant material also aid materially in distinguishing spray or insect injury from similar appearing deficiency symptoms.

3. **Maintenance of soil fertility.**

In tree crops, deficiencies found through the use of leaf analysis, or visual symptoms, can be corrected by appropriate fertilizer applications. However, in annual crops, such as sugar beets, the discovery of a deficiency by means of plant analysis does not insure that the condition can be profitably corrected in the current crop. In cases where the concentration **of a**

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nutrient is found to be deficient in the present crop, changes in the fertilizer practices on succeeding crops should be considered.

4. Leaf analysis surveys.

The use of a plant nutrient survey offers an excellent opportunity for the intelligent selection of sites for fertilizer test plots. An extensive survey covering a wide area or set of conditions will result in the location of the sections which are low in one or more of the three main nutrients These districts can then be sampled intensively, and fertilizer plots established on the fields which offer the best chance for response.

Sugar Beet Survey Procedure

From 1946 through 1950, approximately 1,500 sugar beet leaf samples were collected from 35 districts in Colorado, Montana, Wyoming, Idaho and Oregon. In most cases, two series of samples were collected from the same fields during the season, one at mid-season and the second at harvest time. The sampling and analytical techniques developed by Dr. Albert Ulrich, University of California, Berkeley, were followed in this work.

Table 1.—Mid-Season Samples.

	PPM NO_3-N	PPM PO_4-P	Percent K
Low	0-1,000	0-1,000	0-2.00
Medium	1,001-4,000	1,001-2,000	2.01-6.00
High	4,001 plus	2,001 plus	6.01 plus

The survey was conducted on an extensive basis, which means that one or two samples were collected, at each sampling time, from a number of low, medium and high producing fields in each district. Thus, the results represent the general fertility level in each of the districts sampled, rather than that of the individual fields. An intensive survey wherein a number of samples are collected from each field will be necessary before the nutrient status of individual fields can be determined.

Table 2.—Harvest Time Samples.

	PPM NO_3-N	PPM PO_4-P	Percent K
Low	0- 500	0- 500	0-2.00
Medium	501-2,000	501-1,500	2.01-4.00
High	2,001 plus	1,501 plus	4.00 plus

A sugar beet leaf analysis survey of the Arkansas Valley in Colorado was conducted in 1946 in cooperation with the Holly Sugar Company and American Crystal Sugar Company research and field staffs and the Agronomy Department of Colorado A *8c* M. In 1947 samples were collected in the Utah-Idaho, Holly and Great Western Sugar Company territories of Montana and Wyoming. During 1948 and 1949 the work was confined to districts previously sampled, with the addition of a limited survey of the Amalgamated Sugar Company areas in Oregon and Idaho. In 1950, survey samples were obtained only from the Idaho and Oregon sugar beet growing sections.

Discussion of Results

In tabulating the data, a number of districts with the same general geographic location are included in each of the 7 regions listed. For example, there are 6 districts included in northern Montana, while eastern-southern Montana represents five districts. The percentage of samples which fall in each of the three nitrate, phosphate and potassium ranges is presented for both the mid-season and harvest time set of samples in Xables 1 and 2.

The "critical nutrient levels" of nitrates, phosphates and potassium have not been determined for sugar beets grown in the areas sampled. On the basis of past sugar beet leaf analysis work in California, the ranges listed in Tables 1 and 2 have been chosen as representing low, medium and high concentrations of nutrients at the two sampling periods.

NITRATE-NITROGEN IN SUGAR BEET LEAF SAMPLES

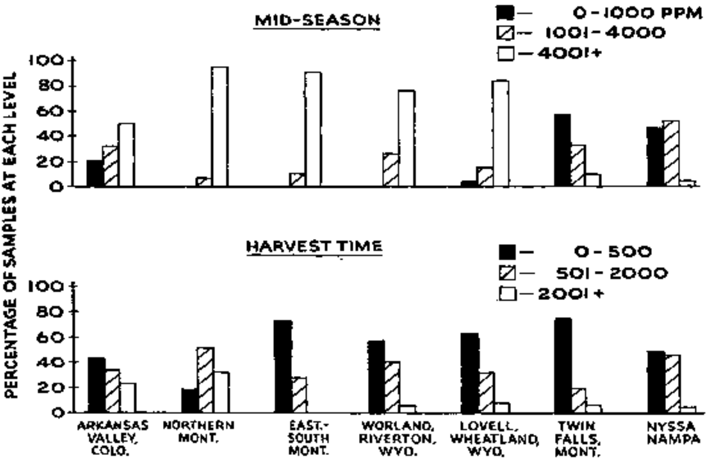

Figure 1.

Nitrate-Nitrogen Levels in Survey Samples

The nitrate-nitrogen results in Figure 1 show clearly that there is a wide variation in the concentration of this nutrient in the various regions sampled. Mid-season levels were lowest in the Twin Falls area with 57 percent of the samples falling below 1,001 ppm. NO_3-N, followed by Nyssa-Narapa with 45 percent and the Arkansas Valley with 20 percent. At this time, the fields sampled in both Montana and Wyoming appeared to be adequately supplied with nitrogen. Judging only from the mid-season figures, there would be an excellent chance for a nitrogen response in half of the Twin Falls and Nyssa-Nampa fields, with little or no possibility of a response in either Montana or Wyoming.

The second series of samples indicated that the nitrogen supply in some of the areas, which had appeared to be ample at mid-season, had become exhausted by, or prior to, harvest time. This drop in nitrate levels was especially marked in the eastern-southern Montana and Wyoming districts. In these districts which had shown high mid-season concentrations, more than 50 percent of the samples contained less than 500 ppm. NO_3-N at harvest time. With the exception of northern Montana, the harvest time nitrate levels would suggest that fertilizer experiments, using nitrogen materials, would be justified in more than half of all the fields sampled.

The use of leaf analysis in test plot work and an accompanying survey of the surrounding area will be of immeasurable value in estimating the

PHOSPHATE-PHOSPHORUS IN SUGAR BEET LEAF SAMPLES

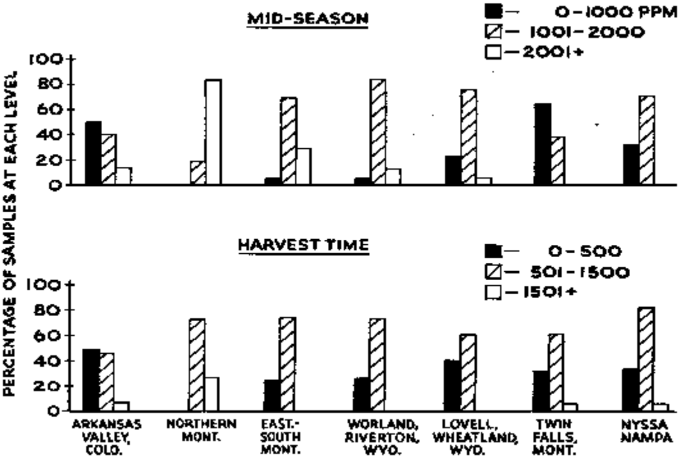

Figure 2.

percentage of fields represented by the test plot. For example, a fertilizer plot showing a nitrogen response at a mid-season leaf level of 1,000 ppm. NO_3-N would be representative of 57 percent of the fields in the Twin Falls area, and only 3 percent of the fields in the Lovell-Wheatland districts.

Phosphate-Phosphorus Levels in Survey Samples

As with nitrate-nitrogen concentrations shown in Figure 2, there were marked differences in the phosphate-phosphorus levels in the seven regions sampled. At mid-season, 63 percent of the samples from Twin Falls and 49 percent of the samples from the Arkansas Valley fell in the low range. The leaf levels indicated that phosphorus supplies were adequate, at this time, in the Montana and Worland-Riverton Wyoming districts.

The drop in phosphorus levels from mid-season to harvest time was most evident in the eastern-southern Montana and Wyoming areas. For example, 21 percent of the samples were below 1,001 ppm. PO_4-P at mid-season and 40 percent below 501 ppm. at harvest time at Loveil-Wheatland.

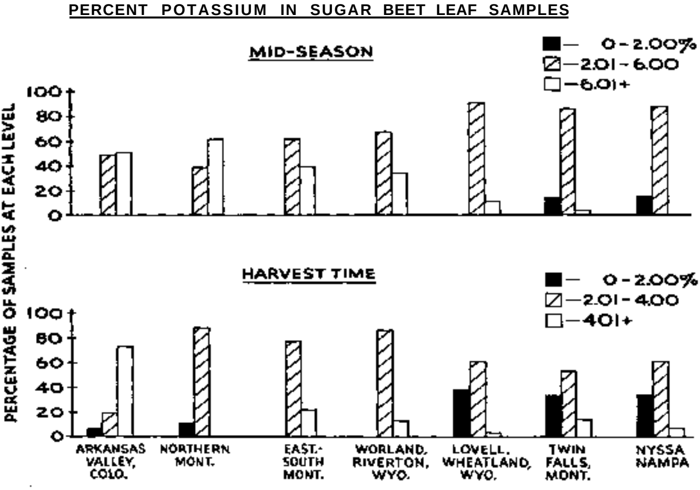

Figure 3.

The second series of samples from Idaho and Oregon is of special interest as the data indicate that the phosphorus-supplying power of the soil holds up late in the season.

The leaf survey data show that two distinct conditions occur in the phosphorus status of sugar beets grown in the areas sampled.

1. In some sections there is rapid depletion of the phosphorus reserves in the soil late in the season. The mid-season levels in the plant may or may not be low.

2. In other areas, with medium or low mid-season values, the decrease late in the season is slight.

Potassium Levels in Survey Samples

Past fertilizer test plots in the areas leaf sampled have suggested as shown in Figure 3 that the potassium-supplying power of the soils was adequate for the growing of sugar beets. Xhe leaf concentration in most of the samples confirms the results of the past fertilizer tests. However, there are sections in which further potassium trials would be in order.

The only areas showing values of less than 2.00 percent K were in Oregon and Idaho. Approximately 12 percent of the samples were below this level at mid-season. Even in these areas, if the usual method of selection of sites for field plots was followed, there would be only one chance in ten that a field low potassium would be included.

The leaf levels of potassium dropped sharply late in the season in the Lovell-Wheatland districts, with 38 percent of the samples below 2.00 percent K at harvest time. At this time, about one-third of the fields were low in potassium in Idaho and Oregon, and the role of this nutrient should receive further attention in further fertilizer test plots in these areas.

Summary

1. The extensive sugar beet plant analysis survey demonstrated that there is a wide variation in the nitrogen, phosphorus and potassium concentrations in the seven regions sampled.

2. Intensive leaf analysis surveys could be used to advantage in the location of sites for future fertilizer test plots.

3. Further test plot and leaf analysis studies, using nitrogen and phosphorus fertilizers, would be justified in six of the seven regions sampled, while potassium may be a problem in three of the regions.

4. The use of leaf analysis techniques in conjunction with a thorough fertilizer test plot program will aid in determining more accurate "critical levels" for nitrogen, phosphorus and potassium.

5. As "critical nutrient levels" are established on various crops, it will be possible to predict the needs of succeeding crops by analyzing plant samples from the current crops.