



# Calcium Uptake by Potato Tubers

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Founder and Director of R&D

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## Academic Background and Experience

- Foundation and BSc Agriculture at Plymouth University
- MSc Crop Science at Sutton Bonington
- PhD in soil-plant science – Nottingham University
- Postdoc root-shoot interactions – Lancaster University
- Executive MBA Aston Business School – Birmingham

### Achievements

- Over 20 publications in scientific journals
- Associate editor of 5 scientific agricultural journals
- Renown agrochemical technologies and products
- Granted patents in the UK, EU, US and others pending



### Last position

- Researcher at Plant Impact PLC
- R&D Manager at Branston (potatoes)
- Academic hut at Lincoln University

### Funding received for R&D



## The Company

Crop Intellect Ltd founded in 2012 to provide solutions to major agricultural issues

Two granted patents in the UK, US, at worldwide stage licensed to a multinational for North-EU

Products with national distributors in the UK and EU

Raised £100K for 6.5% equity in 2015 to support R&D

Our aim and ambition is to become a major technology provider in the worldwide market!

### **Mission**

To make a positive impact to the world's agricultural sustainability for a secure future using innovations that are out of the ordinary!



## Importance of Calcium for Plants

Ca deficiency although not visible, will not only affect the cell wall strength but also plant architecture, cell functioning, division, elongation, signalling, enzyme activation and so on as linked with critical cellular functions.

Passively taken up by water movement upwards from the roots via the xylem! Therefore water solubility is key!

Younger parts of the plant receive more calcium through higher water loss. Ca is diluted with cell expansion and division!

Calcium is not mobile in high quantity in the tissue therefore a continuous supply is essential.

YES – foliage absorbs nutrients through the transcuticular pores (space between cells). Stomata uptake is 10 times more efficient than roots. It can fulfil the requirement for micronutrients (less complex than in the soil).



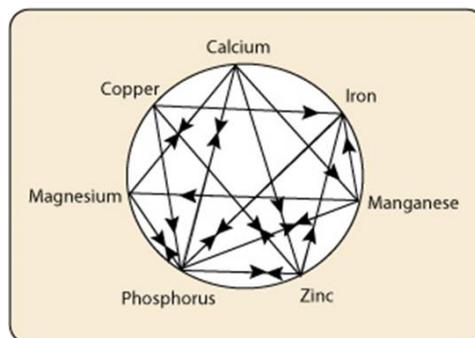
## Calcium Forms for Plants

- Carbonate is only slightly dissolved in water – 14mg/lit
- Chloride is cheap but not kind to plants
- Calcium sulphate – 2g/lit of water
- Calcium nitrate is highly soluble – 1200g/lit

Calcium nitrate is the most available form but it also provides nitrates which promote rapid growth, therefore further diluting the calcium in the plant cells.

Soil applied calcium forms complex substances of which many are insoluble. Chelated Ca is less available than calcium chloride.

- High K will reduce Ca uptake
- High Ca will reduce B uptake
- Ca + P form insoluble substances
- Na (sodium) reduces Ca
- Ca reduces Mg uptake



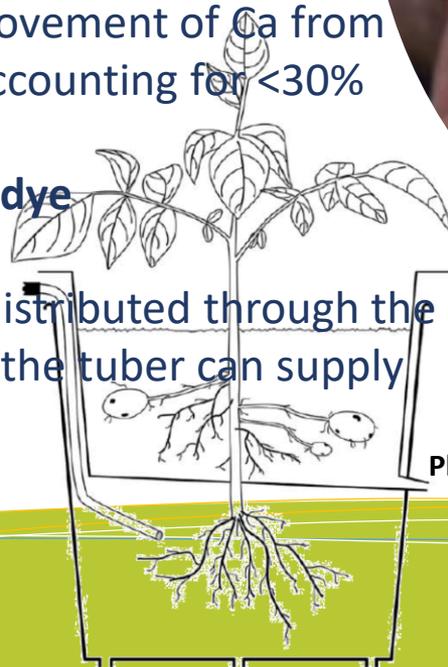
## Calcium Uptake by Potato Tubers

- Calcium transport is through the xylem from root to shoot
- Ca is reported to be phloem immobile suggesting that it does not redistribute in plants unlike other elements (N,P)
- Studies confirmed that the main root doesn't contribute significantly to calcium tuber uptake (only when dry!)
- Only roots of stolon and tuber able to supply Ca to the tubers
- The levels of Ca uptake and movement may vary in some potato varieties
- Other researcher suggested some movement of Ca from phloem but with assumptions and accounting for <30%



### Experiment with radio-labelled Ca and dye

Results indicated that calcium is not redistributed through the phloem, and that roots associated with the tuber can supply water and calcium to it.



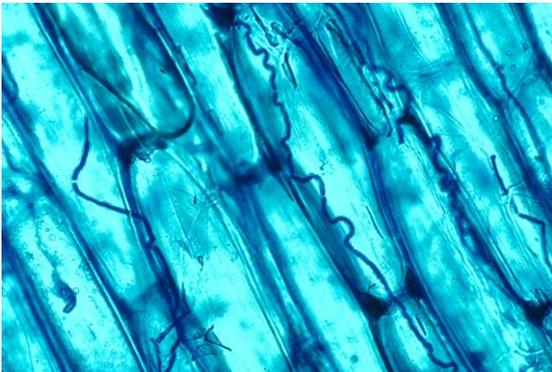
Physiologia Plantarum 128: 313–323. 2006

## Direct effect on Crop Protection

Strengthening pectin with calcium is a chemical reaction. In living plants with abundant available calcium, pectin makes cell walls more resistant to the polygalacturonase enzyme used by most fungal germ tubes to break down plant defences when attempting to exploit tissue.

### Measured benefits in agronomic sense:

- Improved cell functioning/ quicker responses
- Strengthened cell walls/reduce water loss
- Increased shelf-life of plant tissue
- Increased tolerance to abiotic/biotic stresses Firmness
- Uniformity of produce



## Agronomic Advice for Ca on Potatoes

- Ensure that there is Ca in the soil in available form during the tuber formation and till harvest
- Do not use Calcium Nitrate in high quantities to apply Ca to the tubers unless part of your N supply
- Ensure the Ca is in the vicinity of the stolon and tubers
- You may apply Ca through irrigation as drip systems become popular
- Consider foliar calcium applications to enhance crop health in general but not to supply Ca to the tubers
- Be aware that very high Ca will reduce tuber set resulting in less but larger tubers
- The effects of both soil and foliar applied Ca are able to reduce bruising, internal rust spot, internal browning, hollow heart, issues associated with Ca
- Foliar calcium will synergistically support the fungicide program and tolerance to resistance build up
- Remember that variety plays an important role and knowledge on variety and field can help plan ahead!



## Agronomic Advice for Ca on Potatoes

- Long stolon varieties are in most need for supplied Ca and those taken to a larger size i.e. bakers consisting of more cells therefore more Ca requirement.
- Calcium is not transported across the periderm to the interior tuber tissue therefore it has available early
- LimeX can be used as a solution understanding that it will work under certain condition for Ca uptake and reduction of the incidence of scab (note that there are over 10 different *Streptomyces* species causing scab but 5 of them account for 98% of the issue)
- Tissue analysis for Ca provides limited details as it is total and more than 80% can be stored in the vacuole
- Foliar applications will help the overall health of the plant and reduce the shrinking/swelling cycles



## Calcium Uptake Technology – TECAL<sup>®</sup>

- A large number of stimuli such as light and phyto-molecules will increase cytosolic Ca but increases are oscillatory and only last seconds resulting in no prolonged effects.

TECAL<sup>®</sup> technology is a synergy of two activators causing Ca to be released from stores and further blocks the inhibitors of this mechanism resulting in increased cytosolic flux.

The prolonged calcium flux has proven to increase cell functionality and higher Ca re-deposition in the cell wall.

Assuming 10lt/ha overall a cost of £100 is spent per hectare with average marketable yield 40t/ha so £2.50/t cost!

TECAL<sup>®</sup> reduces resistance build up to fungicides and increases effectiveness of fungicide efficacy!

Reduced swelling/shrink extremes, internal defects, bruising, storage disease, canopy water loss, toxicity!



## TECAL® Story!

- The plant cell has c. 80% of the calcium stored in the vacuole and doesn't easily release it. Even when released the Ca will redeposit inside the stores.
- The technology triggers Ca release and inhibits redeposition which is typically in minutes, which, combined with externally applied Ca results in increased Ca in the cell wall.
- The amount of calcium applied is not so relevant as a few 100's of grams per hectare work significantly better than 100s of Kilos.
- Applications of Calcium Nitrate by growers do provide Ca uptake but this is overwhelmed by the presence of nitrates as the most available form of N, resulting in exactly the opposite to the desirable effects.
- TECAL® also enhances the standard practice of Calcium Nitrate applications

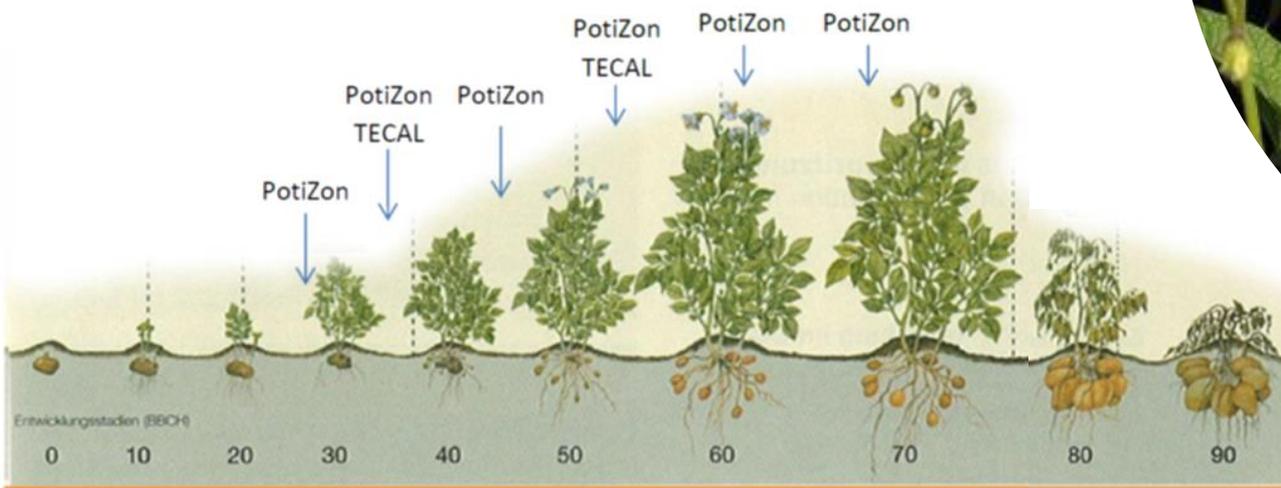


# TECAL® Application - Potatoes

## Application Rate and Dose

Over the whole season the crop should receive 6-10 lt/ha  
1<sup>st</sup> application with the 1<sup>st</sup> fungicide c. 10-15cm height  
@1-1.5lt/ha with standard water volume  
2<sup>nd</sup> application with 3<sup>rd</sup> fungicide application @ 2lt/ha  
Every other fungicide treatment or so @ 2lt/ha  
Prior to expected fast canopy expansion!

\*Combining with PotiZon® will increase yield and uniformity



Thank You!



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