Calcium Nutrition in Plants

CERTIFIED CROP ADVISER

By Greg Patterson, *CCA*

The role of calcium in plants is quite similar to that in people; it is essential for good growth and structure. Insufficient calcium levels lead to deterioration of the cell membrane; the cells become leaky resulting in the loss of cell compounds and eventually death of the cell and plant tissue.

Calcium, in addition to its role in cell structure, also plays a role in regulating various cell and plant functions as a secondary messenger. This function as a secondary messenger assists in various plant functions from nutrient uptake to changes in cell status to help the plant react to the impact of environmental and disease stresses.

Adjusting soil pH based on soil test results is basic in soil fertility. Without adequate soil pH nothing else works properly in relation to plant nutrient uptake and plant nutrition. However it should not stop at this, as soil pH alone is not always the best indicator of soil calcium levels. In many cases, with soil tests that have a pH above 6.2, a buffer pH is not performed on the soil. In the case of a crop that requires calcium for quality, total calcium availability is more important than soil pH.

The ideal % saturation for calcium should be around 70% for most crops and even at that level some crops will require more calcium. A soil that has cation exchange capacity (C.E.C.) of less than 7, a pH of 6.4 and a buffer pH of 6.9 would only have a saturation of around 60% calcium which would not be adequate for most specialty crops. Soils with C.E.C. between 7 and 15 with a buffer pH of 6.9 would have 70% calcium. Soils with C.E.C. greater than that would need pH around 6.6 to 6.7 to have adequate calcium supply. Those soils with a buffer pH of 6.9 would only have about 65% calcium, which would not supply enough calcium in many cases.

In the case of many soils, pH is elevated by more than calcium. Magnesium for example will elevate pH more than calcium. Maintaining the proper balance between calcium and magnesium requires understanding the difference between soil types and predictable availability of the cations. In soils with C.E.C. < 7, you should look for a calcium to magnesium ratio of 3:1 and in soils with C.E.C. between 7-25 that ratio would rise to 5:1. In addition, you want to maintain a potassium to magnesium ratio between 0.2-0.35 which is not always that easy.

This understanding of the calcium/magnesium relationship helps identify many production issues with crops that are paid for based on quality and shelf life more than total yield. In many cases correcting these levels of potassium, magnesium and calcium is difficult and it becomes a matter of managing these soils. One management approach for such soils is a low-level application of calcium materials to supply calcium regardless of pH.

Calcium and Nutrient Uptake

Calcium also plays a role in the plant very similar to a hormone in the regulation of various cell functions. One such function is in the regulation of the protein pump that regulates the uptake and movement of nutrients into the root and throughout cells within the plant. At the root level, calcium activates stimulation of the protein channels that take up nutrients. Adequate availability of calcium at the root surface is required for this process to work effectively.

Aluminum toxicity (greater than 400 ppm.) disrupts the availability of calcium and magnesium but does not interfere with potassium, except for reducing root efficiency.

In crops such as potato where magnesium is important for quality factors, such as total solids, aluminum will reduce available magnesium increasing potential for early die and poor uptake of phosphorus. Raising pH reduces the amount of aluminum that is released in the soil and made available to the root, or alternatively using calcium materials close to the root such as gypsum will reduce the aluminum toxicity.

Calcium and Heat Stress

For most crops, net photosynthesis declines as temperatures increase beyond 34° C. Heat stress in general tends to increase stem length while reducing leaf size and area in a number of crops. Calcium is able to mitigate heat stress effects by improving stomatal function and other cell processes. Calcium is also believed to have an influence on the development of heat shock proteins that help the plant tolerate the stress of prolonged heat.

Calcium and Disease Mitigation

In plant nutrition, calcium is often referred to as the plant's first line of defense. Many organisms that infect plants do so by penetrating the cell tissue with enzymes known as pectinase, which dissolve pectins. The higher the calcium content in plants, the higher the concentration of pectins holding cells together and the greater the ability to withstand these enzymes. In some cases, the pectinase that the pathogen secretes is oxalic acid, which sequesters calcium from the leaf to form calcium oxalate. In these cases, increased calcium levels in leaf tissue or calcium foliar applications can greatly decrease the pathogen's ability to invade the leaf. Adequate levels of calcium in plants also aid in the plant's ability to isolate an infection.

Calcium and Crop Quality

It has long been understood that calcium plays a major role in the quality of many crops. The following is a list of some of those crops where calcium has a big impact on the quality and shelf life.

CROP	SYMPTOM
Apples	Bitter pit, Cork spot, Cracking, Internal Brownspot, Senescent breakdown, Water core
Beans	Hypocotyl necrosis
Brussel Sprouts	Internal browning
Cabbage	Internal tipburn and Club root
Carrots	Cavity spot
Celery	Blackheart
Peppers, Tomatoes and Watermelon	Blossom end rot
Potatoes	Internal browning, Hollowheart, Storage disorders, Low solids, Skin quality

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