Information Sheet

12. RIPENING

12.1 Principles underlying chemical ripening

Basic concepts

Chemical ripeners can provide one of the quickest returns on investment during periods of the milling season when cane quality is low. When conditions are optimal for their use, increases in sucrose yields of more than 1.5 tons/ha can be expected from chemically-ripened sugarcane. Probably the most important consideration when planning to spray chemical ripeners is crop vigour and associated crop maturity. It is of paramount importance that spraying of chemical ripeners takes place when the cane is growing vigorously and crop maturity is low. Why is this so important?

To answer this question one must understand how chemical ripeners work within the sugarcane plant. During the process of photosynthesis in the green leaves, carbon dioxide is converted to sucrose (Figure 1). Not all the sucrose produced by photosynthesis is available for storage in the stalk, because stalk elongation, the formation of new leaves, and maintenance of the rest of the plant requires energy. Energy is provided by sucrose, which is broken down to its component sugars, glucose and fructose, and then used during respiration to fuel these growth and maintenance processes. The portion of sucrose not used for these processes is stored in the stalk. In vigorously growing sugarcane, where stalk elongation and new leaf formation is rapid, the portion of sucrose for storage is therefore relatively small. This is the reason why periods of vigorous growth during summer, or resumption of vigorous growth in spring, cause a decline in cane quality.

Chemical ripeners improve cane quality by inhibiting new growth, thereby decreasing the demand for sucrose as energy source and increasing sucrose storage in the stalk.

In Figure 1, the lower demand for sucrose to fuel new growth is indicated by the thinner orange arrow, while the increased capacity for sucrose storage in the stalk is indicated by the thicker black arrow. Because chemical ripeners specifically target the growth process, they should only be applied when growth is vigorous and crop maturity is low. **As a general rule chemical ripening is not recommended in crops having whole-stalk juice purities exceeding 85%.** This holds true for both annual and longer-cycle crops.

Sugarcane grows vigorously if the crop is disease-free, well-nourished with nutrients, and not experiencing drought stress. Stress, especially from lack of available moisture and low temperatures, will rapidly reduce plant growth rate, and hence, accelerate sucrose storage (crop maturity) through a process called natural ripening (also see section 'Important note on drying-off'). With an increase in crop maturity (increase in juice purity), the benefits from applying chemical ripeners diminish. Adequate soil water supply is important both before and after chemical ripener spraying.

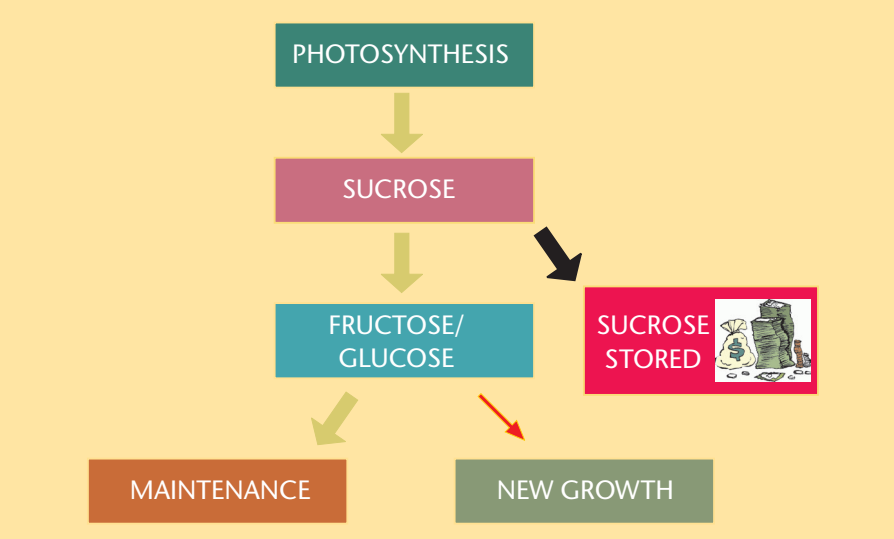


Figure 1. Simplified scheme illustrating how sucrose formed during photosynthesis is used as an energy source for new growth and maintenance of existing biomass. The sucrose not used for these purposes is available for storage in the stalk. Chemical ripeners slow down growth, thus reducing the demand for sucrose as an energy source (indicated by thinner orange arrow), thereby increasing the proportion of sucrose that can be stored in the stalk (indicated by thicker black arrow).

Important note on drying-off

To achieve maximum chemical efficacy it is recommended that ripened crops be irrigated for as long as possible after product application, yet allowing enough time without irrigation to avoid complications during harvesting (stool damage due to wet soil and poor burning efficiency). Excessive drying-off causing drought stress will interfere with chemical ripener action and diminish the benefits from using these chemicals.

Estimation of soil moisture reserves required for optimal ripener responses

When deciding whether to ripen sugarcane that cannot be irrigated after chemical ripener application, it is the safest to assume that no rain will fall for at least five weeks after application. A decision must then be made to maintain a good growth rate during this five-week window period based on whether soil moisture reserves are sufficient. For rainfed cane, the number of days during which the crop will have sufficient moisture to continue growing vigorously can be estimated as explained below.

For this four-step estimation you will need the following information:

- recent rainfall data,
- evapotranspiration (Et) data for the same period,
- the depth (m) of the soil in question, and
- the available water content (AWC) of the soil as mm/100 cm soil depth.

Step 1:

Calculate the total available water (TAW) of the soil when the entire profile is full:

TAW = soil depth (m) x AWC

Step 2:

Determine the date when the soil profile was last full, i.e. when the total rainfall minus Et over a short period exceeded the TAW.

Step 3:

Starting with the above date, subtract the Et for each day from the TAW value calculated in step 1. Remember to also add any rainfall. Continue with these subtractions/additions until the day before the field needs to be sprayed with chemical ripeners. This will give you an estimate of the amount of water in the soil at that point in time (also see alternative estimation method). To calculate whether the amount of water in the soil is sufficient to keep the crop growing vigorously for five weeks after ripener spraying, continue to step four.

Step 4:

From the amount of water in the soil estimated at the end of step three (time of ripener spraying), subtract the predicted total Et (available from your Extension Specialist) for the next 35 days after the date of spraying (refer to example calculation).

Example of calculations described in Step 1 – Step 4:

Step 1:

Soil depth in target field: 0.8 m

AWC of soil in target field: 125 mm/m

TAW = 0.8 m x 125 mm/m = 100 mm

When the amount of water in this soil + rainfall exceeds 100 mm, no additional water will be stored in the soil profile.

Step 2 and 3:

Intended spraying date: 6 March

Date when soil profile was last full: 23 February

Total Et between 23 February and 5 March: 45 mm

Total rainfall between 23 February and 5 March: 5 mm

Available soil moisture on 5 March

= TAW – 45 mm + 5 mm = 60 mm

Step 4:

Available soil water on day before ripener spraying: 60 mm

Predicted daily Et after 5 March: 4 mm per day

Number of days until soil profile is empty:

60 mm ÷ 4 mm = 15 days

In the above example soil water reserves will not be sufficient to maintain a good growth rate for five-weeks following ripener application. All the available water in the soil would have been drawn out through Et after 15 days. Drought stress typically starts developing when about 60% of the soil moisture has been depleted. In the soil (TAW = 100 mm) used in the example above, this means that stress starts developing when the water content drops below 40 mm. Assuming a soil water content of 60 mm (step 4) on the day before spraying, the absence of any further rain after spraying, and an Et of 4 mm/day, the stress point would be reached within five days after spraying and the cane would have developed severe stress before a response to chemical ripeners could develop.

Alternative method to estimate the soil water content of field before planned ripener spraying:

The soil water content before planned ripener spraying can also be estimated using SASRI's WeatherWeb, which may be accessed through the following link:
http://www.sasa.org.za/weatherweb

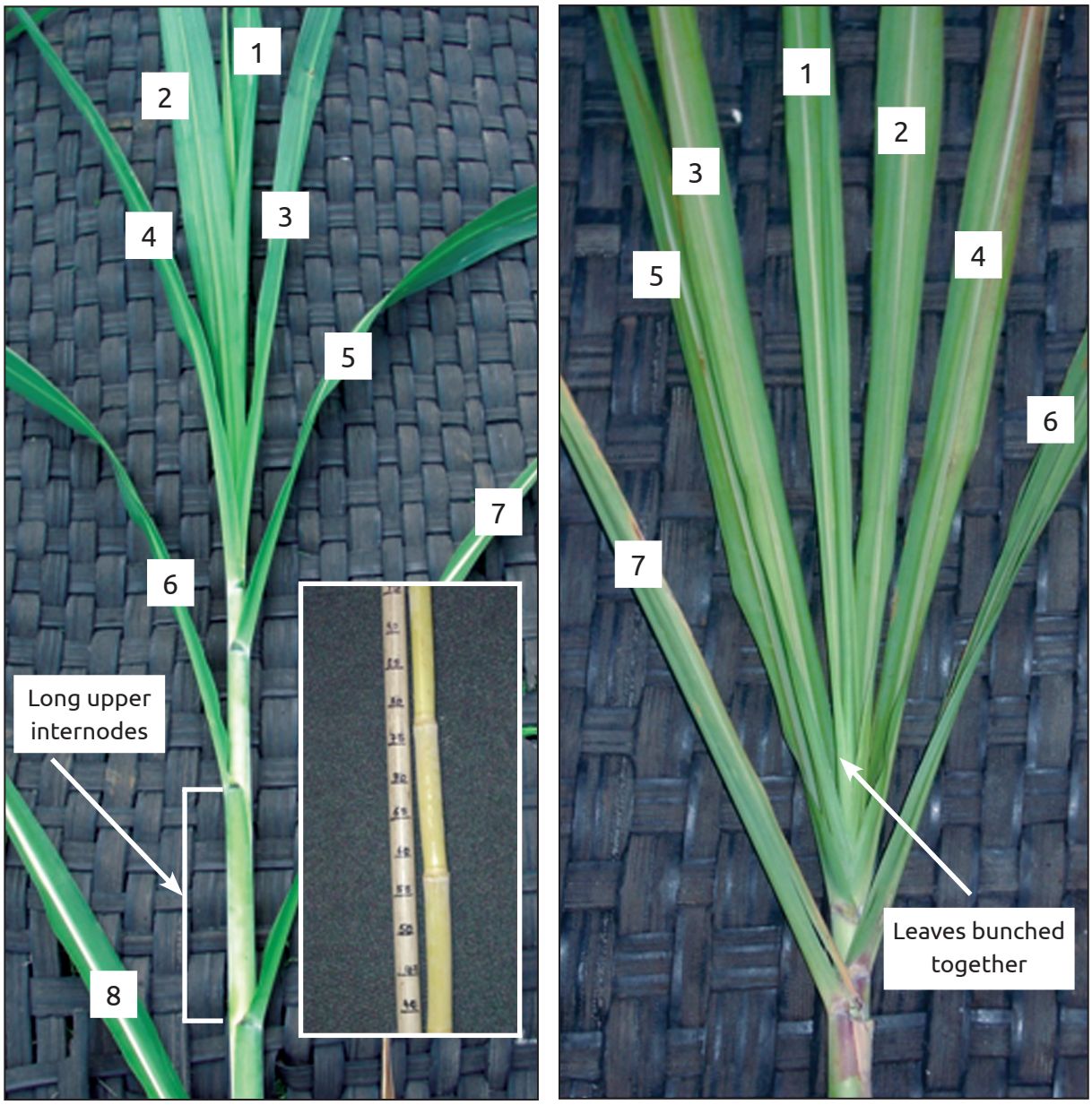


Figure 2. An example of a sugarcane plant displaying vigorous growth (left). Note the presence of eight green leaves as well as long upper internodes. In the insert, the cleaned stalk of the same plant is shown. Note the long internodes (± 20 cm) of similar length below the natural breaking point of the stalk, which indicates consistent vigorous growth. On the right is an example of a plant that, despite the presence of numerous green leaves, is not growing vigorously as indicated by the leaves bunched together at the top of the stalk.

For example if the planned date of spraying is 30 January, the grower should access WeatherWeb **after 11h00** (daily weather data update completed by SASRI) on 29 January to obtain the information for his field as on 28 January. On the web page the user can do the estimation by following these steps:

a) Under the heading "Data views and downloads" click on the "Custom reports" option.

b) Under "Spatial resolution" activate the "Station" option and then select the automatic weather station (AWS) from the drop-down menu that is the closest to the target field.

c) Under "Time resolution" activate the "Daily" option, and under "Period" select the "Start" and "End" days using the calendar icons provided. For example, if the intended date of ripener spraying is 30 January, select 28 January for both the start and end dates. If the user wants to see the history of changes in soil water content in the particular field any earlier "start date" may be selected.

d) Under "Select file format" activate the "Select own variable set and format" option.

e) Under "Select own variables from list" two windows are shown namely, "available items" and "selected items". Clear the "selected items" window by using the ← arrow. Under the "available items" window

scroll down to the options "soil water content 60 mm", soil water content 100 mm" and "soil water content 140 mm". Click the option that most closely matches the TAW of the target field. For example, if the TAW of the target field is 90 mm, select the "soil water content 100 mm" option. By using the ➡ arrow transfer this item to the "selected items" window.

f) Under "Download file" activate the "HTML" option.

g) Click on the "Save the selection" button to save all the selections that you have made.

h) Click on either the "View data" or "Download data" buttons and the estimated soil water content (mm) of the field on the selected date will be displayed.

Indicators of vigorous crop growth and determination of whole-stalk juice purity

A reliable visual indicator of vigorous growth in the field is cane stalks with 8 or more unfurled green leaves COMBINED with long upper internodes (Figure 2, left). Green leaves that are bunched together at the top of the stalk (because of short upper internodes) indicate that growth was not vigorous (Figure 2, right).

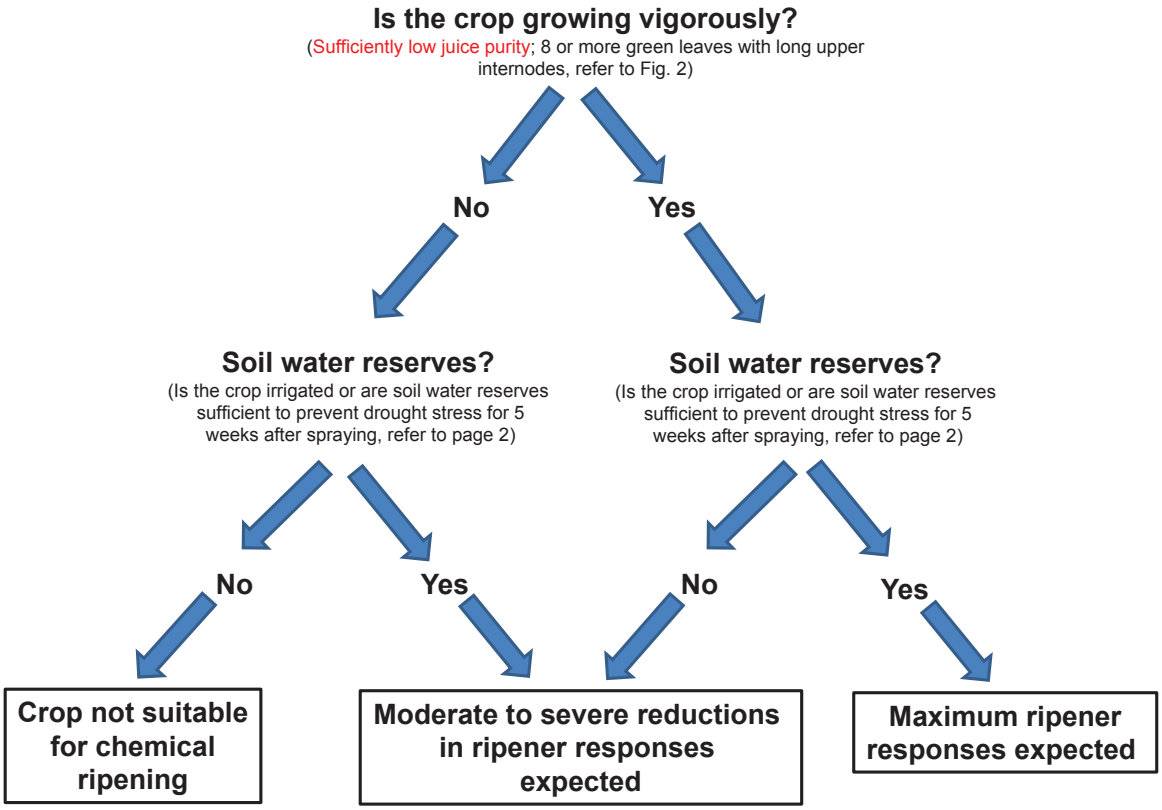
Sugarcane **most suitable** for chemical ripening should also have:

- no symptoms of pest and disease,
- a uniform stand with no lodging, and
- no flowered stalks.

Visual inspection, combined with knowledge of the juice purity status of the crop, will greatly facilitate ripener decision-making. At the time of ripener application, juice purity should be below 75% for ETHEPHON and below 85% for FUSILADE FORTE and MODDUS. Refer to SASRI Information Sheet 12.2, for information on how to determine whole-stalk juice purity through laboratory testing or through estimation on the farm with a portable refractometer together with the smartphone app **PurEst**™.

Decision tree

Use juice purity data and the decision tree as tools to determine the suitability of a particular crop for chemical ripening. If the crop is suitable for chemical ripening, consult SASRI Information Sheets 12.3 – 12.5 for detailed information on the use of registered chemicals for ripening sugarcane: ETHEPHON, FUSILADE FORTE and MODDUS.



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