Good plant nutrition can reduce bacterial diseases

By Dirk Uys, Potatoes SA

South African soils are not always rich in nutrients and high organic content. The potato production budget always makes provision for nitrogen, phosphate and potassium but at least 17 other elements are also essential for optimal crop nutrition. Some are freely accessible in plant-available formats while others are less so.

One essential element is calcium (Ca) which is often present in soil but in an insoluble version such as lime (calcium carbonate) or gypsum (calcium sulphate). Lime requires high volumes of water (> 60 000 ℓ to dissolve 1 kg of calcium carbonate), making it difficult to become plant available. Thus, the type of Ca is important for uptake and soluble Ca such as calcium nitrate is probably the most efficient in this regard.

Preventing bacterial diseases

The global impact of bacterial diseases in potatoes is estimated at US$360 billion. In South Africa, bacterial wilt (*Ralstonia solanacearum*) is a regulated pest, while bacterial soft rot causes significant yield losses in the summer production regions.

Calcium is essential for tuber strength, with varying levels in different parts of the potato plant. The highest concentration of Ca is found in shoots and leaves with the lowest in the tubers, the part that needs protection. This is because Ca transport within the plant is slow and complicated, and older leaves tend to accumulate higher levels of Ca that cannot easily move to the tubers.

An example of soft rot indicating the location of the weak infection spot. (Photograph: Prof J van der Waals)

Inside the tuber, higher Ca concentrations are present in the tuber's outer periderm rather than in the centre (pith). The elevated content in the periderm is associated with direct movement from the soil solution into the tuber skin, which is the barrier that must be protected. This periderm (skin) regulates water, oxygen and carbon dioxide exchange. In the process it also protects tubers with Ca being a component in the cell wall's middle lamellae.

A high Ca concentration optimises the tuber's tolerance against the pectolytic enzymes produced by soft rot-causing bacteria, preventing their entry. Applying Ca, whether through foliar spray or soil drench, significantly impacts quality aspects, including specific gravity.

High soft rot incidences

In the previous season, several potato production regions were seriously affected by bacterial soft rot. This was aggravated by initial wet conditions during the bulking stage, followed by high temperatures during harvesting. Crop protection products do not have a significant effect against bacterial diseases.

A study conducted by the American Society for Microbiology shows that Ca can contribute to tolerance against bacterial diseases. Specifically, Ca contributes to resistance against bacterial wilt caused by *Ralstonia solanacearum* and soft rot caused by *Pectobacterium* sp. The study confirmed that an increase in Ca status in tubers directly impacts resistance to *Pectobacterium*.

An example of hollow heart in potatoes. Hollow heart is often associated with calcium deficiencies. It manifests in the centre of the potato where calcium levels are at their lowest.

Soft rot bacteria require an entry point into the tuber, and susceptibility is directly associated with membrane permeability. Tuber susceptibility increases at low tissue oxygen concentrations often associated with wet conditions, for example when the tuber surface is covered with moisture.

The signal for potassium to close stomata may be delayed when calcium levels are low, and the plant will lose precious moisture through transpiration. This is also a potential entry way for bacterial pathogens.

The absence of Ca during tuber initiation or bulking leads to cell degradation, resulting in physiological issues such as hollow heart or internal browning. Compromised tubers are also more susceptible to bruising. Calcium is needed most during tuber initiation and early bulking to improve the mechanical strength of tubers, which will ultimately determine their susceptibility to attack by soft rot bacteria.

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