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# LEAF ANALYSIS SURVEY OF AVOCADO GROVES IN FLORIDA

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In recent years the use of chemical analyses of leaves to determine the nutritional and fertilizer needs of fruit trees has become widespread. In Florida, this method is being used frequently with citrus but so far little work of this type has been done on avocado.

Many studies have been made in California to determine the relationship between nutrient element levels in avocado leaves, fertilizer applications, and growth and yield of the trees (1, 2, 3, 4, 5, 6, 8, 9). In Israel normal nutrient levels in the leaves of avocados have been determined as a beginning toward diagnosing nutritional needs (10). Considerable work has also been done in Florida by Harkness on leaf analysis and the factors affecting alternate bearing (7). The present survey was made to determine normal levels of major nutrient elements in avocado leaves in commercial groves in Florida. It is hoped that this information can be used as a tool in diagnosing nutritional disorders and also as a beginning for a study of the fertilizer economy of the trees.

In late May and early June of 1960, leaf samples were collected from 25 avocado groves, representing the major commercial producing areas of Florida. Where possible, samples were taken from three varieties in each grove, namely Waldin, Booth 8, and Lula. These represent early, midseason, and late varieties, and are also the three most important commercial varieties in Florida. Five mature leaves, which had expanded. during the March flush of growth, were taken from each of five trees and combined to make each sample. The petioles were removed, and then the leaf blades were washed, dried, ground, and analyzed for nitrogen, phosphorus, potassium, calcium, and magnesium. Nitrogen was determined using the Kjeldahl method. Phosphorus was determined colorimetrically with the vanadate method.

Table 1. Avocado leaf analyses - 1960.

| Grove No. and soil type | N | | | P | | | K | | | Ca | | | Mg | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rockdale | Wald | B-8 | Lula | Wald | B-8 | Lula | Wald | B-8 | Lula | Wald | B-8 | Lula | Wald | B-8 | Lula |
| 1 | 1.64 | 1.44 | 1.92 | 0.17 | 0.22 | 0.18 | 1.26 | 1.34 | 1.31 | 0.77 | 0.71 | 0.80 | 0.21 | 0.22 | 0.18 |
| 2 | -- | 1.62 | 1.50 | -- | 0.19 | 0.16 | -- | 1.12 | 1.15 | -- | 1.08 | 0.93 | -- | 0.25 | 0.20 |
| 3 | 1.62 | 2.04 | 1.84 | 0.17 | 0.18 | 0.19 | 1.18 | 1.19 | 1.60 | 0.79 | 1.21 | 1.11 | 0.20 | 0.27 | 0.29 |
| 4 | 1.67 | 1.64 | 1.34 | 0.15 | 0.19 | 0.18 | 1.14 | 1.08 | 1.04 | 1.16 | 0.84 | 1.74 | 0.22 | 0.23 | 0.27 |
| 5 | -- | 1.58 | 1.64 | -- | 0.20 | 0.15 | -- | 1.19 | 1.06 | -- | 1.03 | 0.97 | -- | 0.27 | 0.23 |
| 6 | 1.69 | 1.77 | 1.56 | 0.17 | 0.18 | 0.15 | 1.15 | 0.97 | 1.10 | 0.86 | 1.67 | 1.12 | 0.19 | 0.36 | 0.25 |
| 7 | -- | 1.62 | 1.77 | -- | 0.20 | 0.18 | -- | 1.32 | 1.25 | -- | 1.26 | 0.73 | -- | 0.31 | 0.22 |
| 8 | -- | 1.46 | 1.42 | -- | 0.19 | 0.17 | -- | 1.41 | 1.19 | -- | 1.05 | 0.82 | -- | 0.23 | 0.18 |
| 9 | -- | 1.40 | 1.50 | -- | 0.20 | 0.18 | -- | 1.19 | 1.38 | -- | 0.98 | 0.94 | -- | 0.25 | 0.28 |
| 10 | 1.82 | 2.24 | 2.20 | 0.20 | 0.20 | 0.18 | 1.46 | 1.51 | 1.48 | 0.96 | 1.34 | 1.26 | 0.25 | 0.29 | 0.29 |
| 11 | 1.77 | 1.92 | 1.72 | 0.15 | 0.24 | 0.18 | 1.26 | 1.56 | 1.66 | 1.02 | 1.01 | 1.38 | 0.38 | 0.24 | 0.27 |
| 12 | -- | -- | 1.58 | -- | -- | 0.18 | -- | -- | 1.35 | -- | -- | 0.96 | -- | -- | 0.22 |
| 13 | 1.72 | -- | -- | 0.19 | -- | -- | 1.56 | -- | -- | 0.94 | -- | -- | 0.30 | -- | -- |
| 14 | 1.80 | 1.92 | 1.90 | 0.15 | 0.17 | 0.18 | 1.28 | 1.33 | 1.46 | 1.28 | 1.47 | 1.05 | 0.30 | 0.38 | 0.25 |
| 15 | 1.62 | 2.07 | 1.62 | 0.17 | 0.20 | 0.13 | 1.27 | 1.38 | 1.42 | 0.99 | 1.02 | 3.00 | 0.31 | 0.29 | 0.40 |
| 16 | -- | 2.13 | 1.92 | -- | 0.18 | 0.16 | -- | 1.25 | 1.12 | -- | 1.79 | 0.93 | -- | 0.39 | 0.27 |
| 17 | 1.92 | 1.98 | 1.95 | 0.14 | 0.18 | 0.13 | 1.09 | 1.21 | 1.32 | 1.74 | 1.42 | 2.13 | 0.36 | 0.35 | 0.40 |
| 18 | 1.74 | 1.87 | 1.62 | 0.17 | 0.13 | 0.14 | 0.95 | 1.00 | 1.12 | 1.14 | 1.59 | 0.92 | 0.27 | 0.35 | 0.25 |
| 19 | 1.92 | 1.96 | 1.87 | 0.16 | 0.19 | 0.17 | 1.07 | 1.20 | 1.35 | 2.19 | 1.51 | 1.80 | 0.41 | 0.35 | 0.36 |
| 20 | -- | 1.95 | 1.64 | -- | 0.19 | 0.13 | -- | 1.20 | 1.32 | -- | 1.33 | 1.88 | -- | 0.32 | 0.35 |
| 21 | -- | 1.80 | -- | -- | 0.13 | -- | -- | 1.63 | -- | -- | 1.65 | -- | -- | 0.39 | -- |
| 22 | -- | 1.62 | 1.50 | -- | 0.17 | 0.14 | -- | 1.34 | 1.12 | -- | 1.18 | 1.03 | -- | 0.33 | 0.25 |
| Lakeland | | | | | | | | | | | | | | | |
| 23 | -- | 1.92 | 2.20 | -- | 0.14 | 0.22 | -- | 1.33 | 1.97 | -- | 0.88 | 0.48 | -- | 0.36 | 0.29 |
| 24 | -- | 1.90 | 1.92 | -- | 0.15 | 0.21 | -- | 1.33 | 0.76 | -- | 0.52 | 1.57 | -- | 0.33 | 0.44 |
| Muck soil | | | | | | | | | | | | | | | |
| 25 | 1.82 | 1.92 | 1.82 | 0.17 | 0.16 | 0.18 | 1.40 | 0.87 | 1.08 | 0.59 | 0.85 | 1.08 | 0.33 | 0.32 | 0.36 |
| Avg. | 1.73 | 1.79 | 1.75 | 0.17 | 0.18 | 0.17 | 1.24 | 1.26 | 1.29 | 1.16 | 1.19 | 1.24 | 0.28 | 0.31 | 0.28 |

Table 2. Average leaf analysis compared with crop size

| Crop size | No. of groves | N % | P % | K % | Ca % | Mg % |
|---|---|---|---|---|---|---|
| None | | | | | | |
| Waldin | 1 | 1.82 | 0.17 | 1.40 | 0.59 | 0.33 |
| Booth 8 | 6 | 1.60 | 0.17 | 1.29 | 1.11 | 0.31 |
| Lula | 1 | 1.50 | 0.18 | 1.38 | 0.94 | 0.28 |
| | Avg. | 1.64 | 0.17 | 1.36 | 0.88 | 0.31 |
| Light | | | | | | |
| Waldin | 6 | 1.75 | 0.17 | 1.24 | 1.23 | 0.29 |
| Booth 8 | 9 | 1.97 | 0.18 | 1.27 | 1.30 | 0.33 |
| Lula | 4 | 1.83 | 0.17 | 1.39 | 0.82 | 0.26 |
| | Avg. | 1.85 | 0.17 | 1.30 | 1.12 | 0.29 |
| Medium | | | | | | |
| Waldin | 3 | 1.68 | 0.16 | 1.26 | 1.13 | 0.27 |
| Booth 8 | 7 | 1.67 | 0.19 | 1.22 | 1.12 | 0.28 |
| Lula | 7 | 1.83 | 0.17 | 1.29 | 1.57 | 0.33 |
| | Avg. | 1.73 | 0.17 | 1.26 | 1.27 | 0.29 |
| Heavy | | | | | | |
| Waldin | 3 | 1.74 | 0.15 | 1.14 | 1.23 | 0.26 |
| Booth 8 | 1 | 2.04 | 0.18 | 1.19 | 1.21 | 0.27 |
| Lula | 11 | 1.68 | 0.16 | 1.24 | 1.22 | 0.26 |
| | Avg. | 1.82 | 0.16 | 1.19 | 1.22 | 0.26 |
| Grand Average | | 1.76 | 0.17 | 1.28 | 1.12 | 0.29 |

Potassium, calcium, and magnesium were determined with the flame photometer.

The results of the analyses are presented in Table 1. In general all of the nutrient levels determined were normal or high in comparison with data obtained in California. Studies by Embleton *et al.,* (4) indicate that for optimum bearing in the Fuerte avocado, the nitrogen level in the leaves should be between 1.6 and 2.0 per cent. The average nitrogen value of Florida leaves was in this range and was almost identical to the

average nitrogen value found by Oppenheimer *et al.,* (10) in Israel. Several of the groves had nitrogen levels a little below this and perhaps could profit by increasing the amount of nitrogen applied. The phosphorous levels in the Florida leaves were all normal or high as compared with levels which have been found to be adequate by Embleton *et al.,* (3) in California. Work by Embleton *et al.* (3) showed that phosphorus levels in the leaves could be as low as 0.10 percent and still no response could be obtained by addition of phosphate in fertilizers. The mean value of phosphorus found in avocado leaves in Israel (10) was 0.12 per cent, which is also considerably below the values found in Florida. The potassium level was similar or slightly higher than levels found in California by Embleton *et al.,* (3) and Fulmer (6). A comparison of the calcium contents must take into consideration the soil and the age of the leaves. Harkness (7) has shown that on alkaline Rockdale soils the calcium content will vary from 0.5 per cent to more than 4 per cent depending on the age of the leaves. Studies by Embleton *et al.,* (3) show that on slightly acid soils the calcium content will also increase as the age of the leaf increases but the maximum value will be less than 2 per cent. On the alkaline Rockdale soils, calcium content appears to give a good indication of the age of the leaves, so on this soil other constituents can be compared on the basis of leaves of equal calcium content. The data in Table 2 were all from comparatively young leaves so the calcium values were similar to those found in California (3) and somewhat lower than found in Israel (10).

Magnesium also increases with the age of the leaves so the values in Table 2 were no more than half the maximum possible. The values found were well within the normal range as determined by Bingham (1) for the Hass variety. He has found magnesium deficiency to occur at levels below 0.15 per cent with the Hass variety in California. Nitrogen, phosphorus and potassium decrease with the age of the leaves (7) but the changes are not sufficient to affect the comparisons that have been made. The average level of the various elements in leaves of the three varieties studied in the present survey is shown at the bottom of Table 1. No important differences were found between the three varieties.

Table 2 presents a comparison of analyses of the leaves and an estimation of the crop carried by the trees at the time of taking the leaf samples. Within each grove the crop conditions for each variety were fairly uniform so that when five trees were sampled the crop on each of them was about the same. Irregular trees were avoided in the sampling. Unfortunately the number of groves representing each yield class was different so statistical analysis was not applied. No important differences are evident with the possible exception of potassium. The potassium level appeared to decrease as the crop increased, indicating a possible withdrawal of potassium by the developing fruit.

In general it appears that Florida avocado growers are using adequate amounts of fertilizer on their groves with the possible exception of nitrogen in a few groves. The possibility exists that some growers are applying fertilizers containing phosphorus, potassium, and magnesium in quantities beyond the needs of the trees. This possibility should be examined in further research.

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