WHAT IS CHELATED IRON?

Harold E. White
Department of Floriculture
University of Massachusetts
Amherst, Massachusetts

In the soil when plant material or organic matter decomposes different organic and inorganic substances are released among which may be such acids as citric, malic, oxalic and tartaric. These organic acids and probably others have a peculiar chemical property of being able to combine with iron present in the soil to produce a relatively stable form of iron that is readily available to plants. This kind of iron is not too readily broken down by other elements or soil conditions that might tend to fix or tie up the iron in a form unavailable for plant use. Here we might say is nature's way of producing a simplified form of chelated iron. Unfortunately this simple, or should we say less complexed or chelated iron, is subject to change back to an insoluble form due to certain variations in soil conditions.

As long as suitable amounts of organic matter are maintained along with proper biological and chemical conditions in the soil then natures form of chelated iron continues to be an available source of iron for plant growth. The manner in which iron chelation takes place in soils is usually sufficient to maintain a supply of minor elements in an available form for plant use, so long as the plant population is at a certain level and the demand for elements by the crop is not too great. However when plant or crop demand for nutrients are stepped up we increase the demand for minor elements over and beyond the capacity of soils to produce an available supply of elements that may be needed even in very small amounts. Also when we bring the total amounts of nutrient elements up to a high or an excessive level we tend to disturb the balance between major and minor plant food elements. A good example of this sort of balance is the maintenance of an excessive level of phosphate and lime in soils. When this sort of condition occurs the phosphate and calcium unite with iron to form types of iron not readily available for plant use. Hence we say we have phosphate or lime induced iron chorosis.

Let it not be assumed from this one illustration that the process of minor element availability and fixation in soils is that simple. The maintenance of a proper balance of nutrient elements in the soil and the process of plant nutrition is regulated and disturbed by many conditions some of which are nature's and others are frequently created by man.

Laboratory Iron Chelates

Since World War II Agriculture and Horticulture have been the beneficiary of a number of industrial chemical developments among which have been insecticides, fungicides, soil conditioners, plastics and more recently a number of chemical compounds known as sequestering or chelating agents. In the trade these materials are known as Sequestrene and Versene. This group of chemicals includes a number of highly complex organic acids or salts which have been found useful in various manufacturing processes to remove undesirable metallic elements from cosmetics, foods, beverages, pharmaceuticals and many other products.

The importance of these sequestering or chelating materials exists in their ability to unite separately with such elements as magnesium, manganese, zinc, copper or iron to produce a complex form of chemical compound such as iron that that will be water soluble yet not readily broken down by an acid or alkaline soil condition. Moreover, the iron in form of iron chelates is not readily displaced by phosphorus or other soil elements that are prone to fix or change ordinary kinds of iron present in soil to a form unavailable for plant use.

The three sequestering or chelating substances which have been used successfully to make iron chelates are: (EDTA) ethylenediamine tetraacetic acid, (DTPA), diethylenetriamine penta-acetic acid and (HEEDTA), hydroxyethylene diamintriacetic acid. Chelated iron or iron chelates may be referred to in the trade under several names such as: Sequesterene NaFe, Fe-EDTA, Versen-ol, Ferro-Grene and others.

Experimental work with Iron Chelates

Published results of experimental use of iron chelates to correct and control iron deficiency symptoms of plants have concerned primarily citrus fruit trees, particularly, in Florida and California. In experiments with citrus trees the single application of 10 to 50 grams of iron chelate per tree are reported by research workers to have resulted in complete greening of leaves on trees that were extremely chlorotic, the response being observed in a matter of weeks. The beneficial effect of treatment of citrus trees has been reported to last for at least 6 to 7 months.

Some results of work reported from California where they treated some 16 different kinds of woody plants including good sized trees, showing symptoms of iron chlorosis had favorable effects. These research workers applied iron chelates of 3 different forms at rates of one ounce to five pounds per tree, depending on plant height and observed no harmful effects. The trees so treated with iron chelates are reported to have responded favorably for a period of 5 months with no further treatments.

Published information on the use of iron chelates on greenhouse ornamental crops are very meager. Reports on research work with iron chelates in Pennsylvania show favorable results from use of iron chelate in water solution applied to chlorotic azalea plants at the rate of 1 to 1½ ounces to 25 gallons of water. Iron chelate was used also in a dry form on gardenias at rates of 1 ounce per 100 square feet of soil surface with good results. Foliar treatments made to rose plants using 8 pounds of iron chelate to 100 gallons of water caused injury to the young growth.

The work with iron chelate conducted this past year by the Floriculture Department at the University of Massachusetts on roses and gardenias in the greenhouses of the Montgomery Company and Butler and Ullman Company gave very favorable results. Three varieties of roses, Goldilocks, Starlite and Golden Rapture that were very chlorotic received treatments of iron chelate at rates of 4 ounces up to 16 ounces per 100 square feet soil area. The iron chelate was applied in a dry form and watered into the soil. Greening of the chlorotic foliage was observed within 2 weeks and at the end of 4 to 6 weeks the plants were completely green. The favorable response was still evident at the end of 6 months. Foliar applications of iron chelate to roses at the rate of 2 pounds per 100 gallons of water caused injury to the new growth within 3 to 4 days.

The most interesting part of these experiments was the excellent favorable response obtained by treating chlorotic rose plants with the chelating agent alone which contained no iron at all. The chelating agent (Na_3EDTA) applied to soil at rates of 4 to 12 ounces per 100 square feet of bed area was just as effective in greening chlorotic plants as the chelating agent carrying iron. The important point shown by this part of the experiment is that there is plenty of fixed or unavailable iron present in our greenhouse soils and that the problem of chlorosis can also be corrected by use of a chelating agent instead of applying more unnecessary iron.

Gardenia plants one year and two years old were treated with an iron chelate and the chelating agent at rates of ½ ounce to 12 ounces per 100 square feet soil area. Here again the results were favorable with both the iron chelate and the chelating agent, particularly, on one year old plants as a preventive treatment.

On two year old chlorotic plants the rates at which the iron chelate and chelating agent were applied did not appear to be as effective as with one year old plants.

More complete experimental studies are to be conducted this year with iron chelates and chelating agents. A part of the work will be concerned with observations on flower production of chlorotic rose plants as compared with normal green plants. The Geigy Chemical Company has made a research grant of $500 to the Floriculture Department for use in the study of iron chelates.