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LEAF TISSUE ANALYSES IN THE FERTILITY PROGRAM

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Abstract. **There are a number of questions to be considered in including leaf tissue analyses in a fertility program. Possibly the three main questions are: (1) How can I personally use it? (2) Of what value will it be to my operation? (3) Is the cost justified?**

Data are presented of instances where leaf tissue analyses have been included in various programs showing improper fertilizer placement, lack of magnesium in tissue although soil analyses indicated sufficient amounts, micro-element deficiencies and boron toxicity.

Most fertility programs are based on information gathered by the production manager from a variety of sources. These sources may be other production managers, University recommendations, and various types of consultants to include fertilizer salesmen, private consultants and people noted in this field.

In addition, soil analysis is a technical aid used by the production manager in his fertility program to keep the soil reaction and cerain nutrients within a desired range. Likewise, leaf tissue analysis also can be used as a technical aid in a fertility program. It does not replace soil analysis, and its greatest advantage is being a form of measurement in areas that cannot be seen visibly. The main disadvantage is that in its present form it is of little value to the crop on the tree at time of sampling.

The present standard ranges of leaf tissue values are the work of many researchers. A publication by Reuther and Smith (5) and later revised by Smith (6) discussed the different factors affecting the results of leaf tissue analyses, and included tables of the various nutritional ranges. Chapman (2) compiled his earlier work into a manual in 1960. Most of these works were related to the spring flush, but varied with fruiting and non-fruiting terminal sampling. More recently, Embleton *et al* (3) compiled most of the work to date. A review of these cited works should be made by anyone attempting to interpret results from leaf tissue analyses.

Data presented in this paper are not from tagged flushes which Anderson (1) found to give more exact data. With the use of tagged flushes more reliability can be placed on the contents of calcium and potassium in relation to age.

Assuming the production manager has the correct samples and analysis, he can personally use leaf tissue analysis to determine the nutritional status of his grove, the need for adjustments in his fertility program, to investigate problem areas, and to become aware of how his grove feeds. It is an aid that can be used in conjunction with soil analysis and experience.

If a grove or area is suffering from too much water, too little water, disease or some other problem that cannot be related to nutrition, it is doubtful that leaf tissue analysis will be of value. Results from many of these groves will give data that appear normal but the visual condition of the grove contradicts this conclusion. Therefore, judgement must be used in determining its value in each situation and in making interpretations against better judgement.

The first step in the use of leaf tissue analysis is to establish sampling sites within the grove. The site may consist of 10 to 20 trees in a line perpendicular to the direction in which the grove is fertilized. These trees should represent the condition of the majority of the trees within the grove and they should be sampled each year. At times, information can be obtained from the first year sampling, but usually basic trends need to be established and this can only be accomplished with sampling over a period of years.

The total number of sampling sites will depend on the extent to which the data will be used. If the production manager only wants to check his fertility program he need only establish enough sites to give him adequate coverage of his area. In addition, he will probably include sites in problem areas or in varieties that have different nutritional requirements, such as the Murcott. He should consider the size of the grove, soil differences, past history, and how the grove is managed.

If each block is going to be considered individually and pushed for maximum production, then each block should be sampled. This data is used along with yield per block, irrigation and rainfall, soil analysis, tree count, etc., to examine the performance of the block. It should be stated again that data from one year will probably be of little value.

Therefore, the area represented by a sampling site is variable and may extend from less than 20 up to 200 acres, or possibly more.

It is noted in the nutrient range table (4) that there is a range for each element. The manner in which a grove is taken care of, the amount and time of fertilization, irrigation, etc., usually determines where leaf tissue values will fall with respect to this range. Many years these values will be approximately the same as previous years, but there are exceptions which appear to be due largley to crop size.

Table 1 shows two growers from the ridge area, Grower A and Grower B, with different views on fertilization. What would happen if a bumper crop year should come along?

If each continued yearly with the same program, the grower with the higher potassium values would have a grove with better nutrient status; although, at present his values appear to be a little too high. But, if the grower with the lower potassium recognizes that he has a bumper crop, and applies additional potassium early in that crop year, he probably can maintain a nutritional status within the satisfactory range. This effect on yield and lowering of potassium leaf tissue values due to the heavy crop are illustrated in Table 2. This holds true for nitrogen, but since it does not have the requirement of needing to be applied early in the season, it may not always be recognized.

Since a potassium problem is probably the most difficult

Table 1. Content of leaves from groves with various nutritional conditions.[z]

	Ca %	Mg %	N %	P %	K %	B ppm
Grower A	3.29	0.46	3.08	0.16	2.30	133
	3.87	0.40	2.79	0.12	2.23	138
	3.35	0.48	2.92	0.14	2.08	160
Grower B	3.85	0.36	2.48	0.13	1.19	75
	3.94	0.36	2.37	0.11	1.18	66
	3.66	0.42	2.64	0.13	1.12	54
Grower C (1)	3.50	0.32	2.69	0.12	1.57	280
	3.20	0.38	2.63	0.12	1.47	250
	3.30	0.38	2.54	0.13	1.20	332
(2)[y]	3.35	0.48	2.92	0.14	2.08	160
	4.28	0.52	2.75	0.13	1.91	160
	3.35	0.51	2.87	0.17	1.84	128
Grower D (1)	4.80	0.43	1.58	0.29	1.16	52
	4.20	0.47	1.86	0.27	1.40	90
	5.40	0.64	2.51	0.17	0.68	69
(2)[y]	4.0	0.30	2.35	0.15	1.11	120
	4.10	0.35	2.32	0.15	1.13	120
	4.00	0.45	2.85	0.09	0.92	98
Grower E Leaf	3.80	0.27	2.27	0.12	1.01	90
	3.80	0.29	2.51	0.14	1.32	97
	3.90	0.29	2.51	0.14	1.26	87
Soil	pH	lbs/A[x]				
7.0	1608	209	—	54	38	—
7.4	3260	204	—	72	38	—
7.2	2520	247	—	99	43	—

[z]Dry weight basis.
[y]Data from the following year.
[x]lb/A = 1.12 K/ha.

to distinguish visually, leaf tissue analysis is of great value in monitoring this element.

It should be again noted that since leaf tissue is sampled later in the year, it cannot be used as an aid for that fruit year. In the case illustrated, it shows what should have been done, or if the action taken was corret. Therefore it makes one aware of the feeding habits of his trees. Probably the Murcott is the variety that drastically illustrates the feeding habit of a tree with respect to crop produced.

By keeping yearly leaf tissue results along with production records a fertility program can be examined to see if adjustments could help your production. There also may be individual problems with elements other than potassium which need to be investigated.

Boron can be placed in the fertilizer or spray application, and if applied in both, quantities in the leaves similar to these of Grower C in Table 1 may be obtained. This grower previously had a problem with boron deficiency and wanted to be sure he did not have the same problem again. He is not far from the 300 to 500 ppm range associated with boron toxicity. By leaving boron out of his program the following year his values were lowered as shown below in the same table.

Grower D in Table 1 knew he had a problem but discarded nitrogen since he had applied an adequate amount. His liquid applicator was adjusted so that nitrogen was applied to only within three feet of the leaf drip. In the sandy area roots were forced by drought conditions to grow to the bottom of the furrow between beds seeking moisture; therefore, roots of this area were in contact with the fertilizer. The increased phosphorus content under these nitrogen deficiency conditions was noted in the previous cited references (3, 5, 6). Placement of nitrogen under the leaf drip the following year corrected the problem as shown.

Other areas where leaf tissue analyses have been useful were in groves with dolomite being the only source of magnesium, (Grower E) Table 1, or in groves where the antagonistic effect of calcium is evident. Under these conditions the pH is usually high and soil test values for magnesium are in the range considered well above adequate, or high.

Of the metal micro-nutrients, manganese is probably the one most often found low, followed by zinc. At times, they may be in the upper deficient range without showing visual symptoms. And with copper it is very difficult to get a true value unless it has not been used in the spray program.

The cost per sample for leaf tissue analyses is high, but when calculated on a per acre basis it may be relatively low, usually ranging from $0.10 to $1.00 per acre, depending on the purpose of the program. It takes very little to justify this cost.

In summary, Leaf tissue analyses can be an aid to the production manager when used in conjuction with soil analysis and experience. Samples should be collected from the same trees each year, and collected over a period of years to show basic trends in the fertility program. In interpreting the results, crop size is very important, and it is very difficult to see how the cost could not be justified.

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Table 2. Effect of yield on potassium content of leaf tissue at different potash levels.

	Applied K_2O (lbs/A)[z]							
	50		100		150		300	
Year	Yield Boxes/A	Leaf % K	Yield Boxes/A	Leaf % K	Yield Boxes/A	Leaf % K	Yield Boxes/A	Leaf % K
1972-73	297	0.65	414	0.88	398	0.95	482	1.16
1973-74	209	—	311	—	292	—	303	—
1974-75	284	0.71	317	1.17	313	1.53	310	1.80
1975-76	246	0.69	288	1.10	298	1.42	306	1.75
1976-77	308	0.42	434	0.69	529	0.80	502	1.24

[z]lb/A = 1.12 K/ha.