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Leaf Symptoms of Manganese Deficiency in Avocado Trees[1]

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Abstract. Leaf Mn concentrations in relation to severity of chlorosis patterns were determined for the 'Hass' and 'Bacon' varieties in an orchard where Mn deficiency was induced by application of Fe chelates. Mild symptoms occurred at 16 ppm, which is taken to be the critical concentration with respect to chlorosis pattern. Degree of chlorosis increased as Mn decreased to the minimum observed value of 1.3 ppm.

Leaf samples from a naturally Mn deficient orchard of 'Hass', 'Nowels', and 'Zutano' varieties in Sicily exhibited a similar relation between Mn concentrations and degree of chlorosis.

INTRODUCTION

Existing descriptions of Mn deficiency symptoms in avocado leaves (2, 3, 7) derive from young plants grown in pots and do not provide information on concentration of Mn in the leaves. The absence of reports of field occurrence of such deficiency suggests that it is not common, although it could be mistaken for Zn deficiency because of similarity in chlorosis patterns.

Herein are reported two instances of Mn deficiency in orchard grown trees, one induced by application of Fe chelate to the soil and the other unrelated to prior treatment, along with leaf analysis data.

MATERIALS AND METHODS

In a local avocado orchard consisting of 'Hass' and 'Bacon' varieties growing on an unmapped calcareous clay loam soil, trees of various ages in one small area developed moderate to severe symptoms of Fe deficiency. Several of these were treated in the spring of 1961 by soil applications of EDDHA-HFe [Fe chelate of ethylene-diamine di (o-hydroxy-phenylacetic acid)][3] at rates of 50 or 100 g per 2 year old tree. These treatments eliminated the symptoms of Fe deficiency and stimulated growth during that season. Some of the trees, particularly those of the 'Hass' variety, developed another leaf chlorosis pattern that resembled published photographs of Mn deficiency symptoms (7). This pattern disappeared by the end of summer and Fe deficiency chlorosis began to return. In each of 2 subsequent years several trees in the area were retreated with Fe chelate during February or March to provide material for studying the induced symptoms. Application rates varied with tree sizes, the maximum being 450 g for trees more than 3 m tall. Characteristic symptoms were evident by mid-June in each year, coinciding with maturation of the spring cycle leaves. All leaf samples for analysis were taken during June and July.

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Foliar spray treatments were applied in mid-June to check the visual diagnosis and distinguish the symptoms from those of Zn deficiency. Sprays consisted of either Mn or Zn at 300 ppm in the form of sulfates, with addition of 0.02% Na-dioctyl-sulfosuccinate as spreader. In one test, terminal shoots were paired for equal symptoms and one shoot from each pair received Mn spray. Two such comparisons were made on each variety. Another test involved 2 adjacent limbs on a large 'Bacon' tree. One limb received a Mn spray and the other a Zn spray.

Natural occurrence of a similar leaf chlorosis pattern was observed by one of us (M.P.M.) in Sicily in December 1964. 'Hass', 'Nowels', and 'Zutano' varieties, growing on the slopes of Mt. Etna in soils derived from lava and volcanic ash, all exhibited the leaf symptoms without having received any treatment that seems likely to induce this condition. Severe symptoms of typical Mn deficiency occurred in nearby citrus trees. Mature leaves for analysis were collected, washed, and dried at that time.

Leaves from both of the orchards were prepared for analysis by washing with soap, drying at 65 °C, pulverizing in a chromium-plated grinder, and dry ashing at 500°. Analyses were done colorimetrically, using the o-phenanthroline procedure for Fe (8), the ammonium persulfate procedure for Mn (8), and the zincon procedure for Zn (4). All concentration values are expressed on a dry weight basis.

RESULTS AND DISCUSSION

The foliar spray tests resulted in virtual elimination of the chlorosis by Mn and no observable benefit from Zn, thus supporting the visual diagnosis. Analysis of the leaves showed Zn values all above 20 ppm and Fe values above 40 ppm, indicating that neither of these elements was deficient.

The range of leaf chlorosis patterns induced in the 'Hass' variety by treatment with Fe chelate is shown in Fig. 1. Mn concentrations in these leaves were 16, 10, and 1.3 ppm, top to bottom. Only mild symptoms occurred in the 'Bacon' trees and the lowest Mn concentration found was 10 ppm. Leaves of the 'Hass', 'Nowels', and 'Zutano' varieties from Sicily exhibited intermediate chlorosis levels and Mn concentrations ranged from 5 to 8 ppm. Zn values exceeded 20 ppm and Fe values exceeded 40 ppm, hence were not deficient. Thus, present evidence indicates that the association between Mn concentrations and severity of chlorosis is similar for the 4 varieties studied.

Previously published data on Mn concentrations in avocado leaves all exceed the values reported here by substantial margins. The range of values is illustrated by the finding of 56 to 63 ppm Mn in the 'Hass' variety in one location (5) in contrast to a maximum of about 1600 ppm in the 'Fuerte' variety at another location (6).

Unpublished data obtained in conjunction with studies of Zn deficiency (1) show a range of Mn concentrations from 81 to 563 ppm among trees in a single orchard, possibly reflecting differences in soil pH. Minimum values observed in that study, representing 358 samples from individual trees in 7 orchards in widely different soils, taken over a period of 3½ years, were 17 and 19 ppm in recently matured leaves from 2 trees of the 'Fuerte' variety. Until initiation of the present study, these were the lowest Mn concentrations in avocado leaves of which we were aware.

Comparison of the lowest value reported here - 1.3 ppm - with the high value of 1600

ppm previously reported (6) represents a possible range in excess of 1000 fold. This is an unusually high range of concentrations of a single nutrient element in living leaves.

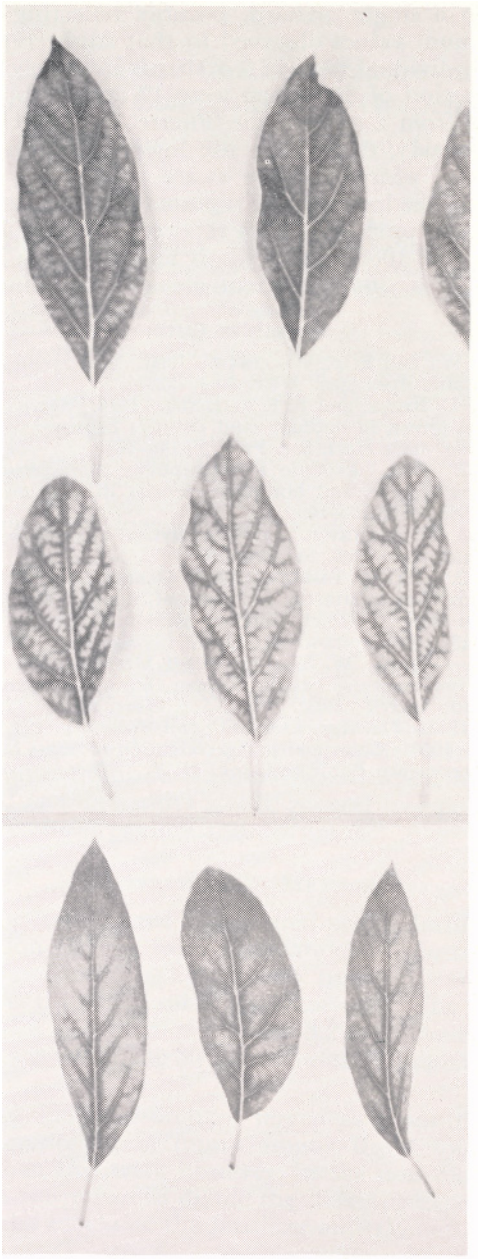

Fig. 1. Photographs of recently matured avocado leaves—'Hass' variety, collected in mid-June—showing the observed range of symptoms of Mn deficiency: Mn concentrations—top 16, middle 10, and bottom 1.3 ppm.

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