Information Sheet

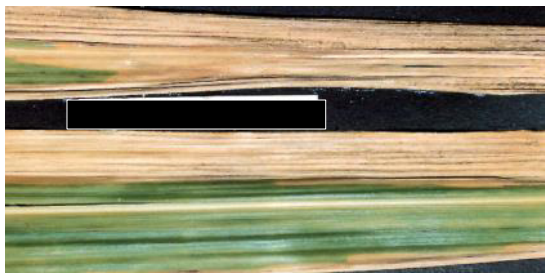
7.7 Calcium and magnesium management

A typical 100 t/ha sugarcane crop removes between 40 - 50 kg calcium (Ca) /ha and 30 - 50kg magnesium (Mg) /ha. Deficiency is often associated with acidic soils, where crop removal and excessive leaching can lead to inadequate soil supply. Calcium is important for growth and development of the spindle, leaves and roots. It forms part of cell walls and is involved in nitrogen (N) chemistry in the plant. Calcium also ***protects*** *roots against* ***aluminium toxicity*** *and promotes a vigorous root system. Magnesium is needed in photosynthesis, respiration and sugar production. Mg is used to move P through the plant and is essential for N chemistry in the leaves. While deficiencies are not commonly reported, these can occur on acidic soils, sandy soils, and sometimes where excessive potassium (K) is applied. Calcium deficiency often occurs in association with Mg deficiency due to the close association of these elements in the soil. In soils that have excessive Mg, relative to Ca, soils may become heavy and sticky with poor workability (known as a magnesic soil).*

Defciencies symptoms

Calcium

- Older leaves exhibit symptoms first, with leaves turning pale green with yellow mottling or a rusty appearance and may die prematurely.
- Young leaves may be distorted (curled) and necrotic and leaf margins may develop serrated appearance.
- Stalks are thin and taper towards the growing point and apical meristems may die.
- Top growth is poor.
- Low soil levels can lead to poor root growth.
- In severe cases, young leaves curl and become hooked and the spindle dies off at the tip and edges.
- Primary shoot may die.



▲ Calcium deficiency symptoms.

▲ Mg deficiency symptoms.

Magnesium

- Older leaves usually show symptoms before young leaves.
- Young leaves are green, while older leaves are paler with yellow mottling or interveinal chlorosis.
- Development of "orange freckle", where older leaves develop chlorotic spots which turn orange, and later dark brown. It may give the appearance of rust on the leaf.
- Stools are weak and overall growth is slow.

Impact of excess calcium and magnesium

Excess Ca or Mg is not a common problem in rainfed regions, but may be problematic in the less weathered, base-rich soils of the drier, irrigated areas. Problems are not usually associated with excessive uptake, but rather interference with uptake of other essential nutrients. In these soils, Ca and Mg levels can be very high and lead to nutrient imbalances, particularly affecting uptake of each other, K and sometimes, micronutrients. Similarly, where excessive amounts of lime are applied, there may be similar impacts. Under alkaline (pH>7) soil conditions, phosphorus (P) may also be complexed with Ca and Mg into plant unavailable compounds.

A key problem with excess Mg, relative to Ca, is the development of soils that are heavy, sticky and that have poor infiltration, are susceptible to crusting and dificult to till (often referred to as magnesic or Mg-rich soil).

▲ A heavy soil with alkalinity (pH > 7).

SASRI advises that the **Ca:Mg ratio should be >1**.

Factors affecting availability

Both Ca and Mg are plant-available as positively charged cations in the soil and are thus controlled by surface reactions with clay and organic matter (called **cation exchange capacity**). Soils with high cation exchange capacity (clay soils) tend to have far greater amounts of Ca and Mg than low cation exchange capacity soils (sands). In very sandy soils, deficiency may be caused by excessive leaching from the plant rooting zone.

Acid soils are typically deficient due to aluminium (Al) displacing Ca and Mg from the soil surface exchange sites leading to leaching losses. Excess K has also been shown to compete with Ca and Mg in crop uptake. Deficiency may also occur on saline or sodic soils, where excess soluble ions relative to Ca or Mg may lead to imbalances.

▲ Regularly soil sample your soils to determine Ca and Mg availability.

Application guidelines

A soil threshold of **300 mg/L** is advised for Ca and **50 mg/L** for Mg for adequate crop growth, while the ratio of Ca:Mg should be maintained at >1 (i.e. more Ca than Mg, on a concentration charge basis). Several fertilisers contain varying amounts of Ca
(e.g. limestone ammonium nitrate, super phosphates), thus it is often added where these types of products are used. Magnesium is typically not applied in routine fertiliser applications, though may be added where dolomitic lime is used to address soil acidity.

As Ca and Mg deficiency is most often associated with acid soils, liming is advised to address the constraint. Where Ca is deficient, but Mg not, calcitic lime is typically advised. Where Mg is deficient dolomitic lime will be advised. In plant crops, it is important that the lime be applied several weeks prior to planting to ensure adequate reaction in the soil to increase availability of Ca and Mg. In ratoon crops, topdressing of lime, along with gypsum, is advised to promote movement of the elements into the soil profile. For both plant and ratoon crops, broadcast applications (to ensure even spread across field) of liming material is recommended.

Application guidelines (continued...)

In rare instances where deficiencies are not associated with an acidic soil condition, a soluble source of Ca or Mg is preferred. For Ca, gypsum is mostly commonly advised. Broadcast applications of between **1000 and 2000 kg/ha** are usually suficient to raise soil Ca to satisfactory levels. Where gypsum is used to increase Ca levels, co-apply with at least **1000 kg/ha of dolomitic lime** (contains both Ca and Mg) to ensure that the Ca does not lead to Mg leaching, particularly on sandy soils. Where Mg is deficient, magnesium sulphate (Epsom salts) is considered the most available source. Because of the cost of this product, banding is generally recommended to improve the effective application rates.

In soils with excess Mg, it is dificult to raise Ca levels suficiently to overcome the excess Mg. In these soils, banded gypsum applications at rates of 500 to 1000 kg/ha are advised. This will result in localised improvement of the Ca:Mg ratio, where the aim is to increase this to >1. This will not effectively remedy the whole soil volume, but should improve crop growth for that season and several thereafter.

In sodic soils, gypsum is advised at rates to displace excess sodium from exchange sites. Where Mg deficiency is also present it may be necessary to apply magnesium sulphate too.

Available calcium and magnesium fertiliser formulations

Source/product	Ca%	Mg%	Other %	Solubility	Notes
Gypsum ($CaSO_4$)	16-19		S:12-18	Good	Suitable for of all soil types but may require additional Mg when applied to sandy soils
Epsom salt (magnesium sulphate)	-	9.6	S:12.4		Can be used to quickly elevate Mg levels, but costly
Potassium magnesium sulphate	-	11	K:11 S:22		Supplies Mg, K and S, but costly
Calcitic lime	30-40	-	-	Low, only dissolves in acidic soils	Suitable for acid soils with low Ca or Mg content.
Dolomitic lime	14-18	-	Mg:8-10		
Burnt lime	68	-			
Slaked lime	51	-			
Silicate slags	35	-	Si:13		
Magnesite (Magnesium carbonate)	-	28	-		
Magnesium oxide	-	54	-		

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