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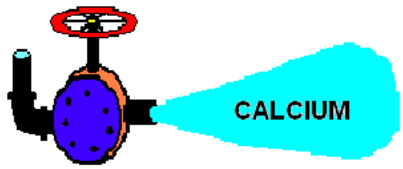

Calcium

Calcium -A Transportation Problem

Supplying plants with all the nutrients they need in the right ratios, via a well balanced nutrient program should produce fruit and foliage that is not deficient in any element. Some plant nutrients in particular can become deficient in leaf and plant tissue even if they are in plentiful supply in the nutrient solution. The most common problem nutrient is calcium. A lack or shortage of calcium in leaf tissue can cause the disorder *tip burn* in a huge range of plants and calcium related disorders in fruit such as *blossom end rot* and *bitter pit.*

Often growers don't associate *die back* or *burning of the leaf tips* with calcium tissue deficiency since their nutrient program usually has more than sufficient calcium. Tip Burn or dying of the leaf margins can have other causes such as wind/sun/temperature damage, scorching under intense lighting, physical damage, insect or disease damage and ageing of plant foliage. Other nutrient deficiencies can also show these symptoms, i.e. potassium deficiency.

True tip burn however, is characterized by occurring on the inner, younger leaves, visible as soon as they develop in the center of the plant. The tissue affected initially looks like a water soaked area that turns brown, then blackens and may rot away in severe cases. The water soaking seen in the early stages are caused by leaf cells breaking down and leaking cell fluids into the surrounding tissue -making an ideal media for rot pathogens to grow on. The black rot is evidence of fungal and bacterial degradation of dead tissue. These areas may also provide infection points for many pathogens.

Tip burn is most common on hearting varieties of lettuce. The leaves inside the heart are the most severely affected. Tip burn can also occur on a number of other plants such as strawberries, leaf crops, herbs, most vegetables, tree fruit and many ornamental species. Blossom end rot on fruits such as tomatoes and peppers is also caused by inadequate calcium - a lack of calcium in the cells right at the end of the fruit (at the blossom end) which causes cellular break down, and a blackening of the affected area. In tomato fruit calcium levels at the bloom end are twice as higher as in the middle and stem end of the fruit.

Calcium is deposited in plants cell walls during their formation - it is required for the stability and function of cell membranes and acts as a cementing agent in the cell walls in the form of calcium pectate. Calcium pectate is the glue binding adjacent plant cells together. If adequate calcium is not transported during cell formation, tissues become less stable and are more prone to disintegration. Calcium, once incorporated into plant tissue is immobile. A constant supply is necessary for continued growth.

Concentrations of calcium are higher in older foliage, therefore, the newer growth first shows deficiency symptoms. Calcium also plays a role in activating enzymes, regulating the flow of water movement in cells and is essential for cell growth and division. Calcium also helps as a buffer when excesses of other elements are present in the cell sap. Calcium is an important component of a plants' root structure. Calcium is primarily taken up by the tip of roots and this area extends from the tip to the area just below the root hair zone.

Tip burn and blossom end rot symptoms are usually a result of a calcium transport problem through the xylem the plant. Within a plant there are two types of transport tissues, the xylem and phloem which act as a circulation system carrying minerals and sugars around the plant for growth. The xylem vessels carry water and dissolved nutrients from the roots upwards to the leaves. The phloem carries sugars and other organic compounds from the leaves to other growing points or sinks including roots. Water is lost from the foliage in the form of water vapor (transpiration). This creates suction drawing water up the xylem vessels to other areas of the plant. Since calcium ions are transported principally in the xylem, any factor which either influences the plant's water supply (and hence xylem flow) or the xylem tissues themselves will affect calcium nutrition.

Calcium is a relatively immobile element and follows the transpirational flow of water. It moves less readily to organs with low rates of transpiration, like fruits and the tips of rapidly expanding leaves, than it does to actively transpiring leaves. Because of this reduced movement to fruits and tips of young leaves, calcium deficiency disorders tend to occur in fruits and leaf tips.

A primary way to insure that calcium gets into all foliage is to encourage a steady rate of evapotranspiration. Control of evapotranspiration is environmentally driven except in a greenhouse or other controlled area. As water is lost from the leaf surface, the xylem will bring more water and calcium to the leaf and the leaf tip, thereby preventing tip burn. Low humidity levels below 90% promote this process. Air movement across the leaf surface will move transpiration water from the surface, cooling the plant and will help maintain the flow and deposition of calcium.

Blossom end rot of fruit (particularly of tomato and capsicum fruit) is often a result of environmental and internal plant conditions and not as much a direct result of calcium depletion in the nutrient solution. Blossom end rot usually first appears as a water-soaked region around the blossom scar, which gradually turns dark brown and becomes sunken as the infected tissues lose water. Each affected fruit may have one or several initial spots of infected tissue. The dead tissue often induces premature ripening of the fruit close to the sunken area. Virtually no calcium is transported to the fruits from surrounding leaves, therefore, calcium nutrition during the fruiting phase is the first step in prevention.

The incidence of blossom end rot in a crop, can be reduced by spraying with a calcium nitrate and/or calcium chloride solution. Rates may vary by crop but a general rule of thumb is to routinely apply 4 – 7 pounds of Calcium Nitrate per 100 gallons of spray solution per acre and add Calcium Chloride at 1 – 2 pounds per 100 gallons of spray solution per acre. Both materials may not be needed. Regular and frequent tissue testing will provide a template for calcium addition to foliar spray programs. The green fruit must be sprayed as well as leaves. Leaf spray alone has little beneficial effect unless it begins early during vegetative growth and prior to flowering or fruit set.

Blossom end rot of fruiting crops can be prevented or minimized in a number of ways. High humidity favors blossom end rot development, particularly if combined with high temperatures with little or no wind or air circulation. Shading is beneficial in some crops under summer or high light conditions. Cultivar selection is also important, many varieties of tomato and capsicum have been developed which have considerably more resistance to developing blossom end rot than older varieties. Attention to ECe levels can assist with blossom end rot prevention. There is a general reduction in calcium uptake under high nutrient ECe levels. Tables are available showing ideal ECe levels for most crops. (ECe = conductivity of soil solution usually measured in dS/m – dS/m X 640 = ppm)

Adequate calcium concentration in nutrient solutions in hydroponics systems is usually maintained with calcium nitrate or other calcium salts. Low calcium levels in plant tissue and the occurrence of deficiency symptoms is usually caused by other factors that impede calcium uptake or hinder its distribution within the plant.

Calcium uptake may be reduced by the competitive effects of a high concentration of other cautions such a potassium, sodium, magnesium, aluminum or ammonium in the solution. Since calcium moves in the xylem tissue, its uptake is also affected by low root temperature (cool soil) and by restricted water movement through the plant caused by high salinity in the media or excessive humidity in the atmosphere. Some soils have a texture that reduces lateral movement of water. A Root Nutrient Uptake Pipeline discusses mechanisms of nutrient uptake. Proper soil leveling and drainage patterns/systems can also reduce calcium uptake problems. If soil water is not moving around the roots driven by conditions favorable for transpiration, calcium uptake as well as uptake of other nutrients will be reduced.

Higher ECe levels in the nutrient solution reduce the uptake of calcium, unlike nitrogen and potassium uptake that increase in leaf tissue concentration with higher ECe levels. Reducing the ECe of the nutrient solution enhances water uptake, therefore, more calcium can be taken up and transported within the plant to developing tissue. In particular, lowering the ECe at night promotes calcium uptake. Calcium uptake and distribution is favored at night when xylem sap pressure can pull water and calcium into the low or non-transpiring tissues like young leaf tips and fruits. Calcium is incorporated into the inner heading leaves of vegetables and other plants more abundantly at night than during the day. This is also the case with calcium transport into tomato fruit.

High soil ECe levels create a situation where water movement into the roots is reduced because salt concentrations in the soil solution around the roots are higher than in the roots. This reduces osmotic movement of water into roots following the ion concentration gradient. If water movement into the root zone is reduced, many cations and anions that rely on this movement for mass flow may become deficient. Plants usually have 4 or 5 times more calcium moving by the roots than they require but the uptake is directly proportional to water movement around roots, water uptake into roots and to conditions favorable to total water movement to roots and out of the leaves. Anything that restricts water movement into or out of a plant system greatly limits calcium uptake, translocation and also limits uptake and translocation of all other nutrients.

To avoid calcium disorders like tip burn and blossom end rot, maintain adequate calcium levels in a balanced nutritional solution with the correct ECe level, maintain adequate levels of other required nutrients in the soil solution, insure water movement in the root zone is not restricted by compaction or other physical barrier and select cultivars less susceptible to developing these disorders. Understanding the environmental conditions which favor calcium disorders is also important. Conditions of excessive temperature, high humidity levels and water stress can all reduce calcium uptake and translocation within the plant.

Peanuts have uptake requirements for calcium both in the plant root zone and in the pegging zone. Deficiencies in either location will create yield limiting issues for growers. Soil testing and application rates and timing vs. location become very critical.

For more information on Calcium and crop growth contact: Creech Crop Services, LLC

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