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# EXPERIMENTS WITH ZINC APPLICATIONS TO AVOCADO TREES

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The appearance of little, narrow and cholorotic leaves together with small roundish fruits has been attributed in the literature to zinc

deficiency (8, 14) (Plate 1).

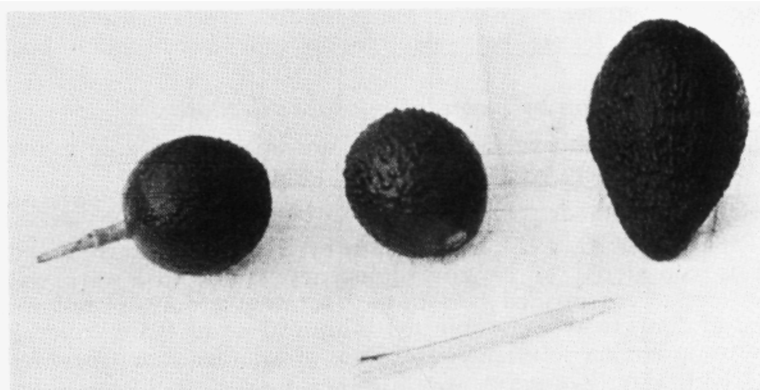

Plate 1. Normal (left) and rounded (middle and right) avocado fruits.

The levels of zinc in avocado trees vary with age of leaf and season (2, 9), but even so it was found that 30 ppm and above is optimal (3, 8) and that 15-20 ppm should be considered as a deficiency level (11, 14).

Avocado trees have difficulties in absorbing mineral elements through their foliage. This is true for nutrient elements such as iron (7) and for toxic elements like sodium and chlorine (5). In spite of this, spraying of apparently zinc-deficient orchards is rather common in California and some other countries (4, 12, 14). Soil applications of zinc are also practiced. In Israel, some growers spray their orchards, but as experiments have shown, no apparent improvement occurs in leaves or fruits following such treatment (1, 10).

In the Glil-Yam avocado orchards, symptoms have been observed which, according to the literature, indicate zinc deficiency. This led us to attempt to clarify the following:

(a) Are avocado leaves capable of absorbing and translocating sufficient amounts of zinc applied on their surface? (b) Are there other efficient means of supplying zinc to avocado trees? (c) By raising the zinc level of trees showing deficiency symptoms, can the leaf and fruit appearance be improved?

## Descriptions of Experiments

*Penetration and translocation of $^{65}Zn$ applied to the surface of avocado leaves.*

Six-month-old West Indian and Mexican seedlings grown in Hoag-land solution were used in a series of experiments. On each seedling two fully developed leaves were fixed horizontally, one with the dorsal and the other with its ventral face up. At the center of each leaf, near the midrib, a thin, 5-mm-diameter plastic ring was attached. Into this ring, every 24 hours for one week, a droplet of $^{65}ZnCl_2$ (sp. act. 0.2 u/ml) was applied. For comparison, the same treatments were carried out on leaves of mung bean. The rate of $^{65}Zn$ penetration and translocation was examined by autoradiography at -18°C to eliminate possible trans-location of the radioactive element in the detached leaf during the exposure period. No $^{65}Zn$ was found in the avocado leaves, whereas in mung bean leaves both penetration and translocation occurred (Plate 2).

*Zinc application by means of pressure injection*

Based on the above finding, pressure injection of zinc to avocado trees in the Glil-Yam orchard was tested.

## Materials and Methods

On October 22, 1974, 12 uniform cv. Hass avocado trees showing what is considered to be zinc deficiency symptoms, were selected. These trees were divided into three treatment groups as follows: (i) Limbs of four trees were injected with 450 cc of 0.5% zinc chelate sequestrene $Na_2Zn$ solution, (ii) Limbs of another four trees were injected with 450 cc of 0.5% zinc sulfate solution, (iii) Four trees were left as controls.

The injections were carried out as described previously (6). Before the injections were carried out, ten fully developed 6-month-old leaves were sampled for zinc analysis. Leaves from the same branches were sampled again on November 6, 1974 and on May 2, 1975. On the latter date young leaves (1-2 months old) of the spring flush were also sampled separately. The last sampling of leaves was carried out on October 7, 1975, at which time only adult leaves were sampled.

The results were analysed statistically by factorial analysis, using the Keuls test of comparison between means (13).

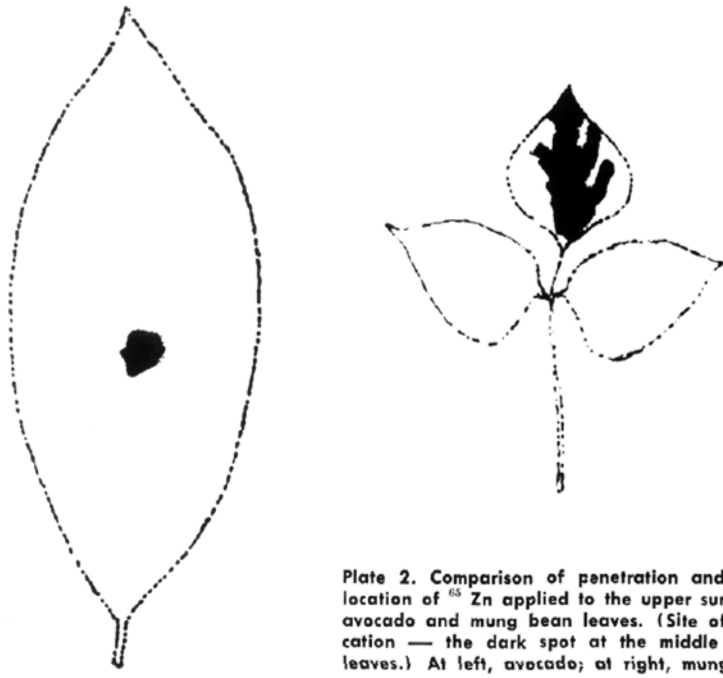

**Plate 2. Comparison of penetration and translocation of $^{65}Zn$ applied to the upper surface of avocado and mung bean leaves. (Site of application — the dark spot at the middle of the leaves.) At left, avocado; at right, mung bean.**

Table 1: Zinc in leaves of Hass avocado trees with zinc injections

| Sampling | Zinc in leaves (ppm in dry matter) | | | | |
|---|---|---|---|---|---|
| | 22. X. 74 | 6. X. 74 | 2. V. 75 | | 7. X. 75 |
| Treatments | adult leaves before experiment | adult leaves | adult leaves | young leaves | adult leaves |
| Sequestrene $Na_2Zn$ | 22 a | 106 c | 66 c | 21 a | 21 a |
| $ZnSO_4$ | 25 a | 34 b | 30 b | 31 b | 26 a |
| Control | 22 a | 27 a | 16 a | 28 ab | 22 a |

* Each figure represents the mean of four replicates.

Standard deviation = 3.58. Values within each date followed by different letters differ significantly at the 5% level.

## Results

Careful observations carried out during the summer of 1975 and until autumn 1976 did not reveal any visible differences between control and treated trees or limbs. The zinc levels in the various leaves are presented in Table 1-

The data presented in Table 1 indicate the following: (a) On October 22, 1974, all trees contained zinc levels which are considered deficient.

(b) Two weeks after treatment, only zinc chelate injections had caused a marked increase in the zinc levels of the leaves. $ZnSO_4$ injections were practically ineffective, (c) The high level of zinc persisted in the leaves of zinc-chelate-injected trees for more than half a year. However, the young leaves of these trees had a zinc level similar to that of leaves from control trees, (d) One year after treatment on (October 7, 1975) the zinc level of all trees was practically identical to that found at the beginning of the experiment.

## **Discussion and** Conclusions

The results presented here indicate that the penetration of zinc through the leaves is so slight that there is practically no use in supplying it by usual foliage sprays. Moreover, it is possible that the symptoms considered to indicate zinc deficiency in the Galil Yam trees did not actually result from deficiency of this element. In the two autumn seasons of the experiment, the zinc level in the leaves was identical, but in the first year the leaves were small and the fruit were round shaped and in the second year these symptoms did not appear.

It is possible that a zinc level of 20 ppm, which is considered to be the threshold of zinc deficiency in avocado trees, is not precise. Apparently, a real deficiency appears only when the level of zinc in the leaves is much lower (around 10 ppm).

An important finding was that zinc injected into the branch as zinc sulfate did not move into the leaves. Zinc injected as zinc chelate moved into the leaves which were present at the time of treatment, but did not move into leaves of the flush bursting sometime after treatment.

These phenomena seem to prove that zinc is fixed in the leaves very rapidly. These results also suggest that for diagnostic purposes. the use of zinc chelates is preferable to the use of inorganic zinc compounds.

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*Editor's note:* Some conclusions in this paper are not borne out by the experiences in California where foliar sprays containing zinc have corrected zinc deficiency.

*Reuben Hofshi's note:* The editor was wrong in his comments. David Crowley reconfirmed the results presented in the paper under California conditions.