CalPac and Calcium

Calcium is king

In agronomic terms, Calcium is so much more than just a nutrient. Calcium dictates plant strength, disease resistance and nutrient regulation in the plant.

Calcium is known as 'the Trucker of all minerals'[1] into the plant. It is critical to plant production because of its influence over the uptake and distribution of other nutrients and carbohydrate stores through plant parts[2].

Calcium is critical to overall crop nutrition, cell function and development and hence influences overall efficiency of plant production. A shortfall in Calcium creates costly flow-on effects, such as increased Nitrogen input[3], greater susceptibility to disease[4], increased lodging tendency in cereals, greater shedding in cotton[5] and greater sensitivity to moisture stress[6].

Calcium from CalPac provides plants:

- Structural stem strength.
- Improved Nitrogen use efficiency.
- Enhanced water use in saline or sodic soil environments.
- Disease resistance through increased Pectin production.
- Greater frost resistance via carbohydrate supply.

Calcium gives plants strength

Humans need Calcium for strong bones, so too plants need Calcium for strong cell walls and plant rigidity. In plants, low Calcium means poor cell wall strength and leaky cell membranes resulting in a loss of integrity and production efficiency.

Increased Calcium in plants results in increased pectin production. Pectins combine with polysaccharides (sugars) to bind plant cells together within cell tissue, giving cells them structural rigidity and strength. Plenty of Calcium means strong stems and reduced potential of lodging.

Calcium and Boron are the slowest nutrients to be translocated from the roots through sap to new tissue. Once deposited Calcium is immobile rendering it unavailable to further new growth. Hence, in rapidly growing crops supply of Calcium to new cell tissue can often be the limiting factor, resulting in reduced structural integrity.

Calcium is the first line of defence against disease

There is a strong relationship between Calcium deficiency and disease in crops. How so? Disease organisms break into plant tissue by producing enzymes (variations of pectinase) which dissolve pectin. Higher Calcium levels increase pectin concentrations and hence resistance to these destructive enzymes. It is not just a case of whether the disease, (e.g., net blotch, rust, *Ascochyta*) is present or absent, it is the level to which the enzymes they produce are able to dissolve their way into plants, breakdown tissue and spread.

Research confirms that good plant Calcium levels reduce disease susceptibility both during the growing season and post-harvest storage.[7] CalPac can increase Calcium concentration and pectin levels; a valuable management tool to reduce plant susceptibility to disease.

Calcium is the link between pectin levels and plant resistance to disease.

Calcium deficiency symptoms include:

- Abnormally dark foliage.
- Death in the tips of new growth.
- Weakened stems.
- Premature shedding of fruiting parts.

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Calcium in soil

Why have people in agriculture applied Calcium for over 2000 years, well ahead of the green revolution? The answer is not for soil pH alone nor mineral replacement. It is about 'efficiency'.

In soil, when Calcium as a proportion of the mineral cations exceeds approximately 60%, there are improvements in the soils physical properties. Flocculation, the process of binding peds together, is increased and structure and friability improved. Magnesium and Sodium (which make soils hard and dispersive) are displaced and the water holding and infiltration capacity increased.

Plant growth responds to these soil improvements, crops have reduced Nitrogen requirements, are less moisture sensitive and show improved overall strength because the efficiency of the soil:plant dynamic is better than where Calcium is low. Throughout history agriculture has thrived where Calcium in soil is plentiful, and struggled or failed where it is deficient.

Calcium is a plant regulator

As it is for soil, so too in plants, Calcium is more than a simple component part – it can be managed to affect plant efficiency by being a regulator of plant response to changes in environmental conditions. For example, in sodic or saline root-zones (which impede moisture flow into plant roots due to osmotic gradient), Calcium actually regulates the selectivity of nutrient uptake to reduce the impact the salts have on photosynthesis and productivity[4]. As shown below, Calcium will positively reduce plant Sodium uptake.

This can occur because a large proportion of plant Calcium sits within the cell wall structure, whilst another portion remains exchangeable (in plasma membrane and within the vacuole) from where it is able to regulate cell function by selectivity in nutrient uptake.

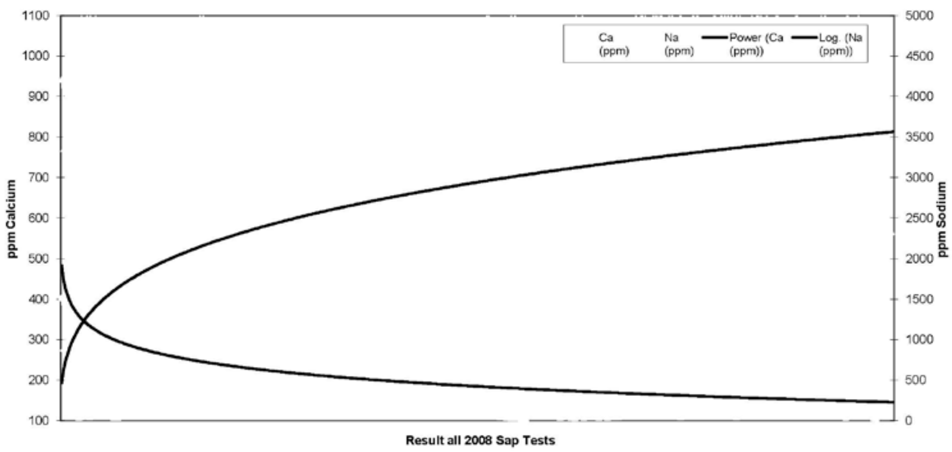

Figure 1: Relationship between plant sap Calcium levels and Sodium. (BioNutrient Solutions SAP test data, all crops, 2008).

Soluble Calcium facilitates crop selectivity in nutrient uptake, reducing the impact of excess salts.

"After regular applications of CalPac, our irrigated lucerne has significantly improved, stems are solid, yield has increased 15% and we have noticed superior recovery following cuts in the heat of January. We are seeing big improvements in the crops ability to take in water and withstand heat stress, better than ever before. We calculate a $5 return per dollar spent, excluding lower insect pressure."

Angela Druery, 'Santa Lea', Moree, NSW. February, 2009.

"Calcium, assisted by Molybdenum, is the basis of Nitrogen fixation and amino acid chemistry. Nitrogen, allied with Calcium in the form of amino acids, reacts with every other nutrient element, the most important being Magnesium, which is the basis for chlorophyll and photosynthesis. Chlorophyll traps energy and shunts it via Phosphorous into Carbon structures, which go where Potassium, the main electrolyte, carries them.

Thus the biochemical sequence for plants is B, Si, Ca, N, Mg, P, C, K."

Source - *Hugh Lovell.*

Unlike other nutrients, Calcium stands in reserve, ready to activate a response when there is a stress associated with moisture, salinity, nutrition or heat.

Repeated pulses or spikes in the Calcium concentration allow plants to maintain cell elongation, cell division and cell pH during critical growth stages. Calcium will exchange with K^+, Na^+ or H^+ to help maintain optimal plant function.

Solubility is essential. Soil Calcium is very slow to move into new plant tissue. Foliar applications of soluble Calcium such as CalPac can significantly increase plant responses compared to soil applied Calcium.

Quick Facts:

- Foliar applied soluble Calcium has been found to increase plant absorption of ammonium by as much as 100%, improve soil nitrate extraction and increase photosynthesis[8];
- A greater Calcium to ammonium ratio in tissue increases plant deposits into harvestable parts. For example, Calcium concentration increases at ear emergence result in greater transfer of flag leaf energy production into grain yield[2].
- Calcium is responsible for regulating the flow of carbohydrates from structural (stems) to fruiting parts thus improving the weight of grain, lint or fruit at harvest.

Putting it all together

- Greater plant Calcium levels positively influence the efficiency of plant production. It regulates the uptake and movement of other nutrients from roots throughout the plant cells, particularly Nitrogen.
- Soil Calcium is essential, but very slow to translocate through plants, particularly during periods of rapid growth and cell division. Hence foliar applied soluble Calcium can overcome a shortfall quickly and cost-effectively compared to soil applications.
- Appropriate foliar or fertigation of soluble Calcium will reduce Nitrogen fertiliser needs, decrease disease susceptibility and increase mineral density in harvestable plant parts.

Calcium is more than a nutrient, it improves soil and plant resilience to stress.

What can limit Calcium supply to crops?

1. Low soil Boron.
2. Elevated Sodium, Chloride or Aluminium soil levels, which increase deeper in the soil profile.
3. Excess soil Potassium.
4. Soil applied ammonium (MAP/DAP or anhydrous ammonia) resulting in Calcium loss to precipitation (conversion into unavailable forms). Plant and biological processes then need to re-release the Calcium.
5. Periods of rapid plant growth that dilute and restrict the movement of Calcium through the plant to new cell tissue.
    - In cereals during rapid tillering, stem elongation and booting.
    - In cotton 30-50 days after emergence during peak squaring.

References

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CalPac application

CalPac is soluble Calcium bound within carbohydrate to provide plant available Calcium and energy, for plant and microbial needs.

- CalPac is less likely to burn plant leaves than nitrate forms.
- Provides Sulphur, Potash and trace elements.
- Is approximately 300 times more plant available than lime.

Figure 2: Solid lucerne stems, fertigation applied CalPac

When to use CalPac

- Liquid injection at planting into soils with elevated Sodium or Aluminium.
- In fertigation water to improve water quality (high Sodium or Magnesium) and provide crop nutrition.
- Foliar applications to improve Nitrogen utilisation during periods of rapid growth, e.g., tillering or stem extension in Cereals. Apply with Nitrogen (e.g., UAN) to increase ammonium absorption, nitrate uptake and to buffer against burn potential.
- Foliar applications to regulate nutrient flow in situations where soil or sap Chloride, Sodium, Aluminium or Potassium levels are elevated.
- As part of a structured disease management program, to build leaf cell wall strength and resistance to pathogens.

Figure 3: Liquid inject Calcium enhanced root growth.

Rates and timing of CalPac applications

Root Zone	Liquid injection	10-12L/ha in dry land broad acre. Higher rates are required in sodic or high Aluminium soils.
	Fertigation	7-15L per irrigation depending of production goals and soil type.
Foliar	Early season (during rapid growth)	5-6L/ha.
	Booting and pre-flowering	7-10L/ha.
	With Nitrogen application	1:5 ratio with UAN or urea solutions.
	Within disease management program	10L/ha. CalPac is not compatible with fungicides or insecticides. It is recommended to supplement, not replace, any specific disease management practices.