Use of Iron Chelates

supplying plants with iron through soil treatment limited to high-value plantings

O. R. Lunt and A. Wallace

Use of chelating agents—especially the new compound Fe 138—to correct iron chlorosis by effectively supplying iron to plants has proved promising in a series of experiments.

All plant species tested—but not all individual plants—responded to treatment, and some of the individuals within species did respond with retreatment.

Treatment responses in the field have lasted from two to six months. Woody plants treated late in the summer have given good responses. Responses are more difficult to obtain for large trees than for small trees and shrubs. Some large trees required several months following treatment to become green.

None of the polyamine polyacetate chelates—of which EDTA is the best known—tested in the experiments has proved as efficient in correcting iron chlorosis by soil applications in California as in Florida. The reasons for this difference have been intensively studied.

Absorbed by Plants

Iron chelates supply iron to plants by being absorbed as a single molecule by the plant. Present evidence suggests that the chelate also helps effect translocation of iron in plants. The mechanism of release of the iron from the chelate within the leaf or the ultimate fate of the chelating agent in a plant is poorly understood.

The chelating agent, DTPA, has been a better source of iron for plants in many, but not all, calcareous soils than has either EDTA or HEEDTA. All three of these agents can be toxic.

Iron chlorosis in California almost always occurs in basic calcareous soils. Iron is precipitated as the hydroxide from chelates in basic solutions. In simple systems such as nutrient solutions this reaction proceeds very slowly, but in a clay suspension at alkaline pH—relative acidity-alkalinity—values above seven—neutral—the reaction proceeds rapidly. Apparently clay catalyzes the hydrolysis reaction by which iron is precipitated. In addition, the chelated molecule itself is fixed to a considerable extent under either basic or acid conditions in some soils, and this appears to be related to the amount and kind of clay in the soil. The mechansim of this fixation is not known, but reaction rates indicate it is not a simple exchange reaction. Soil organic matter, moderate amounts of salt in the soil, or soil microorganisms have very little effect upon the solubility of iron chelates in the soil.

Other Agents Studied

Additional chelating agents of the same family of compounds as EDTA that are capable of keeping iron soluble in basic solutions better than does EDTA have been studied. These were disappointing because they also were fixed on the clay portion of the soil, as was EDTA. Fixed iron chelate is a poor source of iron to plants as compared to soluble iron chelate. Within limits, iron chelate fixation in soil usually varies with the rate applied. Application of iron as the EDTA chelate at the rates of 40, 160, 320, 1,280, and 2,560 pounds iron per acre of soil to samples of Dublin silt loam containing 57% calcium carbonate, resulted in 85, 74, 68, 42, and 32% of fixation in 72 hours. These values represent the summation of both methods of fixation. Even the 40-pound rate is of doubtful economy for orchard operation. Smaller application rates in the field have proved ineffective, while in the laboratory such low rates are almost completely fixed within 24 hours. Rates beyond 160 pounds iron per acre have often been toxic.

The decreasing rate of fixation of chelated iron with increasing application rates does not necessarily imply that the soil becomes saturated. Some clay minerals did not exhibit a change in per cent of fixation with increasing application rate in the range studied.

New Chelates

Among a number of new chelating compounds supplied by the chemical industry one, an aromatic amine, designated Fe 138, appears especially promising for use in calcareous soils. There is little precipitation of iron from this chelate in calcareous soils during extended periods. In fact, this chelate performs the prodigious feat of solubilizing iron in calcareous soils. It has effectively supplied iron to a number of plant species and corrected chlorosis. It appears to be much less toxic to plants than is EDTA. The evidence obtained to date indicates Fe 138 is not readily decomposed by microorganisms and is not absorbed appreciably by the clay fraction of the soil. Although these data are highly encouraging, it must be emphasized that extensive testing will be required to evaluate the chelating compound.

O. R. Lunt is Assistant Professor of Soil Science, University of California, Los Angeles.

A. Wallace is Assistant Professor of Subtropical Horticulture, University of California, Los Angeles.

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VAPOR-HEAT

Continued from preceding page

the taste test. The heat treatments destroyed the fresh delicate flavor of the navel orange, and the loss of flavor and the reduction in acidity of the fruit gave the treated navels a flat taste.

The off-flavor in the lemons was considerable. The treated lemon samples which exhibited internal breakdown during subsequent storage developed extremely bad off-flavors.

Off-flavors could be detected in grapefruit and Valencia oranges, but they did not occur or develop in the storage of these fruits to the same degree as they did in the navels and lemons.

Injury to Avocados

The avocados tested—Fuerte and Dickinson varieties—would not tolerate a 16-hour treatment in a saturated atmosphere at 110F or the 120F temperature of the quick-run-up method.

All avocados were damaged by the vapor-heat treatments. The injury to the fruit consisted of off-flavors, rancid odor, and darkening of the interior. These injuries were intensified on storing the fruit at 50F for one week. The high, moist temperatures of the vapor-heat treatments appeared to inactivate the enzyme systems of the avocado fruits to the extent that treated fruit failed to ripen normally. In storage, the treated fruits were readily attacked by fungi, and consequently deteriorated very rapidly.

Walton B. Sinclair is Professor of Biochemistry, University of California, Riverside.

D. L. Lindgren is Entomologist, University of California, Riverside.

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