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## **COPPER SULFATE AS A CORRECTIVE FOR DIEBACK, A NEW DISEASE OF THE AVOCADO**

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A serious disease, causing dieback of young avocado trees and their death in many instances, was observed in Highlands County this past season. It was brought to our attention in September 1939, when a specimen tree was sent by Mr. W. F. Ward to the Subtropical Experiment Station for diagnosis.

Examination of the specimen indicated that the trouble was physiological in nature, since no pathogenic organism could be found in the affected tissues. Reference to a disease of the avocado with similar symptoms could not be found in the available literature.

Groves of avocados under two years of age in Highlands County were visited early in October. The disease was evident in all groves except one, in which the trees were growing in soil that had previously supported a citrus grove. The condition was severe in groves planted on virgin soil.

In Mr. Ward's young avocado grove, affected trees had been given various soil treatments, including a mixture of sulfates of copper, iron, manganese, and magnesium in a well balanced fertilizer high in organic sources of nitrogen. Some had been given applications of poultry or stable manure, and others had received fertilizer treatments of different analyses. The only treatment which appeared to be beneficial was the mixed fertilizer containing copper, manganese, and magnesium.

### **Symptoms**

Affected trees appear somewhat starved in the incipient stages of the trouble. Older leaves have a dull appearance, with the veins becoming prominent at first and then assuming a reddish-brown color which may gradually spread into the leaf blades (Plate 1). The premature shedding of such leaves may or may not be accompanied by a dying back of the tips.

The symptoms in more advanced stages have certain characteristics in common with dieback of citrus. Multiple buds form at the tips of the twigs, sometimes forming a cluster three-quarter of an inch in diameter (Plate 2). These buds attempt to put forth new leaves, but almost immediately begin drying up and dying back until the entire twig showing the multiple bud growth is dead (Plate 3). Occasionally an affected tree will start new branches lower down on the trunk, which may in turn develop the multiple bud condition and die back. This condition may extend over a period of six months or more before the final death of the tree occurs in severe cases.

The disease appears to be confined to trees growing in the light sandy soils of the Ridge section, although a careful survey of the situation in other sections of the State is incomplete to date. Characteristic symptoms have been observed in a few instances on avocado seedlings, but the trouble is more pronounced on budded trees. Dieback without multiple bud formation was observed on a lone seedling tree of bearing age, which was growing in a poultry yard near Lake Placid. This tree had been showing more or less die-back for several years, according to the owner of the property. The disease was not observed in bearing trees growing in commercial groves.

## **Experiments**

The favorable response by affected trees to a fertilizer containing copper, manganese, and magnesium, in Mr. Ward's grove, indicated that the trouble is probably a manifestation of deficiency of one or more of these elements. Absence of the disease in bearing trees which have been sprayed annually with copper fungicides for control of fungous diseases, indicated that copper might be a corrective. Moreover, the absence of characteristic symptoms on young avocado trees growing in soil which formerly supported old citrus trees that had been sprayed in past years with bordeaux mixture, was also indicative that copper might be beneficial.

Soil applications of copper sulfate and of magnesium sulfate were made to several severely affected trees in two groves on October 12. The materials, applied in each case at the rate of two ounces per tree, were spread evenly and worked lightly into the soil within a radius of about 18 inches from the trunks.

The five trees treated with copper sulfate were showing decided improvement by November 22. New foliage which had developed since the treatment was normal in appearance, and where the multiple bud growth had died back new branches were appearing below the dead area. Untreated trees and those treated with magnesium were showing more pronounced symptoms of the disease than they had shown six weeks earlier.

Additional trees were treated with various materials in the same manner on November 22 in a grove near Lake Placid. Copper sulfate, manganese sulfate, magnesium sulfate, and a combination of copper and manganese were included in this series of treatments. Two trees were also given soil applications of borax at the rate of one-half ounce per tree. The trees were protected through the freeze in January 1940 by banking them with soil, and little damage from cold occurred.

They were examined early in March for response to the different treatments.

The dieback condition had become more pronounced on untreated check trees (Plate 3) during the winter months. On the other hand, five of the six trees receiving the copper sulfate treatment in November were showing good recovery in March, with normal twig and foliage development (Fig. 4). The sixth tree receiving copper sulfate had died before the freeze, probably because the disease had progressed too far before the treatment was applied. Of four trees receiving both copper and manganese sulfates, one had been severely injured by the freeze, two had made good recovery, and the fourth was growing feebly in March from basal shoots which had appeared after the top

was killed back either by cold or by disease.

The results from treating three severely affected trees with manganese alone were conflicting. One had made good recovery, but the others had apparently received no benefit from the treatment. The magnesium treatment had again failed to correct the dieback condition, and borax apparently served only to hasten the death of the trees.

The freeze in January severely killed back the trees in the grove where the first treatments were made, so that further observations on their response could not be made.

A number of trees in a young avocado planting near Sebring had died from the same disease during the summer of 1939, and scattered trees throughout the grove were showing symptoms of the trouble in November. It was suggested to the owner that a copper spray be tried for correction of the condition. The suggestion was followed, but unfortunately checks were not left in the grove.

All of the trees were sprayed in November with a mixture containing copper sulfate, manganese sulfate, and lime. The grove survived the freeze with only slight damage. The trees were generally showing normal growth in March 1940 without evidence of further development of the disease.

## **Discussion**

The disease of young avocado trees, herein described for the first time in Florida, may be called "dieback" appropriately. Although it has been observed thus far only in groves planted on the light sandy soils of Highlands County, a complete survey of young avocado plantings may show that it occurs elsewhere.

Dieback has been under observation for a relatively short time and hence the information is not complete regarding its etiology and control

The experimental work here reported has been exploratory in nature.

The work to date would indicate that dieback of young avocado trees is probably a copper deficiency disease, and that it can be corrected by applications of copper sulfate to the soil if the trouble has not progressed too far. Detailed recommendations for treatment cannot be given at the present time since the tests have not been extensive enough to answer definitely the question of optimum time, amounts, or even the form of application of copper. The disease has certain characteristics in common with "dieback" or "copper deficiency" of citrus. It is entirely possible that copper sulfate applied with lime as a spray will correct dieback of the avocado as it does dieback of citrus, but this point has not been definitely determined by experimental tests.

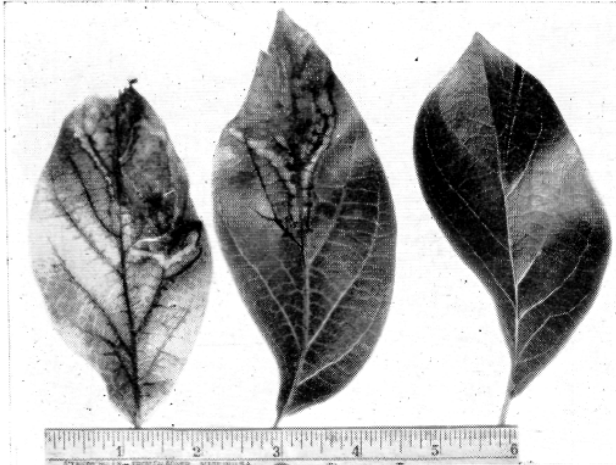


Plate 1. Old leaves from severely affected tree. Note prominence and discoloration of veins.

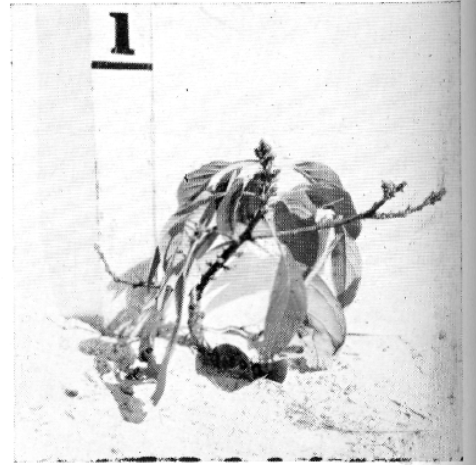


Plate 2. Multiple bud formation and dieback of young avocado tree. Photo taken November 22, 1939.



Plate 3. Untreated tree, March 6, 1940, showing severe multiple bud formation and dieback. This tree was just beginning to form multiple buds on November 22, 1939.



Plate 4. Correction of a severe case of multiple bud and dieback of young avocado tree. Copper sulfate applied to soil November 22, 1939; photo taken March 6, 1940.