Information Sheet

4.2 Nutrient management and cane quality

To ensure sustainable and profitable returns from sugarcane production it is essential that growers adopt crop nutritional and soil health management practices that optimise both cane yield and quality. Apart from cane yield and sucrose content, some practices can affect non-sucrose components such as dextrans, fibre, gums, phenols and ash content. Excessive levels of these non-sucrose components can lower recoverable sucrose and thus reduce sucrose yield.

This information sheet highlights key aspects of crop nutrition that influence cane yield and quality parameters. For specific nutrient and soil health related guidelines see the topic specific information sheets available from the eLibrary on the SASRI website: www.sasri.org.za.

Soil fertility and crop nutrition

The effect of nutrition on cane yield and quality is complex, where nutrient deficiency, excess and imbalance can all result in below optimum production. However, some general trends have been observed that provide useful guidance to better manage crop nutrition for optimal sucrose yields.

Nitrogen

Nitrogen (N) has a dominant role in stimulating vegetative growth in sugarcane and is essential for the biomass accumulation in the crop. Where N is deficient, overall growth is retarded leading to both reduced cane yield and photosynthesis (sucrose production by the green leaf canopy) resulting in lower sucrose yield. It has also been found that N is important for efficient uptake and use of other nutrients, thus suboptimal levels can lead to poor utilisation of the other nutrients, lowering nutrient use efficiency and further compromising yield and quality.

▲ **Nitrogen deficiency in sugarcane.**

However, where N is available in excess, sugarcane will take up N in excess (luxury consumption) which can have adverse effects. Where soil moisture is not limiting, high N uptake leads to rapid growth which increases stalk moisture and non-sucrose content and lowers sucrose content. While it is desirable to promote rapid early growth during crop establishment and grand growth stages, excessive vegetative growth is undesirable during crop maturation phases. In the three to five months before harvest, excessive vegetative growth reduces sucrose content in the stalks in favour of leaf production.

Excess N has also been linked to increased occurrence of pest and disease due to the development of "soft" plants, particularly where other nutrients, such as K and Si, are deficient. Excess N has also been linked to lodging of cane, and can indirectly affect sucrose content and increase harvesting costs.

Key points to note are:

- Increasing amounts of N beyond optimal levels leads to a decline in sucrose content. Studies in the irrigated regions have shown that, while increasing N typically results in an increase in cane yield (tc/ha), there is a reduction in sucrose content of between 0.3 and 0.45 RV% units for each additional 50 kg N/ha applied between 50 and 200 kg N/ha. This leads to a near linear decline in RV yield (tRV/ha).
- Similar trends occur in the rainfed region, though the effect of variable soil moisture and soil N supply confounds N availability and uptake by the crop over a season.
- Nitrogen application late in the crop cycle should be avoided (at least 3 to 5 months from harvest) to promote maturation and increases in sucrose content.
- Applying N during dry conditions does not increase uptake by the crop and must be avoided. Of particular concern is that if soil moisture levels rise sharply later in the season following N applications during an earlier drought period, N uptake will increase sharply and promote vegetative growth. If this occurs in the weeks before harvesting then sucrose yield may be compromised at harvest.

Potassium

Potassium plays a key role in plant water relations and the translocation and storage of sucrose in the plant. Sugarcane takes up large amounts of K and sugarcane juice ash contains up to 30 to 50% K, highlighting its importance in sucrose accumulation. It has been found that K is one of the most effective nutrients to lower starch content and also linked to lower fibre content. It has been associated with mitigating negative effects of excess N, reducing pest and disease occurrence and improving tolerance to water and salt stress. As such, there is a belief that supplying K at very high rates is beneficial.

▲ Severe potassium deficiency (along with excess phosphorus) in sugarcane.

However, sugarcane is a luxury consumer of K and can take it up in amounts in excess of its biological requirement for optimal yield and quality, with no clear evidence of either yield or quality decline. Excess K in the soil and crop can lead to several problems though. Key points to note include:

- The application of K fertiliser to a soil deficient in K improves sucrose yield through an increase in sucrose content, higher cane yield and a reduction in fibre and starch content.
- In the soil, excess K may indirectly impact cane yield and quality:
    - o High K in the soil can interfere with the uptake of Ca and Mg, resulting in yield and quality declines.
    - o In extreme cases, excessive K applications from fertiliser and products such as CMS or vinasse, can lead to build-up of salts that lower cane yield and quality.
    - o Excess K uptake may lead to crop lodging, thus lowering sucrose content and increasing harvesting costs.

▲ Potassium-rich leachate from drainage lines due to excessive use of CMS/vinasse that may lead to salinity problems.

- While excessive soil K levels and luxury uptake of K has not been directly linked to losses in sucrose yield from a grower perspective, a few rare studies have shown that excessively high rates of K application have led to reduced sucrose content.
- While high K levels may not directly lower sucrose yield, high K in the cane juice reduces the exhaustibility of final molasses, as well as negatively affecting the colour and ash content of raw sugars. Potassium forms a complex with sucrose which reduces crystal recovery.

Phosphorus

Phosphorus (P), while not taken up by the crop at the high rates as for N and K, is often a limiting nutrient in sugarcane production. It plays an important role in photosynthesis, root development and tillering. Key points include:

- The benefit of P is most noticeable on deficient soils, where increases in sucrose yield tend to be attributable to improvements in cane yield rather than marked increases in sucrose content.
- In severely P-deficient soils some studies have shown that application of P leads to an increase in sucrose content, which along with cane yield increases provide strong sucrose yield responses.

▲ Phosphorus deficiency can result in a poorly established crop (field on right) and thus lower cane yield.

- Due to high application rates of P fertiliser and the use of P-rich organic amendments in some regions, there is evidence of excessive levels of soil P. Excess soil P and crop uptake have been linked to a lowering of sucrose content.

Other nutrients

Other nutrients most commonly considered in sugarcane production include secondary macronutrients (calcium, magnesium, silicon and sulphur) and micronutrients (mainly boron, copper, iron manganese, zinc). The specific impacts of these nutrients have not received as much attention as N, P and K, though there is sufficient evidence that deficiencies (and occasionally toxicity) can influence both cane yield and quality, thus lowering sucrose yield. In some instances nutrients have been linked to increased stress tolerance and resistance to attack by pests, the most notable being silicon. This provides indirect benefit for cane yield and quality.

Often the cause of deficiency or toxicity of these nutrients is linked to other soil related problems (such as excess acidity or salts), thus it becomes imperative that these issues are addressed to ensure more optimal use of the available nutrients. Where true deficiency is present then appropriate nutrient management strategies can be adopted to remedy these.

Soil amendments

In some regions, growers make use of various mill and farm wastes and by-products to supply nutrients and organic matter to the soil or apply amendments to ameliorate soil health problems (such as liming for acidity or gypsum applications for sodicity). While the use of such practices are generally encouraged, mismanagement of these amendments can lead to nutrient imbalances and result in declining cane yield and quality. The main issues that have been noted include:

- Excessive and prolonged use of filtercake, manures and litters can lead to the build-up of N and P in the soil. This will be made worse where adjustments are not made to conventional fertiliser applications, leading to further overloading of the soil. In some instances, products may continue to supply excessive rates of N late into the crop-cycle which can then compromise natural ripening.
- High application rates of high fibre by-products (e.g. bagasse, sawdust, paper-mill sludge) can lead to N lock-up in the soil thus leading to N deficiency in the crop with negative consequences on cane yield and quality.

- Excessive use of CMS can lead to oversupply of K, and in extreme cases result in a K induced salinity problems.
- Application of liming agents to acidic, high organic matter soils (notably humic soils of the cooler cane growing regions) can stimulate the breakdown of organic matter and release large amounts of N. It is essential that lime is applied several weeks to months before planting (to allow the soils to equilibrate) and that the recommended adjustments are made to the N fertiliser rates.
- Very high rates of gypsum can lead to salinity problems, and on sandier soils, lead to the leaching of K and Mg, potentially causing deficiencies.

▲ Filtercake applied in a sugarcane field.

Soil health factors

Any soil related factor that leads to poor root growth or that adversely affects the availability of a nutrients in the soil can lead to some of the problems noted. The most common soil health considerations include acidification, compaction, waterlogging and salt (salinity and sodicity). Guidance on the management of these conditions are provided in topic-specific information sheets.

Additional notes

- Soil testing remains the preferred approach to establish nutrient requirements and to guide nutrient applications and detect several chemically related soil health problems (e.g. acidity, salts)
- Leaf testing is a valuable tool that can be used to assess crop response to nutrient and management practices and thus guide future adjustments to existing practices.
- Recommendations given by SASRI have been developed based on crop responses that provide optimal sucrose yield and nutrient use efficiency. These recommendations should form the basis of any nutrient management plan, with adjustments being made for site specific and situational conditions. This requires continual evaluation and refinement due to the ever changing nature of the environment.

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