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Lime-Induced Chlorosis

Chelating agents a possible means of control in citrus, avocado, and other subtropicals

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Lime-induced iron chlorosis in citrus and avocado trees may be controlled by chelating agents, such as EDTA—ethylene-diaminetetraacetic acid.

Chelating agents have the ability to form complex compounds with metal ions—iron, zinc, manganese, and magnesium—holding the metals in a soluble form in various degrees of tenacity.

Iron is held most firmly and, for this reason, the prospects may be best for the control of iron chlorosis—perhaps the most difficult nutrient deficiency to correct.

EDTA has the ability to hold iron as a chelated complex in acid, neutral, and, to a certain extent, in mildly alkaline and calcareous soils. It has proved successful in soil applications in correcting iron deficiency, mostly in the glasshouse, on several plant species including citrus, avocado, azalea, macadamia, and Leptospermum. Several species of chlorotic trees and shrubs in calcareous soil in the field have become green following soil applications.

Care must be taken in making soil applications of EDTA. Some plants — citrus, avocado, azalea, macadamia, Leptospermum, and corn—were severely burned by large applications.

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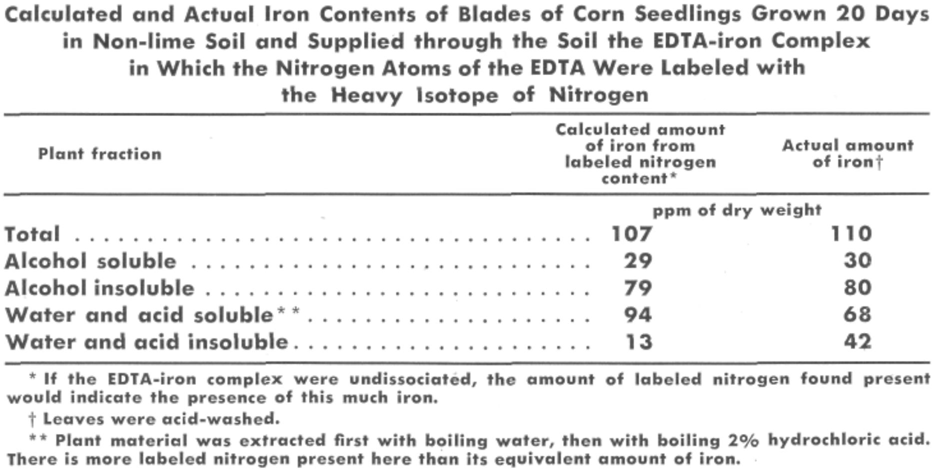
The exact cause of lime-induced chlorosis is not yet known. It may be an actual iron deficiency resulting from the low availability of iron in calcareous soil. Or the iron in the plant may be inactivated because of changes induced by the calcareous soil.

If the chlorosis is a real iron deficiency, iron chelates can correct it by keeping iron in a soluble form until absorbed by the plant. If the disorder results from inactivation of iron within the plant, it may not be possible to obtain complete control because the factors inducing the iron inactivation would still be present. However, if chlorosis is caused by iron inactivation in the plant —possibly in the roots—and if the EDTA-iron complex is completely absorbed by the plant, and remains intact so as to facilitate the translocation of iron from the roots to the leaves, satisfactory control may be possible through use of chelating agents.

The work to date does not indicate that EDTA necessarily facilitates iron translocation in plants. Some leaves sprayed with iron-EDTA greened in small spots similar to other iron sprays indicating either poor absorption or poor translocation or both. The EDTA molecule appeared to be absorbed with the iron according to results obtained using the stable nitrogen isotope to label the EDTA molecule in soil applications. Each EDTA molecule has two nitrogen atoms and the presence of substantial quantities of the isotope in leaves of orange, avocado and corn plants after additions to the rooting media indicated that the EDTA was absorbed with the iron. Once in the plant the EDTA appears to be separated from the iron— possibly metabolized to other compounds—and probably does not help the transport of iron throughout the plant.

Evidences for Metabolism

Some evidences for metabolism of EDTA are indicated in the table: EDTA salts are water and alcohol soluble; yet, much of the isotopically labeled nitrogen was present in water, alcohol and acid insoluble fractions of the test plants. This possibly means that the EDTA was split and its nitrogen synthesized to proteins or other insoluble compounds. In one instance there was more soluble labeled nitrogen than the equivalent amount of soluble iron, indicating a definite separation of iron from EDTA but not necessarily a metabolism of EDTA. It is possible that all the iron in the corn leaves came from the EDTA iron complex, since the total iron present—110 ppm—almost equals the calculated amount of iron—107 ppm— associated with the amount of the isotope nitrogen from the EDTA found present. For this reason it would have been impossible in this instance, without breakdown of the complex, to get more than three times as much iron in the acid-insoluble fraction as that indicated from the amount of EDTA nitrogen present in the fraction. This problem is being studied in more detail with other isotopes.



Calculated and Actual Iron Contents of Blades of Corn Seedlings Grown 20 Days in Non-lime Soil and Supplied through the Soil the EDTA-iron Complex in Which the Nitrogen Atoms of the EDTA Were Labeled with the Heavy Isotope of Nitrogen

Plant fraction	Calculated amount of iron from labeled nitrogen content*	Actual amount of iron†
	ppm of dry weight	
Total	107	110
Alcohol soluble	29	30
Alcohol insoluble	79	80
Water and acid soluble**	94	68
Water and acid insoluble	13	42

* If the EDTA-iron complex were undissociated, the amount of labeled nitrogen found present would indicate the presence of this much iron.

† Leaves were acid-washed.

** Plant material was extracted first with boiling water, then with boiling 2% hydrochloric acid. There is more labeled nitrogen present here than its equivalent amount of iron.

EDTA thus is of value in getting iron from soil into plants and there are good chances that the chelating agent will provide a means of controlling some cases of lime-induced chlorosis. It is possible, however, that it will not facilitate the translocation of iron through the plant.

There are some soils too alkaline and too calcareous or otherwise unfavorable for successful treatment. New chelating agents are being developed by the chemical industries for trial on such soils. Some of these are giving encouraging results. It is hoped that soil acidification in combination with chelated iron placed near the roots will improve the effectiveness.

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