Why Calcium is So Important

Calcium - A Transportation Problem

By Dr. Lynette Morgan

As hydroponic growers we like to think that by supplying our plants with all the nutrients they need in the right ratios, via a well balanced nutrient solution ... the fruit and foliage won't become deficient in any element and won't show any deficiency symptoms. It would nice if this was true, but some plant nutrients in particular can become deficient in leaf and plant tissue even if they are in plentiful supply in the nutrient. The most common offender of this problem is calcium. A lack or shortage of calcium in leaf tissue can cause the disorder `tipburn' in a huge range of plants and calcium related disorders in fruit such as `blossom end rot' and `bitter pit'.

Many newer growers don't often associate die back or `burning' of the leaf tips of their plants as a calcium tissue deficiency since their nutrient solution usually has more than sufficient calcium levels. To make things even more confusing, `tip burn' or a drying 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.

True tip burn however, is characterised by developing mostly on the inner, younger leaves, visible as soon as they develop in the centre of the plant. The tissue affected starts off by looking like a water soaked area, which browns, then blackens and rots away in severe cases. The water soaking seen in the early stages are the leaf cells breaking down and leaking cell fluids into the surrounding tissue - making an idea media for rot pathogens to then grow on. Tip burn is most common on hearting varieties of lettuce when the leaves inside the `heart' are the most severely affected. However, tipburn can also occur on a number of other plants such as strawberries, salad greens,

herbs, most vegetables and many ornamental species. Blossom end rot which affects fruits such as tomatoes and peppers is the same problem - 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.

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 type of `cementing agent' in the cell walls in the form of `calcium pectate'. Calcium pectate is like a glue binding adjacent cells together so if inadequate calcium is not transported during cell formation, tissues become less stable and prone to disintegration. Calcium, once incorporated into plant tissue is immobile so a constant supply is necessary for continued growth. Concentrations of calcium are higher in older foliage, so it is the newer growth which 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 and is therefore an important component of a plants' root structure.

Tip burn and blossom end rot symptoms are usually a result of a calcium transport problem within 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. Water is lost from the foliage in the form of transpiration, and this creates a suction which draws water up the xylem vessels and around the plant. Since calcium ions are transported principally in the xylem, any factor which either influences the plant's water loss (and hence xylem flow) or the xylem tissues themselves will affect calcium nutrition. Calcium being a relatively immobile element, follows the transpirational flow of water, so it moves less readily to organs with low rates of transpiration such as fruits and the tips of rapidly expanding leaves, than it does to actively transpiring leaves. This means that calcium deficiency disorders tend to occur in fruits and leaf tips. One of the best ways of making sure calcium gets into all foliage is to encourage a steady rate of evapotranspiration - as the water is lost from the

leaf surface, the xylem will bring more water and calcium to the leaf and hopefully right to the leaf tip, thus preventing tip burn from occurring. Keeping humidity levels below 90% helps this process, but more importantly having some gentle air movement across the leaf surface will drive transpiration from the surface, cooling the plant and keeping the flow and deposition of calcium going.

Blossom end rot of fruit (particularly of tomato and capsicum fruit) is also more often a result of environmental and internal plant conditions than it is a direct result of calcium depletion in the nutrient solution. Blossom end rot (BER) 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, so attention to good calcium nutrition during the fruiting phase is the first step in prevention. The incidence of BER in a crop, can be reduced by spraying with a 0.2% calcium nitrate solution - however it is the green fruit which must be sprayed as spraying the leaves alone has no beneficial effect.

Blossom end rot (BER) of fruiting crops can be prevented or minimized in a number of ways. High humidity favours BER development, particularly if combined with high temperatures - so 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 EC levels can assist with BER prevention - there is a general reduction in calcium uptake under high nutrient EC levels.

Calcium in nutrient solutions

In hydroponic systems, adequate levels of calcium are usually maintained with calcium nitrate or other calcium salts. Therefore the lowering of calcium levels in the plant tissue and the occurrence of deficiency symptoms usually result from the influence of other

factors which impede either calcium uptake or its distribution within the plant. Calcium uptake may be reduced by the competitive effects of a high concentration of other cations such a potassium, sodium, magnesium or ammonium in the solution. And since calcium moves in the xylem tissue, its uptake is also affected by low root temperature and by restricted water movement through the plant caused by high salinity in the media or excessive humidity in the atmosphere.

Higher EC levels in the nutrient solution reduce the uptake of calcium, unlike nitrogen and potassium which increase in concentration in leaf tissue with higher EC levels. Reducing the EC of the nutrient enhances water uptake and with this, more calcium can be taken up and transported within the plant to developing tissue. In particular, lowering the EC at night is most beneficial for calcium uptake - calcium uptake and distribution is favoured at night when xylem sap pressure can drive water and calcium into the low or non transpiring tissues such as enclosed leaf tips and fruits. It is well known that calcium is incorporated into the inner heading leaves of vegetables and other plants more abundantly at night than during the day and this is also the case with calcium transport into tomato fruit.

Avoiding Calcium disorders

Perhaps the two simplest means of preventing calcium deficiency disorders such as tipburn and blossom end rot is to firstly maintain adequate calcium levels in a balanced nutritional solution with the correct EC level and if possible, select cultivars which are less susceptible to developing these disorders. Understanding the environmental conditions which favour calcium disorders is also important. Conditions of excessive temperature, humidity levels and water stress can all be influenced by a grower by manipulating the plant's environment. Keeping the plants stress free, providing gentle air movement across the leaf source to encourage transpiration and preventing excessive temperatures all help drive calcium into leaf tips and developing fruits.

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