California Avocado Society 1960 Yearbook 44: 101-105

MAGNESIUM DEFICIENCY OF THE HASS AVOCADO TREE

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The avocado grower is usually familiar with deficiency symptoms such as those caused by lack of sufficient iron (3), zinc (11), and nitrogen (4). Also excesses of certain elements produce characteristic symptoms which may be readily identified, e. g. chloride and sodium (2, 9). However, little information is available concerning the remaining elements absorbed by the tree, their symptoms along with leaf standards. The Department of Soils and Plant Nutrition initiated Project 1694, "The Basic Mineral Nutrition of Avocado Trees," in January, 1956, to develop specific information on the mineral nutrition of the avocado tree. During the winter 1955-1956, ten large sand culture units were developed on the Riverside campus for such studies. Although the present experiment involves magnesium, additional elements could be investigated with the same ease; accordingly plans are now being made to extend the investigation to manganese, phosphorus, potassium, etc.

EXPERIMENTAL

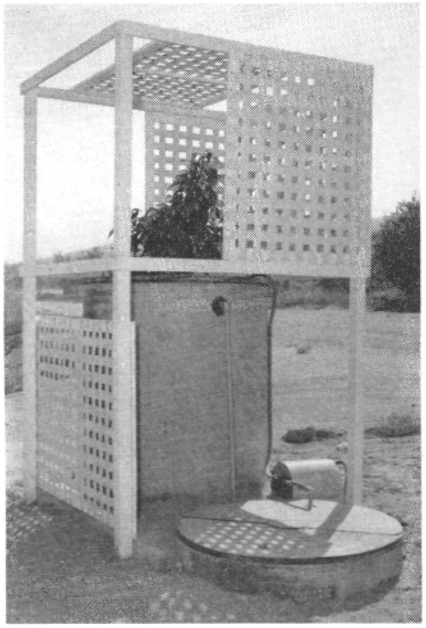
Apparatus. Each sand culture unit was constructed in a manner such that it was automatic. By means of appropriate timers and switches, each culture could be flooded with nutrient solution on a predetermined schedule. The sand itself was especially selected for its purity. Over a ton was used for each unit. Plate la shows the arrangement of the sand culture in relation to the reservoir tank coupled with an electric motor-driven pump to circulate the solution. The arrangement of each complete unit to another is illustrated in plate 1b. Also, note the wind breaks. The control panel board is given in plate 1c. At the time of these photographs the plants had been in the sand cultures for only three months (spring, 1956). Plate 1d shows the appearance of a control tree as of March, 1960.

Experiment plan. Commercial Hass avocados on Mexican rootstocks were bare rooted and then planted in the sand cultures during the spring of 1956. The trees were maintained on uniform, complete nutrient solutions for two and one-half years before being treated differentially. In November, 1958, six trees were deprived of magnesium—actually a low amount was present (2-4 ppm. Mg.) but all other nutrients were present in adequate amounts. Four trees were kept on complete solutions. Every 60 days thereafter the solutions were completely renewed, and in addition leaf samples were collected for chemical analysis. By controlling the level of magnesium in the solution cultures (#5-#10) to a low level, specific deficiency symptoms were produced which were associated with leaf levels and thus establishing reliable leaf standards.

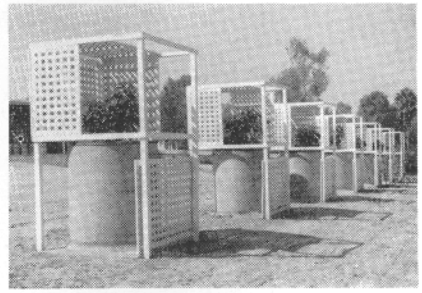
Symptoms. Definite leaf symptoms due to low magnesium were not apparent until the trees had been on low magnesium solutions for at least eight months. However, by July, 1959, visible symptoms began to be evident. The symptoms were only found on older leaves. Plate 2a shows the specific pattern. The wide, green area along the midrib and lateral veins is specific for the symptom. As the deficiency became more severe, necrotic areas developed between the veins and occasionally along the leaf margins. The leaf dropped off prematurely. Plate 2b shows, in particular, the margin scorch with only the older leaves showing a pattern. The magnitude of the premature defoliation due to low magnesium is indicated in plate 2c.

In addition to the above symptoms, foliage of the deficient trees was more bronze-like in color during the winter. The branches were especially brittle too.

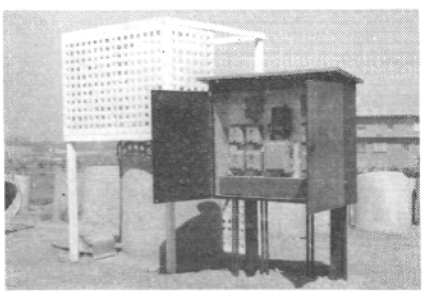
Leaf content. Beginning in November, 1958, leaf samples were collected every two months from each of the sand culture trees as well as from field trees. Chemical analysis of all major and microelements were made to establish the effects due to leaf age, season, and magnesium nutrition control. Only the magnesium data will be presented now.



1a



1b

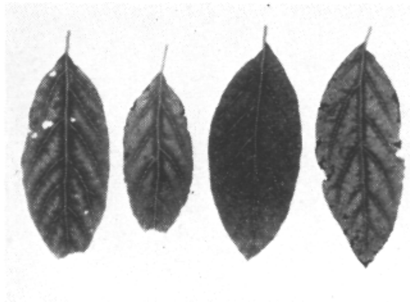


1c

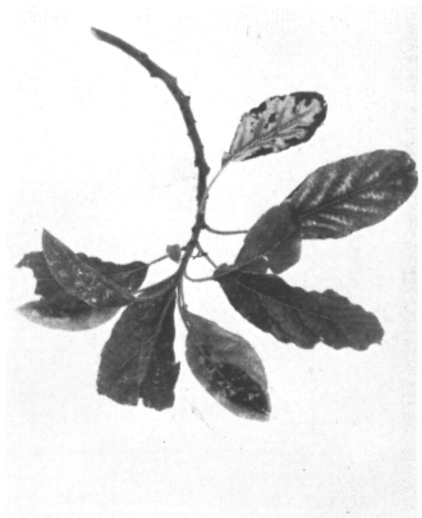
1d

Plates 1a, 1b, 1c, and 1d. Sand culture equipment used for the magnesium deficiency experiments. Plates 1a, 1b, and 1c were photographed in the spring of 1956; plate 1d in March, 1960, showing the healthy appearance of a control tree (receives all nutrients).

Magnesium, unlike many elements, did not vary greatly with age or season, meaning that a reliable leaf sample may be taken practically any time during the year as far as magnesium is considered (see figure 1, note the control and the field tree samples varied only to a small extent). Furthermore, the petiole as well as the blade contains essentially the same amounts when expressed as per cent. Either tissue may be analyzed. Figure 1 shows the rapid decrease in leaf magnesium for the low magnesium trees up to about July. The level dropped from a normal amount of 0.30 to 0.40% to 0.10% Mg and then gradually decreased to 0.07% Mg. The new leaves formed this spring (1960) contain only 0.11% Mg and probably will reduce in amount to 0.04-0.05% Mg before prematurely defoliating.



2a



2b

2c

Plate 2. Examples of magnesium deficiency in the Hass avocado: 2a, close-up of selected leaves. Note the thickened green area along the midrib and main laterals; 2b, shoot showing that the older leaves had the pattern; and 3a, magnesium deficient tree. Note the severe defoliation. Photographed the same time as the control shown in 1d.

After two years of study the following leaf levels are concluded for the Hass avocado:

Range	% Mg
Normal	0.25-0.50%
Low	0.15-0.25%
Deficient	Less than 0.15%
Severely deficient	Less than 0.10%

The above values are applicable only when leaf samples are collected in a manner where the most recently matured leaf is sampled randomly.

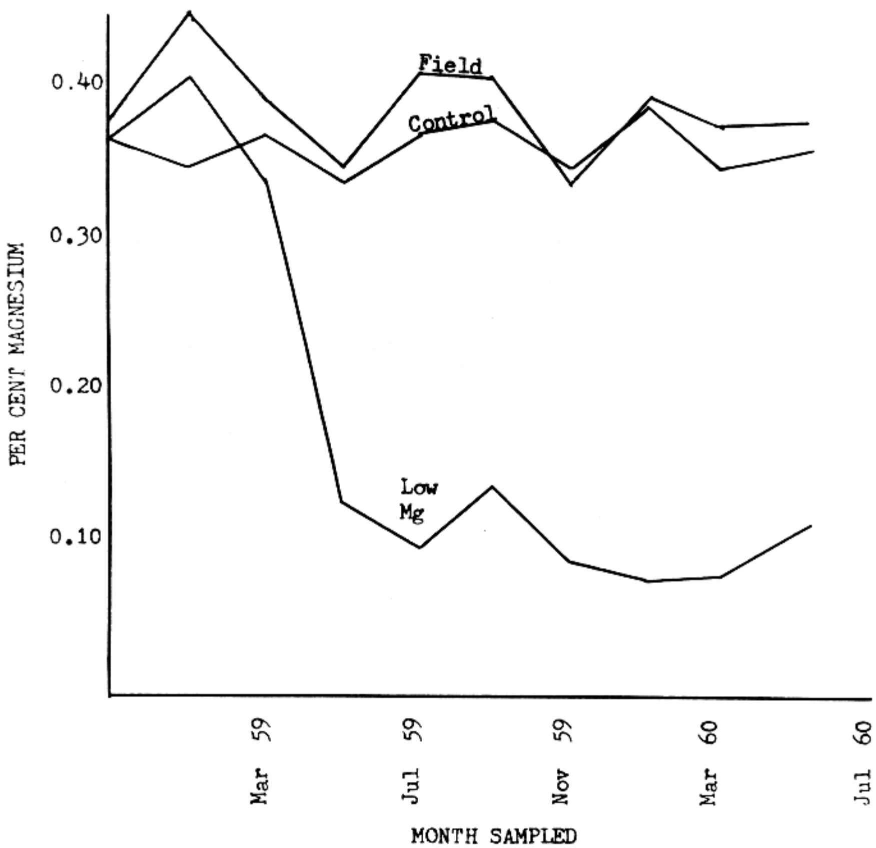


Figure 1. Relationship between treatment and sample time to leaf content of magnesium. For comparative purposes, data from companion trees growing in Field 17S are included.

Fruit content. Fruit samples were collected for various physical and chemical measurements including size, shape, number, weight, oil content, mineral content, etc. No consistent differences were noted to be in relation to the treatments. In terms of averages, the seed contained 0.09% Mg; the fruit skin, 0.13%; and the pulp, 0.10%, all on a dry weight basis. These values are surprisingly similar to those reported in 1937 by Haas (6) for a variety of avocado fruit samples.

CONCLUSION

The present experiment, though dealing with only magnesium, illustrates the possibilities of extending the experimental approach to other nutrients. The equipment, being fully automatic, provides a convenient means for controlled nutrition studies.

A second conclusion relates to the symptoms and associated leaf standards. By only such control as used herein is it possible to produce specific symptoms due only to the nutrient in question and simultaneously develop the associated leaf analysis data. A report from Florida (10) comments on avocado trees failing in a marl-soil area, presumably due to low available magnesium but no leaf data were presented, hence leaving the diagnosis open to question. Another report also from Florida (5) describes briefly symptoms attributed to magnesium deficiency produced by a sand culture technique. In general, the symptoms' description of Furr **et al.** (5) coincide with that of the author's, but as with the previous citation, no chemical data were presented. Haas (7, 8) commented on a possible magnesium deficiency but his reports do not contain substantiating data. The present report describes the only substantiated study of magnesium deficiency including photographs that the author could find.

As for the practical aspects implied, there is only the single report from Florida (10) where magnesium deficiency may have existed in the field. Surveys (1, 8) of the major avocado districts of California indicate all samples to be well above the deficiency level of 0.15%. If field deficiency occurs, it probably will be produced in areas low in available magnesium, where an unfavorable balance between elements, say magnesium and potassium, had been created. Removal by fruit harvest is not a major factor since only 5 to 10 pounds per acre of magnesium are removed by a heavy crop (up to 10,000 pounds).

However, with magnesium symptoms and leaf levels established, we will be able to evaluate possible nutritional problems more systematically. Visual examination alone will not be sufficient, leaf analysis must be included for substantiation, regardless of the nutrient disorder in question.

ACKNOWLEDGMENT

The author expresses appreciation for a grant of $500.00 made by the California Avocado Society. The money was used to help equip the automatic sand cultures.

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