THE IMPORTANCE OF MINOR ELEMENT FERTILISATION FOR CROP YIELD AND QUALITY

Traditionally, crop fertilisation has been dominated by the major elements: nitrogen, phosphorous and potassium (i.e. N-P-K fertilisers) with the minor elements neglected unless some damage due to deficiency is observed (e.g. leaf chlorosis).

Although the minor elements are required, on a weight basis, in lower quantities than the major elements, their availability is just as important in determining yield and quality. Only after sufficient fertilisation with both major and minor elements are yield and quality limited by non-nutritional factors (e.g. plant genetics).

To achieve maximum yield and quality, minor element fertilisation must be considered.

Leaf analysis of minor elements can be misleading because many elements are relatively immobile in a plant and lab results may not reflect shortages in rapidly growing tissues.

Similarly, soil analysis of minor elements may be misleading because the elements may exist in forms not readily available to the plant.

The first step to understanding a more accurate and scientific approach to fertilisation is “The Law of the Minimum” also known as “Liebig’s Law” or “Liebig’s Law of the Minimum” (named after the German chemist Justus von Liebig).
This is a principle of agricultural science that states that plant growth is limited by the scarcest resource, not by the total amount of resources available.

Put another way, abundant N-P-K is of no benefit if growth is being limited by the availability of another element. The result of fertilising with N-P-K alone can be illustrated graphically:

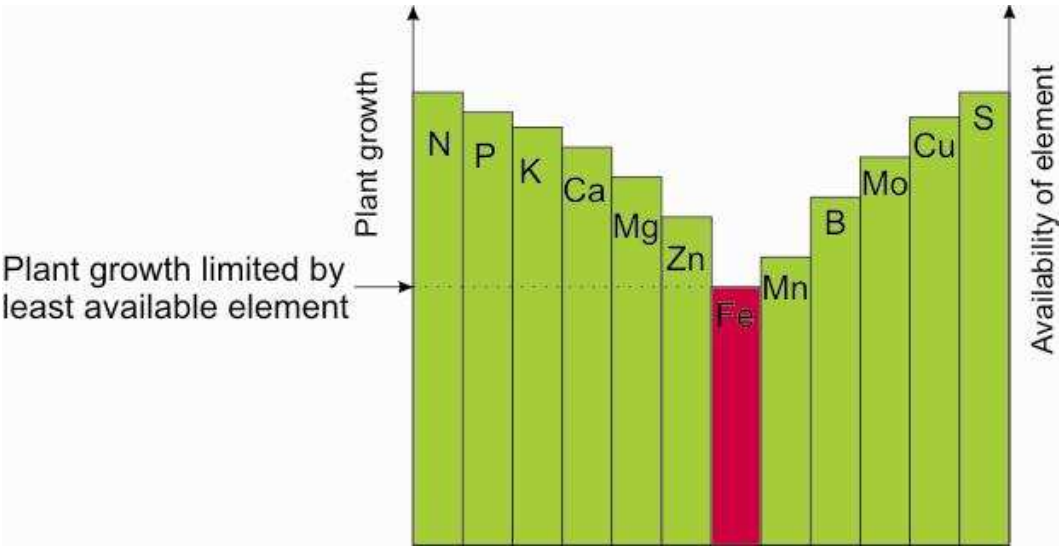

Figure 1. "Law of the Minimum" shown graphically

Visible signs of minor element deficiency such as leaf chlorosis do not need to be present for growth to be limited; visible damage indicates severe deficiency.

The availability of minor elements not only impacts on crop yield, but also quality characteristics such as appearance, firmness, sugar content etc: "The Law of the Minimum" can be applied to crop quality as well as yield.

Attempting to increase minor element availability by applying fertilisers to the soil is very difficult in practice because there are many factors that interact with these fertilisers and affect the outcome:

Difficulties in Improving Minor Element Availability by Applying Soil Fertilisers

Soil pH

Soil pH affects the solubility (and therefore availability) of the minerals containing the minor elements.

Unfortunately, some elements are more available in acidic soils while others are more available in alkaline soils. For example: calcium and magnesium tend to be more available in alkaline soils while iron and zinc tend to be more available in acidic soils. Therefore, while different plants often prefer different pH soils, in terms of minor element availability there is really no optimum soil pH.

Applying a minor element fertiliser to soil with the incorrect pH will likely be a waste of money as the element will be bound in an insoluble form that the plant cannot use. Applying iron to alkaline soils for example will result in the formation of iron oxides and hydroxides (essentially rust) with extremely low availability to the plant.

Soil moisture
Minor elements are leeched away in poorly drained soils and are also less available when the soil is very dry.

Soil microorganisms
Moderate levels of microflora (e.g. mycorrhiza) increase the availability of the minor elements, however when over-abundant they can become significant competitors instead. On the other hand, too few microorganisms can reduce the availability of minor elements as well.
The level of microorganisms in the soil is difficult to control and affected by many factors such as soil chemistry and environment, fertilisers use etc.

Soil aeration
Roots require sufficient oxygen for healthy growth. In soils with poor aeration, the root network may be stunted and therefore less able to take up minor elements

Organic matter content
Although organic matter can act as a reservoir for minor elements, high levels of organic matter can form insoluble complexes with minor elements in certain soil pH's.
Organic matter releases minor elements slowly and cannot correct acute shortages.

Using Foliar Sprays for Minor Element Fertilisation

All the above problems can be avoided by applying minor elements in foliar sprays - **so long as the sprays are chemically suitable for this purpose**.

Modern Plant Nutrition minor element fertilisers are of a type called **amino acid chelates**.
Amino acid chelates have a large body of high quality scientific evidence supporting their effectiveness at delivering minor elements to plants and resulting improvements in yield and quality.

No other type of foliar fertiliser has been demonstrated to be as effective.

Advantages of Using Amino Acid Chelate Foliar Fertilisers

Bioavailability
Amino acid chelates rapidly penetrate leaves and become systemic through plants. Plant cells recognise amino acids and quickly absorb the whole chelate molecule. Once inside, the cell's enzymes are able to break the chelate molecule down, releasing the minor element for use.
The combination of rapid penetration and distribution through the plant with easy use by the target cells means that amino acid chelates deliver elements with extremely high bioavailability.
High bioavailability also means good value for money: the grower is not paying for material that is unavailable to the plant and a waste.

Mobility

Once an amino acid chelate has penetrated a leaf, the nitrogen component of the amino acid is recognised by the plant as valuable and the whole chelate is then transported by the phloem to parts of the plant most in need (rapidly growing tissues). This means that the minor element is mobile and becomes systemic within a few hours.

In contrast, ionic forms of minor elements are often immobile within a plant and unable to be used by growing tissues. It is common, for example, to observe calcium deficiency in the rapidly growing tissues of a plant that has normal levels of calcium in a leaf analysis.

Consistency

As described previously, the soil is a very complex environment and many factors influence the availability of minor elements, making consistent delivery of these elements to plants difficult.

Foliar application of amino acid chelates, however, deliver consistent, controllable doses of minor elements.

Convenience

Modern Plant Nutrition amino acid chelates are liquid concentrates that mix immediately with water. Also, they are completely compatible with each other so that the full range of elements can be applied in one spray. They are also compatible with phosphites and most insecticides and fungicides.

Phytotoxicity

Unlike many foliar sprays, amino acid chelates will not cause leaf burn or other forms of phytotoxicity when used as directed.

Use of Amino Acid Chelate Fertilisers in Australia

Amino acid chelates are popular as minor element fertilisers in the United States and other parts of the world, and are gaining popularity here in Australia.

Crops in Australia tend to become deficient in certain minor elements. Among the most common deficiencies are **calcium, magnesium, zinc, iron** and **manganese**.

Modern Plant Nutrition offers these five minor elements chelated with the amino acid glycine for the benefit of Australian growers.