

The Calcium KICK

Improving potato quality begins with supplemental application

BY JASON HARRIS, PUBLISHER, WITH JIWAN PALTA

Recent studies show that potato tuber quality can be improved by increasing the calcium content of the tubers. Benefits from supplemental calcium application include reduced incidence of internal defects such as internal brown spot and hollow heart, according to Jiwan Palta, potato researcher from the University of Wisconsin. Data from several studies also suggests that higher calcium tubers store better and have reduced incidence and severity of soft rot. Recently Palta and his graduate student, Chris Gunter, have also investigated the influence of seed tuber calcium contents on seed piece performance.

"We have obtained some evidence that in some cultivars the seed piece tuber quality can be improved through calcium application. In this study we found that seed-piece tubers given calcium nitrate during their development gave higher yield in the following season," explained Palta.

In addition to these issues they have also investigated practical means of delivering soluble calcium products, timing and source of application of calcium. Since the common water soluble products (calcium nitrate, N-Plus and NHIB) supply calcium and nitrogen, they have also investigated the interaction of calcium and nitrogen application on quality and yield.

WHY CALCIUM?

Calcium has long been known to play an important role in the growth and development of plants. It has been well recognized that the cell membrane

health is very crucial to the survival and health of the plant cell. It is now well established that the health of the cell membranes cannot be maintained in the absence of a critical level of calcium around the membranes. If the level of calcium associated with the membranes is reduced, the membranes become leaky resulting in an unabated loss of cellular salts and organic compounds. Such loss, if not reversed, leads to the eventual death of the cell.

The tuber is botanically a stem tissue. As compared to the above-ground stem portion of the plant, tubers contain very little calcium. On average, calcium concentration in the tuber is less than one fifth of the calcium of the stem tissue. Transpiration is the main driving force for calcium transport in plants. Calcium, therefore, moves along with water in the xylem. Tubers, being surrounded by moist soil, will have much less transpiration as compared to the above-ground part of the plant. Consequently low transpiring organs, such as tubers, accumulate much less calcium per unit fresh weight than leaves.

More than four years ago, Palta and his graduate student, Marian Kratzke, provided evidence for the existence of functional roots on the tuber and at the



Dr. Jiwan Palta (Photo courtesy of Wolfgang Hoffman, UW Madison)

tuber-stolon junction.

"In a follow-up study, we showed that these roots displayed normal root



Potato tuber showing root system.



The main root system supplies nutrients and water to the foliage, not the tuber.

anatomy and they appear to derive from parenchyma cells adjacent to the vascular tissue," Palta said.

By feeding a water-soluble dye, it was demonstrated that these roots were able to supply water to the tuber whereas the main root system supplied water to the top part of the plant. Since water and calcium are known to move together, they suggested that these tuber and stolon



The tuber and stolon roots supply nutrients such as calcium to the tuber as shown by the dye.



roots are able to supply calcium to the tuber.

In a follow-up study they found that the addition of calcium to the main root system did not increase the calcium concentration of the tuber tissue. However, application of calcium to the tuber and stolon area resulted in a three-fold increase in the calcium concentration in the tuber peel and medullary tissue.

These results showed that placing calcium in the tuber and stolon area could increase tuber calcium content. Thus, on a practical level, these results indicated that placement of calcium is important for enhancing calcium uptake by the tuber.

TIMING FACTOR

"To enhance tuber calcium uptake, we need to 'spoon feed'

potatoes during bulking with calcium fertilizer. Prior to our research, growers used to complete fertilization at hilling. This was a necessity, since no nutrient application could be made by tractor after hilling without damaging the plants. Our results show applications of calcium need to be made much later in the season. This can be easily achieved by injecting calcium fertilizer directly into the irrigation line. Since tubers develop during the late part of the season it would be important to add supplemental calcium during bulking, which is even more critical in sandy soils," Palta added.

Due to low-moisture-holding capacity, sandy soils are irrigated two-to-three times a week. Thus, the top portion of the hill is continuously washed by the irrigation and rain, with water moving soluble nutrients to the lower portion of the hill. These nutrients remain accessible to vegetative growth via the main root system. However, the tubers developing during late season will not have access to these nutrients via the tuber and/or stolon roots.

SOURCE, QUANTITY

Calcium should be applied in water-soluble form to facilitate uptake by the tuber. Lime and gypsum, common sources of calcium used in agriculture, are not water soluble. Thus they have studied water soluble calcium products such as calcium nitrate, N-Plus and NHIB and found them to be effective at improving tuber calcium contents.

CALCIUM AND TUBER QUALITY

Internal defects such as brown center and hollow heart produce no external symptoms on effected tubers and, therefore, cannot be culled out before sale. They have examined the impact of calcium fertilization on internal defects over several seasons. Individual tubers were analyzed for the defects as well as for calcium contents. They found, in general, a reduction in the internal defects by calcium application.

"However, it is important to point out that at a given level of tuber calcium there is a large variability (especially at low calcium concentration) among tubers for the incidence of internal defects. In other words, in addition to calcium there are other factors that

contribute to development of internal defects. Furthermore, there are variations among cultivars in terms of the incidence of internal defects, suggesting genetic control for these traits," he said.

Other recent studies also suggest that timing of nitrogen application and interaction between calcium and nitrogen may influence the incidence of tuber-internal defects.

HEAT STRESS

Heat stress is known to reduce plant growth and reduce partitioning of photosynthate to the tubers. Although there are differences among cultivars in their response to heat stress, in general, heat tends to increase stem length and branches while reducing the leaf size and total leaf. In addition, high temperatures also reduce the net photosynthesis. The overall result of heat stress is a decrease in plant growth and tuber yield.

Recent studies by Palta and his graduate students, Ahmed Tawfik and Matt Kleinhenz, have shown that calcium applications can mitigate heat stress effects on potato plants.

Although they do not know a mechanism by which calcium is able to mitigate heat stress effects on potatoes, their results provide some insight.

"For example, we found that stomatal conductance was higher in calcium-treated than control plants under heat stress. Maintenance of stomatal opening could be important in avoiding heat stress effects via enhanced transpirational water loss. We found a decrease in the calcium concentration in leaves of plants exposed to heat stress but the calcium concentration was maintained at the same level as prior to heat stress in the leaves of plants given calcium fertilization during heat stress," he added.

"It appears that during heat stress calcium is able to sustain cell division and cell elongation in the apical meristem. We are currently investigating the mechanisms by which calcium is able to do this and mitigate heat stress effects on a plant," he concluded. 🍅

(Editor's Note: Dr. Jiwan Palta is a potato researcher for the University of Wisconsin. Photos courtesy of Jiwan Palta, UW Madison.)