THE ROLE OF CHELATES IN THE GREENHOUSE

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Chelates (pronounced as key-late) are used in the greenhouse to provide the four micronutrients, iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu). In the past all micronutrients were provided through the continuous exchange of field soil for greenhouse soil and the use of manure as well as organic nutrient sources. These practices are not used today; thus, micronutrient fertilization is often a necessity. The most common sources of micronutrients are the inorganic salts; i.e., manganous sulfate, borax, cupric sulfate, etc. These are inexpensive and effective in many situations. There are, however, situations in which these fail to perform and it is here that the more expensive chelated micronutrients play an unchallenged role.

What are Chelates?

The word chelate has its origin in a Green word meaning claw. This is appropriate since chelates hold very tenaciously to certain metals, in our case the four micronutrients, Fe, Mn, Zn and Cu. Chelates have a chemical structure comprising several arms, each with a point of attachment for the micronutrient. In this way the chelating agent encircles the micronutrient attaching to it in such a way that a series of rings is formed. Due to the strong holding force of the chelating agent the micronutrient is not readily available to other binding agents such as clay lattices and the hydroxides of high pH soils which would otherwise bind the micronutrient into an insoluble form unavailable to plant roots. Fortunately, the micronutrient - chelate complex can be absorbed into the root and later split apart. Inorganic salts, on the other hand, do not protect the nutrient from tie-up with agents that render it unavailable to the plants.

Function of Chelates.

The explicit value of chelated micronutrients can best be seen in the relationship between soil pH and the availability of Fe. In the top 6 inches of an acre of an acre of soil there is approximately 80,000 pounds of Fe and of this only 10 pounds is necessary for the growth of a crop. Often, not even 10 pounds is in an available form and more must be applied. The proportion of the total Fe which is available is controlled by the soil pH level. For each rise of one unit (5.0 to 6.0) the quantity of available Fe is reduced to one-tenth of the previous value. Thus if 1,000 pounds of Fe were available at pH 4.0 only 100 pounds would be available at pH 5.0 and 10 pounds at pH 6.0. This same effect takes place when inorganic Fe fertilizer is applied to the soil. It undergoes conversion to an unavailable form. The speed of this conversion increases 10 fold for each rise in pH of one unit. At pH levels approaching neutrality, 7.0, it becomes impractical to use inorganic forms for correcting Fe deficiency in greenhouse soils. Chelated Fe must be used due to its resistance to tie-up. Manganese is affected in the same way by soil pH and must also be applied in a chelated form in neutral and alkaline greenhouse soils.

Types of Chelates.

The story of chelates does not end here since there are different types. The Rayplex series of Fe, Mn, Zn, and Cu chelates lend themselves well to foliar sprays. These chelates are the by-products of paper pulp processing. Considering synthetic chelates, the same micronutrients are available in the chelating agent EDTA which is sold under numerous trade names of which two of the more common are Hamp-ene and Sequestrene. Fe, Mn, and Cu are also available as a chelate of HEDTA under the

trade name Hamp-ol. Other Fe chelates are DTPA and EDDHA sold as Sequestrene 330 and Sequestrene 138 iron chelates respectively. The difficulty in selecting a chelate lies mainly with Fe. In terms of increasing stability, or length of time that Fe is held available, these chelates may be lined up as: HEDTA, EDTA, DTPA and EDDHA. Thus in an alkaline soil of pH 7.5 and above EDDHA, Sequestrene 138 Fe Chelate, is the best choice even though it is the more expensive. In a slightly acid soil, below 6.8, EDTA would be a better choice due to lower price and effectiveness at that pH level. The favorite choice for greenhouse soils has been DTPA, Sequestrene 330 Fe Chalate, due to its high degree of effectiveness in mildly alkaline soils, intermediate price range and water solubility.

Fe Content of Chelate.

Do not be fooled by the Fe content of chelates. This bears no resemblance to rates of application. The cheaper inorganic source of Fe, ferrous sulfate, contains 21% Fe while chelates range from 6 to 14% Fe. Of all these materials the chelate with 6% Fe content is used in the smallest quantity and ferrous sulfate with 21% Fe is used in the largest quantity to do an equal job under similar conditions. A good case in point is the work of Leonard and Steward in Florida depicted in Table 1.

Table 1. Quantities of Fe from different chelate sources necessary to correct Fe deficiency of a single citrus tree at various soil pH levels.

Soil pH	Chelate - g Fe/tree		
	EDTA	DTPA	EDDHA
Below 7.2	10	10	10
7.2 - 7.8	70+	10	10
7.8 - 8.3	100+	80+	10

Application of Chelates.

One point remains to be considered, that of chelate application. The rates listed in Table 2 apply to florists crops in general and are designed to be used as a single corrective application. Two sets of recommendations are given for soil applications. The first column indicates the pounds of chelate which should be dissolved in the amount of water necessary to water 1,000 sq. ft. of bench crop. The second column applies to soil application of pot crops and is equivalent in rate to the first column. In both cases the chelates may be added to the normal fertilizer formulation and applied simultaneously. The foliar spray rates should be tested on a small scale first since crops vary greatly in susceptibility to

Table 2. Rates of various chelated micronutrients for soil and foliar application on greenhouse crops.

Micronutrient	Soil application		Foliar spray
	lbs/1000 sq. ft.	oz/100 gal.	lbs/100 gal.
Fe	1.0	3.2	1[a]
Mn	0.5	1.6	0.5
Zn	0.25	0.8	0.5
Cu	0.25	0.8	0.25

[a] Do not use Fe EDTA chelate as a foliar spray.

spray injury. Do not use Fe EDTA chelates as foliar sprays; they are very toxic. Spreader-stickers greatly increase micronutrient uptake from foliar sprays and are worth using.