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SOME OBSERVATIONS ON THE NUTRITIONAL STATUS OF AVOCADO TREES IN ISRAEL

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INTRODUCTION

The expansion of avocado growing in Israel (7) has made it desirable to investigate the nutritional status of avocado trees of different varieties in the different regions of the country.

This work was begun with a survey, carried out in 1958 and 1959 with the aid of a grant from the Ford Foundation.

This paper gives a short summary of some of the results of this work.

MATERIALS AND METHODS

Of the many varieties included in the survey, results are given here only for the two most important. Fuerte and Nabal.

Avocado trees in the Coastal plain (orchards a,b,c) are budded on Mexican or Guatemalan rootstocks, while those in the Interior Valleys (orchard d) are budded on West-Indian rootstock. Only this race can withstand the high salt content of the irrigation water.

The 4 orchards included in this report are:

a. A commercial orchard in the northern sector of the Coastal Plain, on rather heavy soil with high lime content, planted 1953, kept under non-tillage.

b. A commercial orchard in the central sector of the Coastal Plain, on soil of medium texture with low lime content, planted also in 1953, and also kept under non-tillage.

c. The trial orchard of the Agricultural Experiment Station in the southern sector of the Coastal plain, planted in 1949 as a stock-scion trial (6), on medium to light soil of low lime content.

d. A trial orchard planted in 1951 in the Jordan Valley on soil of very high lime content and irrigated with water of about 300 ppm chlorine content.

Analysis for Nitrogen, Potassium, Calcium and Magnesium were carried out five times: in summer and autumn of 1958 and in spring, summer and autumn of 1959. Those for

Phosphorus and Iron were made only at the last three surveys. Analysis for Copper and Zinc were made once only in summer 1959.

Full grown healthy mature leaves were taken for analysis; this means that spring leaves are older than summer and autumn leaves. The complete leaf with the petiole was used. Leaves were analyzed separately from the east and north sides of the trees— but the figures given below are means of both as no constant differences were found. Each sample was composed of leaves from 6 to 8 trees in each of four replicates.

The leaves were transported in plastic bags to the laboratory, washed twice (in tap and distilled water), dried for 24 hours at 149°F, ground in a Willey mill, sieved at 40 mesh and ashed at about 1000°F.

The following methods of analysis were used:

Nitrogen: Micro-Kjeldahl

Phosphorus: colorimetrically, by molybdate method

Potassium: flame photometer

Calcium and Magnesium: complexometric titration by versenate solution

Iron: colorimetrically, after complexion with thiocyanate method

Zinc: colorimetrically, after extraction with dithizon solution in carbon tetrachloride Copper: colorimetrically, after complexion with diethyl-dithiocarbamate in solution in carbon tetrachloride.

RESULTS

Table 1 shows the values found for the six elements nitrogen, phosphorus, potassium, calcium, magnesium and iron in the two varieties Fuerte and Nabal at 4 orchards.- Where not otherwise stated the figures are the means of five surveys in 1958 and 1959.

Table 1. Leaf content (in %) of 2 avocado varieties in 4 places

Variety	Place	N	P(x)	K	Ca	Mg	Fe (x) (ppm)
Fuerte	a	1.94	0.12	0.48	2.26	0.76	103
	b	1.86	0.12	0.62	2.50	0.60	91
	c	1.68	0.10	0.53	2.85	0.58	96
	d	1.69	0.11	0.62	2.09	1.01	162
Nabal	a	1.73	0.13	0.93	2.60	0.83	118
	b	1.70	0.13	0.97	2.35	0.72	128
	c	1.84	0.12	0.81	3.32	0.68	179
	d (xx)	1.74	0.15	1.97	2.04	0.75	233

(x) mean of 3 surveys (xx) mean of 2 surveys

The following deductions can be made from these figures: (Seasonal trends are summarized from the original figures not shown in the table.)

Nitrogen: General Mean: 1.77%; range compares well with usual in California (1). There is no difference between the two varieties. Values in orchard a are somewhat

higher and those in orchard d somewhat lower than the mean. Autumn values are higher than those for summer and spring.

Phosphorus: General Mean: 0.12%. This if. somewhat higher than in California (1). There is probably no danger of P deficiency in any of these orchards. Values for Nabal are higher than those for Fuerte. Orchard c has somewhat lower values than the three others. Autumn values are higher than those for summer and spring.

Potassium: General Mean: 0.87%. There is a very wide range in individual values and means are less reliable than for the other elements. Values for Nabal leaves are higher than those for Fuerte in all four orchards but especially in orchard d. Orchard d has a high value also for Fuerte. In the Coastal Plain orchard b had the highest and orchard c the lowest values. Summer values are higher than those of autumn and spring.

Calcium: General Mean: 2.50%: A high value as compared to California (1). Nabal values are slightly higher than those for Fuerte. Values for orchard c arc very much higher than those for the other three orchards—those for orchard d are the lowest. Summer values were higher than autumn and spring.

Magnesium: General Mean: 0.74%. There is no difference between the two varieties. Values are highest in orchard d and lowest in orchard c. There is a danger of Mg deficiency on light soils and some leaf symptoms have been seen. Autumn values are higher than those for summer and spring.

Iron: General Mean: 139 ppm. Nabal values are very much higher than those for Fuerte. Values for orchard d are very much higher than those for the other three orchards, the lowest values are in orchards a and b. The question of the interrelation between soil, irrigation water, type of rootstock, iron content of leaves, chlorosis and its control by chelate treatment will be dealt with in a separate paper.

The cation content of the leaves shows the following relations:

a**. Total content of three cations (K, Ca, Mg):** Fuerte 3.94%, Nabal 4.40%

b**. Ratio Calcium/Potassium:** Fuerte nearly double than Nabal (4.3 against 2.2). Highest in orchard c (4.6) and lowest in orchard d (1.6)

c. **Ratio Calcium/Magnesium:** Ratio highest in orchard c (light soil), lower in orchards a and b (medium to heavy soil) and lowest in orchard d (interior, soil of high lime content, West Indian rootstock)

d. **Ratio Potassium/Magnesium:** Fuerte has more Magnesium than Potassium (ratio 0.8) and Nabal has more Potassium than Magnesium (ratio 1.2).

Table 2 shows figures taken from a survey carried out in the summer of 1959.

Table 2. Leaf content (in ppm) of Zinc and Copper, or 2 Avocado Varieties in 4 Orchards

Variety	Orchard	Zn	Cu
Fuerte	a	21	12
	b	22	12
	c	21	(x)
	d	30	13
Nabal	a	26	15
	b	25	12
	c	24	13

(x) trees were sprayed with a copper fungicide; values between 9 and 81 ppm were found—no mean could be calculated.

Zinc: General Mean: 24 ppm/Nabal values are slightly higher than Fuerte. There are no differences between orchards a, b, and c. The slightly higher value for Fuerte in orchard d is of doubtful significance but see discussion. In California (5) 15 ppm is considered to be a sign of deficiency. Our figures are not very much higher and deficiency of zinc is common on the light soils of Israel both for Citrus and Mango. Some signs of probable zinc deficiency have also been seen in avocado.

Copper: There seem to be no differences between varieties and locations.

A large number of additional observations have been made and some of them will be summarized:

1. No differences were found in an additional trial orchard, in the 6 elements given in Table 1, between Fuerte trees budded on Mexican and West Indian rootstocks. Zinc content of leaves from trees on West-Indian rootstocks was nearly 50% higher (40ppm) than those from trees on Mexican rootstocks.

2. Benik trees in orchard c can be grouped into three categories, as to size and yield: large trees with high yields, small trees with fair yields and large trees with very small yields (less than half of the first group).

No differences were found in leaf content in any of the six elements given in Table 1.

3. Nabal trees in orchard c are alternating but not simultaneously (6). Thus in the same year trees can be found in the on-and-off year condition. No differences between the two groups were found in leaf content of nitrogen, calcium, magnesium and iron. Phosphorus and Potassium are somewhat higher in "off-year" trees—but this does seem to be a result of the high yield and probably not related to the causation of the alternate bearing.

4. The leaves from healthy and chlorotic Fuerte trees from a commercial orchard on heavy soil in the Coastal Plain were analyzed. The leaves from the chlorotic trees had higher values for all cations (potassium, calcium, magnesium and sodium) with a total of 4.3% against 2.7% for the leaves from healthy trees. In this case in general Potassium values were very much higher and Calcium values very much lower than in the orchards surveyed. Leaves from healthy trees had a higher Nitrogen content. There was no difference in iron content.

5. The relationship between yields of individual Fuerte trees in orchard c and the

Nitrogen content of their leaves was calculated. As table 3 shows, no clear relationship could be found, in contrast to the findings in California (3).

Table 3: Nitrogen content and yield of Fuerte avocado trees
(yields are totals for 6 years and given in kg)

No. of trees	Nitrogen	Mean yield	Range
5	below 1.6%	254	189-370
12	1.61% - 1.80%	228	124-401
35	1.81% - 2.00%	239	94-445
17	above 2.00%	210	80-425

The 17 trees in the highest Nitrogen group had a somewhat lower mean yield than the 52 others, but the range in all four groups is so wide that one cannot speak of a correlation between N% and yield.

As orchard c is laid out as a stock-scion trial the figures could be used for an investigation of the influence of rootstocks on Nitrogen content. A highly significant difference was found between the mean Nitrogen content of the leaves of 25 trees on Mexican rootstocks (2.00%) and those of 28 trees on Guatemalan rootstocks (1.79%). The 16 trees on Fuerte rootstocks had intermediate values.

DISCUSSION

The leaf analysis carried out so far shows that our avocado trees have a reasonable supply of Nitrogen, Phosphorus and Potassium. There exists a possible Magnesium shortage on light soils—especially in connection with the very high calcium content of the leaves. The figures for Zinc are low, and deficiencies are at least a potential danger. The situation as to Iron needs further research.

The differences due to variety, rootstock, locality and season can now be discussed.

VARIETIES

Nabal has higher values than Fuerte for Phosphorus, Potassium and Iron. Slightly higher values of doubtful significance were also recorded for Calcium and Zinc.

ROOTSTOCKS

The position is complicated by the fact that in most commercial orchards the type of rootstock is not known. But even when the source of seed is known there can be no genetical uniformity as long as rootstocks are grown from seed.

Nevertheless we have found some cases of rootstock influence and this has to be taken into account whenever figures for different orchards are compared.

In orchard c Fuerte trees on Mexican rootstocks had a higher Nitrogen content than those on Guatemalan rootstocks.

Trees in orchard d on West Indian rootstocks (but see below) had low values for

Nitrogen and Calcium and high values for Potassium, Magnesium and Iron.

In one orchard, trees on West Indian rootstocks had higher values for Zinc than those budded on Mexican rootstocks and this may explain the somewhat higher Zn values for the Fuerte trees in orchard d.

SOIL, WATER AND MANAGEMENT

Unfortunately, it is impossible to know whether the differences between orchard d and the three orchards in the Coastal Plain are due to the influence of the West Indian rootstocks (see above) or to the rather abnormal conditions of the locality—the climate of the Interior Valley, the soil of very high lime content and the irrigation water with a rather high salt content. This impossibility is due to the fact that no trees on Mexican or Guatemalan rootstocks can be grown at this locality.

Between orchards a and c in the Coastal Plain the following differences were found:

Orchard a had somewhat more Nitrogen, Phosphorus and Potassium than orchard c (but the significance is doubtful in all three elements), very much lower values for Calcium, higher values for Magnesium and a lower value for Iron, in Nabal only.

SEASON

Nitrogen, Phosphorus and Magnesium showed highest values in autumn, Potassium and Calcium in summer and Iron in spring. There is some difference to the trends found in California (2).

Season and age of leaf must be taken into account if leaf analysis is to be used for advisory purposes (4), these relationships are now being investigated in greater detail.

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