Calcium, an Essential Nutrient for Potatoes

Why calcium is important?

Calcium is well known for its role in the growth and development of plants. - Cell membrane health is crucial to the survival of the plant, and it is established that for a healthy cell membrane critical level of calcium must be present around it. If the level of calcium around the cell membrane is reduced, the membrane becomes leaky resulting in an unabated loss of cellular salts and organic compounds. If such loss is not reversed, it will lead to the eventual death of the cell. This loss of organic compounds also leads to growth of bacteria and fungus resulting in tissue rot.

In the early 80's research showed that increased calcium level can reduce the severity and incidence of tuber soft rot. Potatoes are stored for several months before they are sold to the processing industry (chips and fries) and in the fresh market. During this time tubers can be subjected to storage rot. Thus, storage quality is of high importance to the potato industry.

Subsequent research in the late 80's by Palta's group demonstrated the beneficial effect of tuber calcium on reducing internal defects such as internal brown spot, hollow heart and brown center. These results have been confirmed in recent studies. Internal defects are a major concern to the processing industry. Growers are paid bonus for tubers with reduced internal defects.

Recent studies by Palta's group have shown that in-season application of water soluble calcium during the bulking period also leads to reduction in blackspot bruising. Since potatoes are mechanically harvested, the tubers are subjected to bruising. This bruising turns into a black spot right under the skin during storage. Thus, blackspot bruising is a major concern to the potato industry. The increase in calcium concentration improves tissue health and in turn mitigates bruise injury. Healthy tubers may also have better ability to recover from the injury.

Calcium also mitigates the adverse effects of heat stress on potatoes. Under heat conditions, calcium supplemented crops produce much higher yield than those which did not receive any calcium applications. Palta suggests that during heat stress, for the normal function of the stomata and cell expansion (growth), a certain level of calcium must be maintained.

As oppose to many other minerals needed by the plant, calcium is considered non-toxic even at high concentration.

How receptive is potato to calcium?

The potato tuber botanically is a stem tissue. Compared to the above-ground stem portion of the plant, tubers contain much lower concentration of calcium. Transpiration is the main driving force for the movement of calcium in the plant. Consequently, calcium moves with water in the xylem. Thus, tubers being low transpiring organ of the plant, accumulate much less calcium per unit weight than the leaves. This means that tubers are naturally calcium deficient and therefore, respond to in-season calcium application.

What is the mode of calcium movement in potato crops?

In a systematic study Palta's group discovered the tiny roots on the tubers and stolons (underground stems close to the tubers) being the route through which they draw moisture from the soil. As calcium moves with water, it is these tiny roots through which calcium is supplied to the tubers. Addition of calcium to the main root system does not increase the calcium concentration of tuber tissue. However, application of calcium to the tuber and stolon area has resulted in many fold increase in the calcium concentration in the tuber peel and medullary tissues. *Consequently, the placement of calcium in the soil cross section at proper level is important for enhancing the calcium uptake by the tuber.*

What should be the timing for calcium applications?

Contrary to earlier practice when calcium was applied at hilling, Palta's work has shown that applications of calcium need to be made after hilling. Since tubers develop after hilling, it would be important to add supplemental calcium during bulking. *These findings by Palta's group led to the development of liquid formulations of calcium that are now routinely applied during the tuber bulking period.* To enhance the calcium concentration in the tubers, it is important that calcium be added in the upper portion of the hill where the tubers develop. This is achieved by injecting

liquid calcium fertilizer into the irrigation line. *Split application of calcium produces greater yield and quality of tubers.*

Major production of potato occurs in sandy soils. These soils are irrigated almost every other day during the growing season. The application of calcium during the bulking period is even more critical in these soils. This is because the calcium placed early in the season is subjected to leaching from the top of the hill where tubers are produced.

What is the most effective source of calcium?

It has been well proven that the most effective source of calcium is in water-soluble form. - Lime and gypsum, common sources of calcium used in agriculture, are not water soluble. Research from Palta's group has established that calcium chloride is an excellent source of water soluble calcium.

Recommended further reading:

Kratzke, Marian G. and Jiwan P. Palta, (1985) "Evidence for the existence of functional roots on potato tubers and stolons: Significance in water transport to the tuber", *American Potato Journal*, Vol. 62, pp.227-235

Kratzke, M.G. and Palta, J.P. (1986) Calcium accumulation in potato tubers: Role of the basal roots. HortSci. 21:1022-1024.

Palta, J.P. (1996) Role of calcium in plant responses to stresses: Linking basic research to the solution of practical problems. HortSci 31:51-57.

Tawfik, A.A., Kleinhenz, M.D. and Palta, J.P. (1996) Application of calcium and nitrogen for mitigating heat stress effects on potatoes. Amer. Potato J. 73:261-273.

Kleinhenz, Mathew D., Jiwan P. Palta, Christopher C. Gunter and Keith A. Kelling, (1999) "Impact of source and timing of calcium and nitrogen applications on 'Atlantic' potato tuber calcium concentrations and internal quality", *J. Amer. Soc. Hort. Sci.*, Vol. 124 (5), pp. 498-506

Kleinhenz, Mathew D. and Jiwan P. Palta, (2002) "Root zone calcium modulates the response of potato plant to heat stress", *Pysiologia Plantarum,* Vol. 115, pp. 111-118

Ozgen Senay and Jiwan P. Palta, (2005) "Supplemental calcium application influences potato tuber number and size", *HortScience,* Vol. 40(1), pp. 102-105

Ozgen, S., B.H. Karlsson and Palta, J.P. (2006). Response of potatoes (cv.Russet Burbank) to supplemental calcium and nitrogen application under filed conditions: tuber calcium, yield and internal quality. Am. J. or Potato Res. 83:195-206.

Busse, James S. and Jiwan P. Palta, (2006) "Investigating the in vivo calcium transport path to developing potato tuber using ^{45}Ca: A new concept in potato tuber calcium nutrition", *Physiologia Plantarum,* Vol. 128, pp.313-323

Karlsson Bjorn H., Jiwan P. Palta and Peter M. Crump, (2006) "Enhancing tuber calcium concentration may reduce incidence of blackspot bruise injury in potatoes", *HortScience,* Vol. 41(5), pp. 1213-1221