

## CONVERSATIONS ON CHELATION AND MINERAL NUTRITION

Much has recently been said about mineral absorption into plants, and there are recent pontifications that the best way to supplement minerals is to take "Colloidal" mineral complexes, while still others professing that "Sulphates" are the way to go, and that "Chelated" minerals are supreme due to their bioavailability.

Everything you hear has some ring of truth to it; each side has a point to make. But unfortunately, neither side has ever told you the whole story about mineral uptake and balance in plant nutrition, and the limits of all the above methods of mineral supplementation. This has led to considerable confusion, misinformation and to the drawing of many inaccurate conclusions. Can it be simplified? Perhaps gaining a better understanding of what each category is may help reduce the confusion allowing growers to make a better decision about what to use.

### INORGANIC SALTS

These are simple mineral compounds such as sulphates or chlorides. Plants are accustomed to dealing with minerals in this form, but don't always do a good job of controlling absorption. Although mineral absorption increases when there is a mineral shortage, and decreases when mineral levels are high, the plants mineral transport system often mis-regulates minerals that share the same transport channels. For example, when copper and zinc salts are consumed together, they compete with each other for transport into the plant. An excess of zinc can therefore cause a deficiency of copper. If one's purpose in using mineral fertilizers is to force the plant to use more minerals than it normally would, the inorganic salts would be a poor choice. The rates of application for inorganic salts can be quite high and the frequency of application is also frequent, therefore making the total cost of inputs quite high over the growing season.

### OXIDES

An oxide is a raw version of a mineral. For example, Iron Oxide is also known as "rust". How soluble is rust? Magnesium oxide is insoluble; however it is used in commercial formulations as a source of magnesium. Oxides can only be dissolved using acids. The availability of oxides is extremely low and these types of formulations are better used in soil applications not as foliar sprays. Companies selling these formulations state that the product is ground to a fine powder rendering it soluble or available. The texture of the product has never been a criteria for the availability of any product. Only the formulation of the product specifies its solubility and availability.

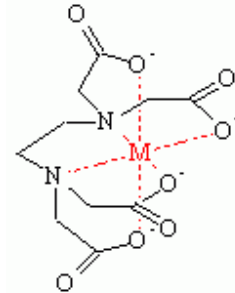
### COLLOIDS (SUSPENSION FERTILIZERS)

Colloids are materials made up of solid particles of such small size that when dispersed in water they remain in suspension rather than sinking. Colloidal minerals consist of mineral salts or other mineral compounds converted into colloidal form, either by grinding or by rapid crystallization.

Most colloidal substances are poorly bio-available, since the colloidal particles, small as they are, are nevertheless far too large to be absorbed whole, and nearly all of the active ingredients are trapped in the interior of the particles, where they cannot come into contact with the transport channels in the cells. However, if a colloidal substance can dissolve, it would then release all of its mineral material for potential absorption.

### EDTA

EDTA or ethylenediaminetetraacetic acid is a novel molecule used for complexing minerals. EDTA is a synthetic chelating agent which binds to an element and is used in cosmetics, medicine and plant nutrition. It is an agent which can not be utilised by the plant (never breaks down) and binds to minerals such as Calcium very tightly and makes the mineral less available once inside the plant. The complexed molecule is large and enters mainly from the underside of leaf. Too much EDTA is toxic to plants. EDTA is best used in pH's below 7.



### MIXTURES

Research has shown that chelated minerals are very important to plant nutrition; hence many companies have rushed to the marketplace with their own brands of “chelated minerals” without doing any research to determine whether or not their methods of chelation will actually enhance the absorption of the mineral. The only objective of these companies is to produce a “new” type of mineral fertilizer whereby their only objective is to gain profit from calling their product a chelate.

Many products claim to be amino acid chelates, however when formulations are reviewed, it is apparent that they are mixtures not chelates. The terms “chelate” and “amino acids” are used very loosely. These products, of which there are many in the New Zealand marketplace, are formulated by using protein powder and mineral salts, mixed together and the resulting product is a mixture, but wrongly called a chelate. Mixtures tend not to carry patent numbers as there generally is nothing to protect about the formulation. Mixtures are very expensive for an imitation of a chelate.

### ABOUT CHELATES

The word “chelator” refers to a substance consisting of molecules that bind tightly to metal atoms, thus forcing the metal atoms to go wherever the chelator goes. The bound pair — chelator plus metal atom — is called a “chelate”. Chelators of nutritional interest include amino acids, organic acids, proteins, and occasionally more complicated chemicals found in plants.

### AMINO ACID CHELATES

Amino acids can act as chelators when they react with positively charged metal atoms, forming a strong chemical bond. The metal atoms of interest here are those that serve as minerals. To take a specific example, a chelate can be formed between the amino acid glycine (the chelator) and calcium (the mineral).

Certain combinations of minerals and amino acids do not form good chelates because the chemical bonding is too weak. For example, if you try to use the amino acid glutamic acid as chelator and sodium as the mineral, you can get monosodium glutamate, which is considered

to be merely an “organic salt”, not a chelate. Generally speaking, sodium and potassium form poor chelates.

Furthermore, amino-acid chelation bypasses the competitive interactions that can occur between different minerals when they are absorbed as salts. Use of chelated minerals avoids this problem since they are transported by different mechanisms.

### THE AUTHENTIC CHELATES

The National Nutritional Food Association (NNFA) created a definition of what an Amino Acid Chelate is in 1996;

*Metal Amino Acid Chelate is the product resulting from the reaction of a metal ion from a soluble metal salt with amino acids with a mole ratio of one mole of metal to one to three (preferably two) moles of amino acids to form coordinate covalent bonds. The average molecular weight of the hydrolyzed amino acids must be about 150 AMU (Atomic Mass Units) and the resulting chelate must not exceed 800 AMU. The minimum elemental metal content must be declared. It will be declared as a METAL amino acid chelate: e.g. Copper amino acid chelate.*

*-Adapted by the NNFA Board of Directors, July 1996*

For a true functional chelate, the following further requirements must be met:

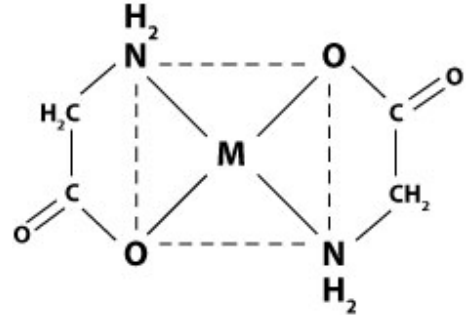
- 1) The chelate must have a molecular weight less than 1000 daltons.
- 2) The chelate must be electrically neutral. The chelate must not be complexed with an easily ionisable anion, such as a halogen or a sulfate group; the ligand must satisfy both the oxidative state and a coordination number of the metal atom.
- 3) The chelate must have a high enough stability constant to avoid competitive chemical interactions prior to absorption.
- 4) The ligand must be easily metabolised.

Formulation	Category	Solubility	Availability
<b>Oxides</b>	Raw mineral	Low	Low
<b>Sulphates</b>	Salt	Soluble	Moderate below pH of 7
<b>Nitrates</b>	Salt	Soluble	Good
<b>EDTA</b>	Synthetic chelate	Soluble	Moderate below pH of 7
<b>EDDHA</b>	Synthetic chelate	Soluble	Moderate above pH of 7
<b>“Amino acid chelates”</b>	Complex chelate / or mixture	Soluble	Moderate
<b>Glycine chelates</b>	True chelate	Soluble	Very high

Chelated nutrients are more plant available than complexed nutrients (EDTA, EDDHA, etc), and complexed nutrients are more plant available than mixtures and uncomplexed nutrients (Quelant, Sulphates and Oxides) as can be seen in the table above.

## COMMERCIAL AUTHENTIC CHELATES

An authentic chelate has all the properties specified above by the National Nutritional Food Association (NNFA). There are two companies worldwide that actually carry patents for manufacturing “authentic chelates” of which Glycine technology is involved in both patented processes. What is Glycine technology? It is a patented process of chelation whereby every element is bonded with two Glycine (smallest amino acid) molecules creating a fully chelated product. The plant recognises this molecule as a protein like nitrogen, allowing it to travel in the phloem quite readily to the growing points such as flowers, fruit and berries where it is required, as well as replenishing leaf levels also. This allows the element to be a mobile element in the Glycine chelated form whereas metals normally have low mobility within the plant. This is especially important for elements like Calcium and Boron.



The Glycine technology methods of delivery are not conventional, like the delivery methods of products such as oxides, sulphates and EDTA based trace elements. The latter products can marginally reduce a deficiency, but the speed by which the elements are released from these products and transported into the growing points is very slow compared to the transportation of elements in the Glycine form.

## How does one evaluate chelates against the other mineral forms in the marketplace which also talk of availability?

Simply ask the following questions:

- 1) Does the product have a patent number?
- 2) What is the chelating agent in the product and what concentration is the chelate?
- 3) Are the minerals truly chelated to amino acids or just complexed or are they simply trace minerals mixed with protein?
- 4) Is there proof of the chelate bond formation in the product?
- 5) Is the product stable when subjected to various pH ranges? (pH 4.0 - 7.5)?
- 6) Is the mineral product small enough in size to allow unhindered movement through the plant?
- 7) Compare pricing. You may pay less for some reported chelates and complexes, but are they really cheaper? If the product is not truly a chelate then you are essentially buying inorganic minerals at a premium price. Without guaranteed availability, you lose two ways: cost and mineral utilisation.

**Only true amino acid chelates will give you your money's worth. Don't be fooled by imitations.**

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