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Effects of Age, Position, and Fruiting Status on Mineral Composition of 'Tonnage' Avocado Leaves[1]

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ABSTRACT. As leaves of 'Tonnage' avocado *(Persea americana* Mill.) increased in age, N, P, and K contents decreased, while Ca, Mg, Mn, Cu, Zn, and Fe contents were higher. A comparison of leaves from 1st and 2nd flushes showed similar trends reflected in leaf age. The basal leaf was lower in P but higher in Ca, Mg, and Cu when compared with the terminal leaf of the same twig. Only N and Cu contents were different when leaves from fruiting and nonfruiting twigs were compared. Practical application of the data in sampling avocado leaves is discussed.

Avocado is classified as a tropical evergreen (2). In the subtropical regions of Florida, California, and Texas, avocado trees shed most of the old leaves each spring just prior to the emergence of new leaves (3, 7, 10). Thus, avocado leaves on the trees are mostly leaves of the current year, which differ from citrus (9) and mango (6) whose leaves may remain on trees as long as 2 and 4 years, respectively. Seasonal changes in the mineral composition of avocado leaves have been extensively investigated in California (1, 2, 3, 7) and to a limited extent in Texas (10). The only study of leaf analysis on avocado from Florida was a 1-year survey of 3 avocado cultivars grown mostly on Rockdale soil (8).

It is recognized that leaf age, position on twig, fruiting performance, cultivar, soil type, and cultural practice may all contribute to variations in the mineral concentration of leaves. To evaluate some of these variables, a systematic investigation of leaf sampling was conducted between 1973 and 1975. This paper reports that portion of the study dealing with the effects of leaf age, growth flushes, position on twig, and presence or absence of fruit on twigs on the mineral composition of avocado leaves. A companion paper discusses the effects of soils and cultivars (11).

Materials and Methods

'Tonnage' avocado was selected for this portion of the study because it is grown on all 3 soils. Descriptions of soils, cultivars, experimental layout, and methods of collecting and processing leaf samples have been described in the companion paper (11).

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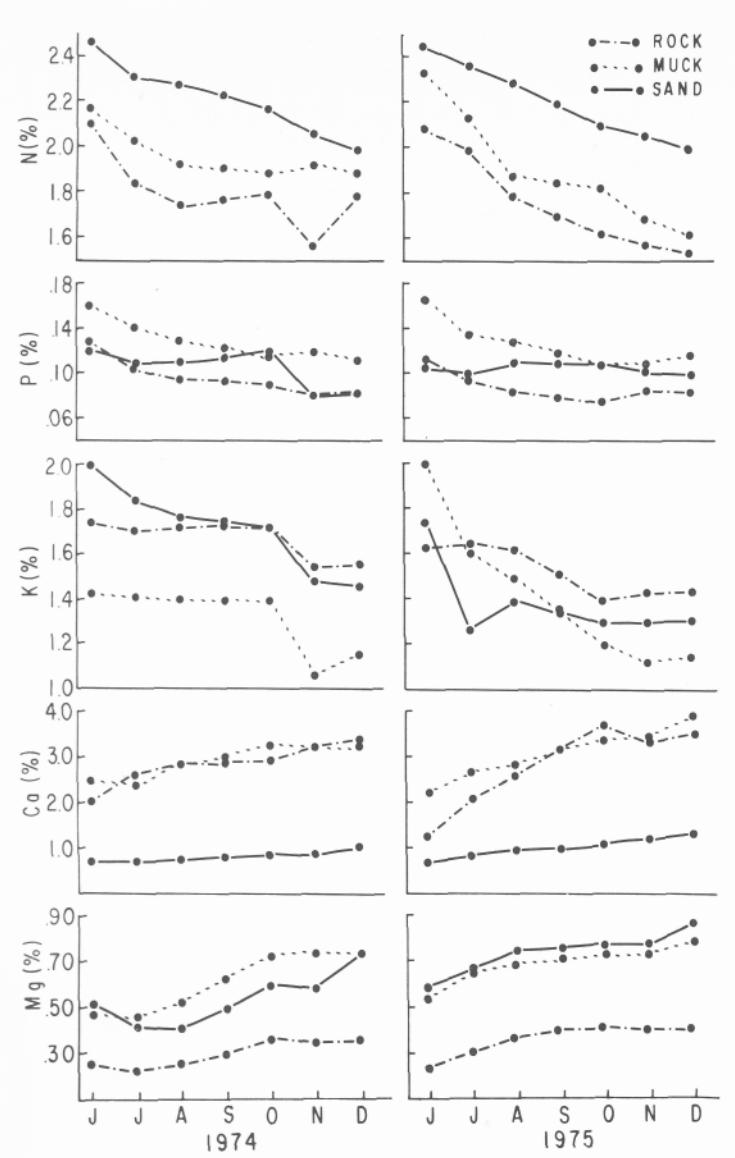

Fig. 1. Effects of leaf age on the macronutrient concn of 'Tonnage' avocado leaves on 3 soils.

For leaf age study, sample collections started in May-June when new leaves were fully expanded and hardened, and continued until Dec. at 4 to 6 week intervals. For comparison of terminal and basal leaves on the same twig, samples were collected in May-June of each year. For regular and late flush comparisons, samples were collected in Dec. Samples for fruiting status comparisons were collected in Oct. 1974 and in July 1975. It was necessary to sample the leaves earlier in 1975 than 1974 because of early fruit maturity and harvest. Leaves from non-fruiting twigs were used for all studies except the fruiting status comparisons when leaves from both fruiting and non-fruiting were sampled. 'Tonnage' trees on all 3 soils were sampled both years for all the studies.

Separate analysis of variance was calculated for each set of variables studied.

Results and Discussion

The mineral concentration of 'Tonnage' leaves at different ages on Astatula sand, Torry muck, and Rockdale soils (11) are plotted in Figs. 1 (macronutrients) and 2 (micronutrients). Data for all variables are summarized in Table 1. Similar trends were found on all 3 sons and in both years for the variables, therefore, only the averages for each comparison are presented in Table 1.

LEAF AGE. N, P, and K concentration decreased and Ca, Mg, Mn, Cu, Zn, and Fe contents increased with age of leaves. Similar trends were found on all 3 soils and in both 1974 and 1975. In general, the levels of most elements in leaves were closer on muck and rock soils than on sand. Variations due to age of leaf appeared to be more pronounced on sand than on muck or rock for most elements. Changes in the concentration of most elements was of greater magnitude in 2 and 3 month old leaves sampled in June and July than subsequent samples. Exceptions to these observations were found. Seasonal differences, changes in fertilizer practices, and the influence of

fruit crop on the trees may contribute to some of the variations. The high concentration of Mn, Cu, and Zn found in leaves in this study was due to nutritional and fungicidal sprays applied to the foliage (11).

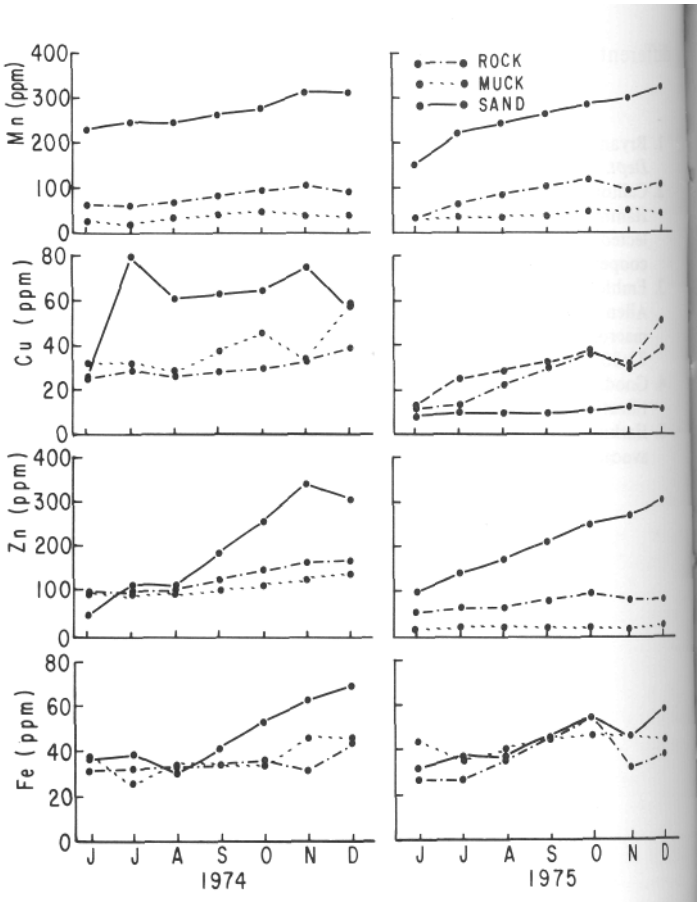

Fig. 2. Effects of leaf age on the micronutrient concn of 'Tonnage' avocado leaves on 3 soils.

Trends with leaf age found in this study were similar to results reported for 'Fuerte' avocados from California (1, 3, 7) and 'Lula' from Texas (10) except in Zn and Cu. No consistent trend was found for Zn or Cu in the California and Texas studies. The effects of age of leaves on N, P, K, and Ca contents found in avocado leaves were similar to that reported for citrus (9) and mango (6). The continued increase of Mg content with age of leaves found in avocado was not observed in citrus or mango. It is possible that the accumulation of Mg in avocado leaves may be related to the relatively high oil content found in avocado fruit compared to other fruit (4).

GROWTH FLUSH. Avocados in Florida generally produce 2 or more flushes of growth in a season. At least 2 flushes of growth were observed in 1974 and 1975 at intervals of 4 to 6 weeks apart. In both years, the 2nd flush produced as many leaves as the 1st flush.

For leaves sampled in Dec., N and P were higher and Ca, Mg. Mn, Cu, and Zn lower in 2nd flush compared to 1st flush leaves (Table 1). No difference in K and Fe concentration was found between the flushes. The differences between the flushes followed similar trends found n the leaf age study, where age difference was reflected in the mineral concentration of leaves.

POSITION ON TWIGS. Leaves along the axis of a given flush of growth are progressively younger as the terminal is approached, but the difference in age on a given flush is relatively small. Most avocado flushes consist of 4 to 8 leaves. Different P, Ca, Mg, and Cu concentration were found between terminal and basal leaves on the same twigs. In general, terminal leaves were higher in N and P but lower in all other elements when compared to basal leaves. Leaf age was reflected in the mineral concentration of terminal and basal leaves as in the comparison of growth flushes. K was the only exception. K was higher in basal leaves than terminal leaves. The difference was not significant but it was consistent with findings in citrus (5) and mango (6) leaves.

Table 1. Summarized effects of age, flush, position, and fruiting status on mineral composition of 'Tonnage' avocado leaves.[z]

Variable	Sampling date	Macronutrients (%) N	P	K	Ca	Mg	Micronutrients (ppm) Mn	Cu	Zn	Fe
Leaf age										
2 mo.	June	2.27C[y]	.13C	1.76C	1.54A	.43A	88A	19A	67A	35A
3 mo.	July	2.10B	.11B	1.58B	1.86AB	.46A	108AB	32B	88A	32A
4 mo.	Aug.	1.98B	.11B	1.56B	2.14B	.50A	119B	30B	95A	35A
5 mo.	Sept.	1.89A	.10AB	1.50B	2.45C	.54AB	140C	35BC	135B	44B
6 mo.	Oct.	1.87A	.10AB	1.46AB	2.52C	.60B	146C	38BC	149B	47B
7 mo.	Nov.	1.80A	.09A	1.32A	2.55C	.60B	151C	36BC	162B	46B
8 mo.	Dec.	1.81A	.10AB	1.34A	2.71C	.64B	156C	42C	172B	50B
Flush	Reg.	1.80A	.10A	1.34	2.70B	.65B	156B	42B	172B	50
	Late	2.03B	.12B	1.31	2.20A	.48A	127A	20A	85A	49
Position	Term	2.29	.14B	1.72	1.43a	.41a	80	18a	64	34
	Base	2.24	.13A	1.80	1.65b	.46b	94	20b	71	35
Fruit	–	1.97B	.11	1.56	2.22	.58	132	18a	129	40
	+	1.87A	.10	1.48	2.29	.56	117	20b	112	38

[z]All values are means of samples collected from 3 soils, 2 years and 3 replications.

[y]Mean separation within columns within variable by Duncan's multiple range test, 5% (small letters) or 1% (capital letters) level. Means not followed by a letter are not significantly different.

FRUITING VS. NON-FRUITING STEM LEAVES. The adjacency of a fruit may affect the concentration of mineral elements in leaves. In citrus, the difference in the mineral composition of leaves from fruiting and non-fruiting stems can be substantial (9), while in mango it is relatively insignificant (6). In avocado fruiting stems, leaves had lower N, P, K, Mg, Mn, Zn, and Fe contents than non-fruiting stem leaves. These differences, however, were small and only N and Cu concentrations were significantly different, regardless of whether sampled late or early in the season.

Findings in this paper should assist in sampling avocado leaves for measurement of nutrient elements. Most of the leaves present on the trees are leaves of the current year, which simplifies the sampling procedure somewhat. Leaf age study indicated that the concentration for most nutrient elements became more stable beginning with the Sept.-Oct. sampling. It was also observed that 2nd flush produced as many leaves as the 1st flush under Florida conditions. Therefore, leaf sampling should be conducted in Sept. and Oct. and include leaves of both flushes. It is virtually impossible to distinguish leaves from the 2 flushes once they are matured. Any leaf on a shoot may be sampled except the terminal and basal leaves. It makes little difference whether leaves from fruiting or non-fruiting stems are taken in sampling. This can best be decided by the absence or presence of bloom or fruit on the tree at the time leaf samples are to be collected.

Based on above considerations, it is suggested that in Florida avocado leaves can be sampled when they are 5 to 7 months old. This usually happens between Sept.-Oct. and Dec. Almost any leaf on the tree may be sampled except the terminal and the basal leaf of each twig.

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