ALBION®
Metalosate® Foliar Plant Nutrition Information
A Compilation of Technical Information and Essential Plant Research Projects
June 2003 Volume 4, No. 2

Metalosate® Zinc in Plant Nutrition

Zinc in the Soil

The average zinc content of uncontaminated soils is in the range of 17 to 160 ppm. The vast majority of this zinc is present in the lattice structure of the soil and therefore unavailable to meet plants' nutritional needs. Available soil zinc is dissolved in the soil solution in ionic or complex form and may be found on exchange sites of clay minerals and organic matter or adsorbed on soil surfaces as Zn^{2+}, $ZnOH^{+}$, or $ZnCl^{+}$. The solubility of zinc is highly dependant upon soil pH. The higher the pH of the soil, the less soluble zinc becomes. The presence of $CaCO_3$ further decreases the amount of soluble zinc because of specific adsorption of Zn^{++} to and occlusion by carbonates. The "adsorption and occlusion of Zn by carbonates are the major causes of poor Zn availability and the appearance of Zn deficiency on calcareous soils."[1] Large applications of phosphorous fertilizers to soils low in available zinc can also induce zinc deficiency.

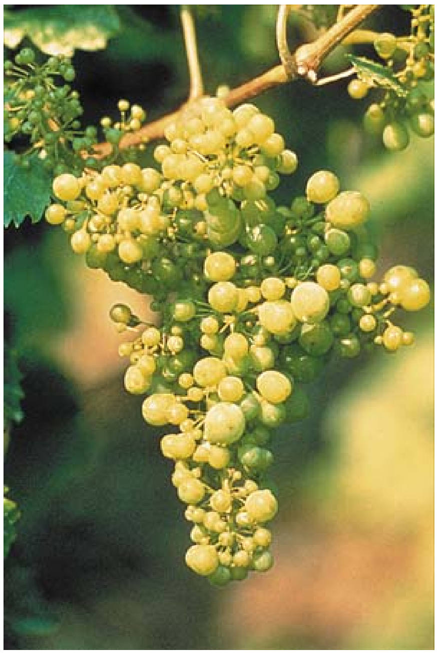
Zinc Utilization by Plants

In plants zinc is taken up in the Zn^{2+} form. At this time it still remains unclear whether this uptake is facilitated as diffusion through membranes specific for Zn^{2+} or whether it is mediated by specific transporters. The possibility exists that both mechanisms are utilized by plants for zinc uptake. Work done in the 1970's concluded that 90.5% of the total zinc required by plants moved towards the roots by diffusion. Zinc diffusion is highly dependant upon soil moisture and this may be the reason why, particularly in arid and semi-arid areas, zinc deficiency is more frequently seen.[2] It has been reported in work done on sugar cane that the presence of Cu^{2+} significantly suppressed the uptake of Zn^{2+}. It appears that these two ion species compete for the same uptake system.[3] Zinc is transported in the xylem system from the roots to the shoots. Fairly high levels of zinc have also been found in phloem sap, indicating that zinc is also transported in the phloem system. One study found that the redistribution of Zn from vegetative to generative plant parts in vetch was as good as that of N and P which are known to be highly mobile within the phloem.[4]

Zinc plays an important role in many biochemical functions within plants. "Zinc is an essential component of over 300 enzymes."[5] In most of these enzymes, zinc makes up an

Zinc Deficiency in Apple

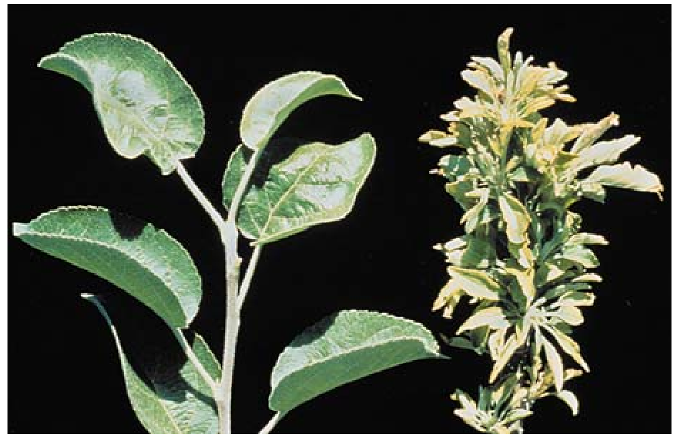
integral component of the enzyme structure. The role of zinc in DNA and RNA metabolism, in cell division, and protein synthesis has been documented for many years. Zinc is very closely involved in the nitrogen metabolism of plants. In plants with zinc deficiencies, protein synthesis and protein levels are drastically reduced whereas amino acids accumulate.



Zinc Deficiency in Grapes

The accumulation of amino acids occurs because zinc plays an important role in helping different combinations of amino acids link together to form enzymes and proteins. Without adequate levels of zinc, the plant is unable to synthesize the various enzymes and proteins therefore causing a build up of amino acids.

The ribosome is the site of protein synthesis within the plant cell. Zinc is a structural component of the ribosome. In the absence of zinc, the ribosomes disintegrate. In the meristematic regions of plants; *i.e.* the shoots and pollen tube, zinc content must be at least 100 ppm, which is essential for the maintenance of protein synthesis. This level is five times the level needed in the leaves and consequently, to meet the high demand for zinc in the shoot meristems, most of the root-supplied zinc is preferentially translocated to the shoot meristem.



Little Leaf in Apple Caused by Zinc Deficiency

The most distinct zinc deficiency symptoms—stunted growth and *little leaf*—are presumably related to disturbances in the metabolism of auxins, indoleacetic acid (IAA) in particular.[6] Zinc is also required for integrity and maintenance of membranes. It binds to constituents of the membrane causing them to become more stable. Under zinc deficiency there is an increase in plasma membrane permeability, resulting in the membranes becoming *leaky*, which is very detrimental to plant health.

Zinc Deficiency

Zinc deficiency is widespread among crops grown in calcareous soils and highly weathered acid soils. The deficiencies in the calcareous soils are often associated with iron deficiency as well. As previously mentioned, the low availability of zinc in high pH, calcareous soils results mainly from the adsorption of zinc to clay or $CaCO_3$ in these soils.

Little Leaf Rosette and Chlorosis in Citrus

Metalosate® Zinc Studies

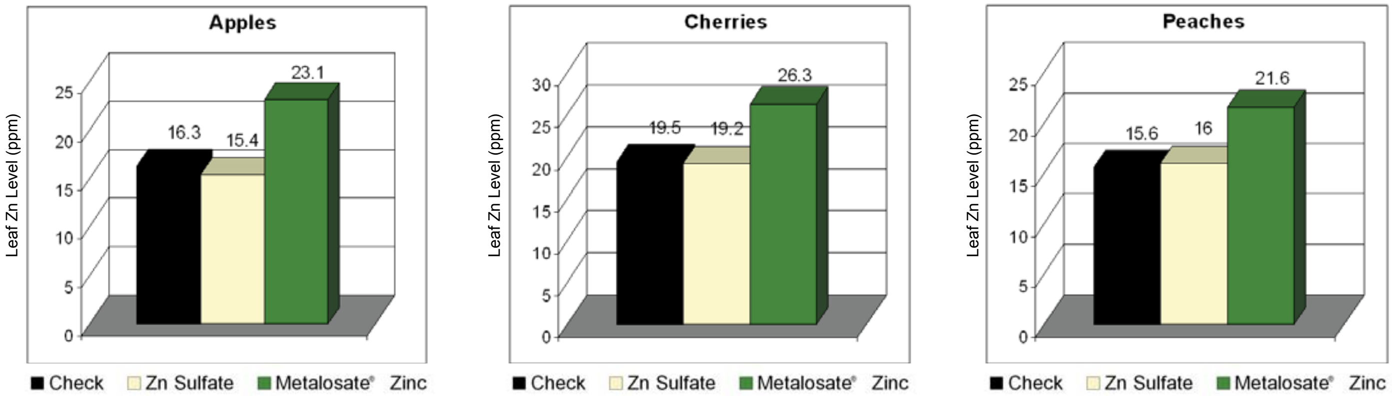


Figure 1. Zinc Levels in the Leaves of Trees Untreated, Treated with Zinc Sulfate, and Metalosate® Zinc
Source: Lindstrom & Frisby—"Zinc Foliar Trials 2001"—Utah State University

The most characteristic visible symptoms of zinc deficiency in dicots are stunted growth due to shortening of internodes (*rosetting*) and a drastic decrease in leaf size (*little leaf*) as shown in the pictures in this newsletter. In fruit trees leaf development is adversely affected. Unevenly distributed clusters or rosettes of small leaves are formed at the ends of young shoots. Frequently the shoots will die off and the leaves fall prematurely. In apple trees this happens early in the year and must be addressed early. In addition to poor leaf development, trees will also have fewer buds form and in many instances the buds that do form frequently will not open and eventually die. Interveinal chlorosis is often present when zinc deficiencies exist. Under severe zinc deficiencies, the shoot apex will actually die back.

Metalosate Research Data

In a zinc trial conducted by Utah State University, Logan, Utah, in 2001, investigators observed a significant increase in leaf tissue zinc levels. To set up the trial, the check trees were treated with zinc sulfate at a rate of 10 lbs. per acre with the following floral bud stages at the time of application: apple at ½ inch green, peach at calyx red, and tart cherry between green tip and tight cluster. The other trees were treated two times with Metalosate® Zinc at a rate of 1 quart per acre. The treatment dates were May 7 and June 6. Leaf samples were taken on July 20 and analyzed for nutrient content. The results of the analysis are represented in Figure 1.

It can be seen that application of Metalosate® Zinc was more effective at increasing the zinc levels in the leaves of these fruit trees than zinc sulfate.

In another notable scientific experiment (see Figure 2), it was shown that Metalosate® Zinc moved into the xylem

Metalosate Studies

Source: Kirkpatrick—"Grape Research Progress Report 2000"—University of California, Davis

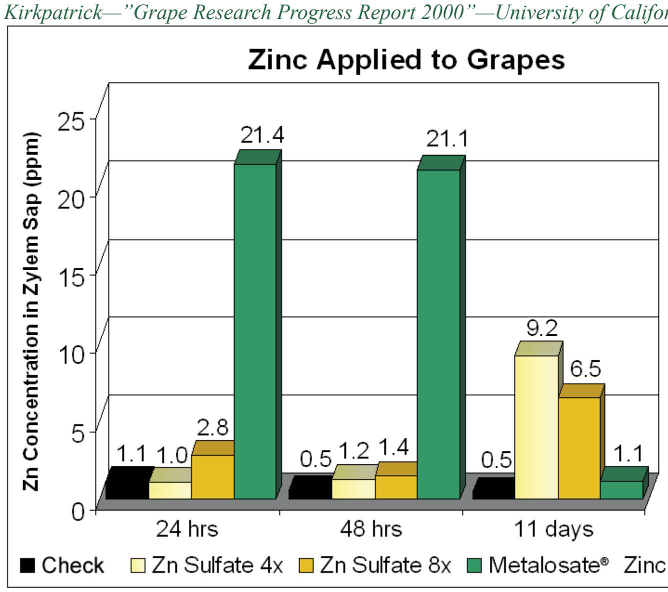


Figure 2. Levels in the leaves of grapes untreated, treated with zinc sulfate 4 times the label rate, treated with zinc sulfate 8 times the label rate, and Metalosate® Zinc at the maximum label rate.

system of wine grapes more quickly and efficiently than zinc sulfate. In work published by Dr. Bruce Kirkpatrick at UC Davis while trying to find possible ways to combat Pierce's Disease in vines, it was discovered that with Zinc Metalosate® application, zinc levels in xylem sap can be elevated many times greater than that of the check. The Metalosate® Zinc was applied at a dilution of 1 part Metalosate® to 20 parts water. The zinc sulfate applications were 4 and 8 times the labeled rate. All of these applications were extremely high concentrations and would likely cause phytotoxicity. The important thing to note from this trial is the fact that the Metalosate® Zinc was able to move through the leaves and into the xylem system of the tree very quickly and efficiently where it available for translocation to the areas of need by the plant without casing phytotoxicity.

References

1. Mengel, K., & Kirkby, E. A. (2001). *Principles of Plant Nutrition* (5th ed.) (p. 585). Dordrecht: Kluwer Academic Publishers.

2. Mengel, K., & Kirkby, E. A. (2001). *Principles of Plant Nutrition* (5th ed.) (p. 594). Dordrecht: Kluwer Academic Publishers.

3. Bowen, J. E. (1969). Adsorption of Copper, Zinc, and Manganese by Sugar Cane Tissue. *Plant Physiology*, 44, 255-261.

4. Caballero, R., Arguzo, M., & Hernaiz, P. J. (1996). Accumulation and Redistribution of Mineral Elements in Common Vetch During Pod Filling. *Argon J.*, 88, 801-805.

5. Fox, T. L., & Guerimot, M. L. (1998). Molecular Biology of Cation Transport in Plants. *Annu. Rev. Plant Physiol. Plant Mol. Biol*, 49, 669-696.

6. Maischner, H. (2002). *Mineral Nutrition of Higher Plants* (2nd ed.) (p. 355). San Diego, CA: Academic Press.

ALBION

Metalosate® Foliar Plant Nutrition Information

June 2003
Volume 4, No. 1

Metalosate® Foliar Plant Nutrition Information is a publication of

Albion Advanced Nutrition
101 North Main Street
Clearfield, Utah 84015-2243
USA
www.albion-an.com
Phone: (801) 773-4631
(800) 453-2406
FAX: (801) 773-4633
E-mail: info@albion-an.com

Local Representatives

Kevin Dickinson
(Intermountain US, Africa, Middle East, Europe, UK)
e-mail: kdickinson@albion-an.com
mobile: (801) 540-6035

Jeremy O'Brien
(Washington and Oregon)
e-mail: jobrien@albion-an.com
mobile: (801) 725-4197

Ludwig Voet
(California, Far East)
e-mail: lvoet@albion-an.com
mobile: (801) 726-4004

Todd Edwards
(Southwestern US, Latin America)
e-mail: tedwards@albion-an.com
mobile: (801) 726-7618