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EFFECTS OF NITROGEN AND IRRIGATION TREATMENTS ON THE MICRONUTRIENT CONCENTRATION IN HASS AVOCADO LEAVES

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Deficiencies of micronutrients in avocado trees are often an important problem in southern California avocado orchards. Several reports (7, 8, 9, 11, 13) indicate that continued application of commercial fertilizers may change micronutrient nutrition of avocados.

This paper presents data from a field experiment dealing with the effects of soil applications of nitrogen and irrigation treatments and years on the micronutrient (zinc, copper, manganese, boron, and iron) concentrations in Hass avocado leaves.

MATERIALS AND METHODS

The experimental orchard and treatments are described in detail by Richards et al. (12). The avocado trees were planted in June, 1952, where native brush had been removed. A Mexican seedling rootstock was used. During the first year, prior to establishment of the experiment, water was applied in small basins around the trees. After the first year, a permanent irrigation system provided water near each tree by means of a riser—a sprinkler-type nozzle. During the first two years each tree received 1½ of a pound of nitrogen per tree per year from calcium nitrate broadcast under the trees in two applications. Differential treatments were started in 1954 for the purpose of evaluating the effects of three levels of irrigation and three levels of nitrogen fertilization on yield, fruit size and quality, tree growth, and chemical composition of avocado leaves. The whole experimental orchard was sprayed with 3 pounds of zinc sulfate plus 1½ pounds of soda ash per 100 gallons of water in June, 1956. In addition to that, soil application of one pound of zinc chelate per tree was applied in 1958. The field layout was a split-plot design, in which irrigation treatments were conducted in the main plots and nitrogen in the subplots. Statistical comparisons were on 3 x 3 split-plot design with sampling date as a sub-subplot. Nitrogen and irrigation differences were evaluated by a multiple range test (3, 15).

Leaf samples for micronutrient chemical analysis were obtained in August, 1956, October, 1957, and November, 1959, from one permanent tree in each nitrogen subplot. Thus 27 trees were sampled at each sampling date. Each sample consisted of 20 fully developed avocado leaves and included both leaf petioles and blades. The method used in preparing avocado leaves for micronutrient analysis has been described elsewhere (10). Only the main effects of nitrogen and irrigation treatments and years on the mean concentration of micronutrients are presented in this paper.

RESULTS AND DISCUSSION

Nitrogen effects:—The data presented in Table 1 show that leaves from Hass avocado trees treated with High-N contained significantly smaller concentrations of copper than leaves from trees treated with Zero—N and Low—N. Zinc, manganese, boron, and iron concentrations in the leaves were not significantly affected by differential nitrogen fertilization in this experiment. Because zinc deficiency symptoms were present on some trees, the whole experimental orchard was sprayed with zinc sulfate plus soda ash in June, 1956. Avocado leaves that were sampled in 1956 were not analyzed for zinc because the zinc deposits from the June sprays were still present on the leaves.

Table 1. Effects of soil application of nitrogen and irrigation on micronutrient concentrations in avocado leaves.

	Concentration in dry leaves (ppm)				
Nitrogen treatments	**Zn**[a]	**Cu**[b]	**Mn**[a]	**B**[b]	**Fe**[a]
Zero—N	14	7_y	58	36	61
Low—N	17	6_y	56	33	58
High—N	14	4_x	52	29	61
F Value	NS	**	NS	NS	NS
Irrigation treatments (Maximum soil suction)					
½ bar	16	7	53_x	34_y	57
1 bar	14	6	62_y	35_y	61
10 bars	15	5	51_x	29_x	61
F Value	NS	NS	*	*	NS

[a]*Each value is a mean of 9 trees for 2 years; zinc—Oct., 1957, and Nov., 1959, and manganese and iron—Aug., 1956, and Nov., 1959.*

[b]*Each value is a mean of 9 trees for 3 years; Aug., 1956, Oct., 1957, and Nov., 1959.*

NS *Indicates that the differences between means are not statistically different from each other if they do not have a common subscript letter after them.*

Subscript letters $_x$ and $_y$ after values indicate populations at the level of probability indicated by the asterisks. Mean values are statistically different from each other if they do not have a common subscript letter after them.

**F Value significant at the 5% level.*

***F Value significant at the 1% level or higher.*

The reduction in copper concentration in avocado leaves as a result of applications of nitrogen fertilizer in this experiment is in agreement with previous observations by Lynch (11) and Ruehle (13) in Florida and by Labanauskas et al. (7, 8, 9) in California.

Zinc concentrations in avocado leaves were unaffected by differential nitrogen treatments in this experiment, possibly, because of the spray and soil applications of zinc sulfate and zinc chelate in 1956 and 1958, respectively.

The results obtained in this experiment suggest that when zinc maintenance spray or zinc chelate soil applications are applied annually nitrogen fertilizers do not have a depressing effect on the zinc concentration in avocado leaves.

Irrigation effects:—The data presented in Table 1 show that leaves front Hass avocado trees receiving the intermediate irrigation treatment (irrigated when soil suction reaches 1 bar) contained significantly higher concentrations of manganese than the leaves from trees receiving the ½ -bar or 10-bar treatments. The data obtained in this experiment are partially in agreement with the observations made by Dunne and Gulvin (4), Bell (1), and Childers et al. (2), all of whom stated that severity of manganese deficiency in apple and peach trees was greater in dry summers than in ones with ample rainfall. Thus, the data obtained in this experiment clearly show that the manganese concentration in the leaves is influenced significantly by soil moisture status.

The boron concentration in the leaves of trees irrigated when soil suction reached 10 bars contained significantly smaller concentrations of boron than the leaves of trees receiving the ½-and 1-bar treatments. Thus it appears that avocado trees may develop boron-deficiency symptoms when subjected to an irrigation practice which allows very dry soil conditions between irrigations, particularly in areas where soil and water are low in boron concentration. This is in agreement with the findings of Hobbs and Bertramson (6) on alfalfa and tomatoes, Heinicke et al. (5) on apples, Smith and Reuther (14) on citrus, and Sorteberg (16) on many different plants.

Table 2. Effects of sampling date on micronutrient concentrations in avocado leaves.[a]

	Concentrations in dry leaves (ppm)[b]				
Sampling dates	**Zn**	**Cu**	**Mn**	**B**	**Fe**
August, 1956	—	6	61	24_x	62
October, 1957	12	6	—	45_y	—
November, 1959	19	6	49	28_x	57
F Value	**	NS	**	**	NS

[a]*See footnotes of Table 1.*
[b]*See footnotes of Table 1.*

Sampling date effects:—The avocado leaves were sampled three times from the same tree in each nitrogen-treated subplot. The leaf material was analyzed separately for each sampling date. The data presented in Table 2 show that differences due to sampling dates are statistically significant at the 1 per cent level or higher for the zinc, manganese, and boron concentrations. No significant differences were found in copper and iron concentrations in the leaves sampled at these three different sampling dates. The data obtained in this experiment are in agreement with previous findings by Labanauskas **et al.** (7, 10) on avocados and on Washington Navel oranges, respectively. They found that the micronutrient concentrations in avocado and citrus have been influenced by age of leaves, season, and differential fertilizer applications.

SUMMARY

These studies show that high rates of nitrogen fertilization to avocado trees tend to reduce the concentrations of copper in Hass avocado leaves. Data presented in this paper show that low soil moisture availability produced by infrequent irrigation, and high soil moisture availability produced by frequent irrigations resulted in lower manganese concentrations in avocado leaves than did an intermediate supply of soil moisture.

Data presented in this paper suggest that boron deficiency may become a problem in orchards grown under an irrigation practice which allows dry soil conditions (irrigated when soil moisture reaches 10 bars) rather than in orchards grown in soils irrigated at the ½ -bar and 1-bar levels.

Zinc, copper, and iron concentrations were unaffected significantly due to differential treatments of irrigation.

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