CHANGES IN THE COMPONENTS OF SUGARCANE STALKS FROM RIPENING WITH FUSILADE SUPER

R A DONALDSON

South African Sugar Association Experiment Station, P/Bag X02, Mount Edgecombe, 4300, South Africa
E-mail: xagrrd@sugar.org.za

Abstract

The effects of the chemical ripener, Fusilade Super, were evaluated over time in order to characterise the response curves of sucrose, fibre and non-sucrose content. This was done to provide a comparison between the responses in terms of sucrose mass and ERC (estimated recoverable crystal) mass. The ERC formula is used as a surrogate for RV (relative value) so that the benefits from Fusilade Super could be quantified in terms of the RV payment system. The raw data of sucrose, fibre and non-sucrose from a single experiment at Pongola on stress–free NCo376 were normalised and responses were constituted as the difference between treated and control values expressed as a percentage of control. A second set of data from 13 experiments were collectively analysed in the same manner for sucrose mass responses. Response curves of sucrose mass were related to radiation Rad, thermal time $TT_{10}$and evapotranspiration ETref accumulated after spraying as a means of producing a base for developing more appropriate time intervals between spraying and harvesting. Data from the experiment at Pongola showed that the fibre and non-sucrose content were reduced by about 10% while sucrose content increased by 15% on a dry matter basis, 58 days after spraying Fusilade Super. The changes in the partitioning of stalk components resulted in an increase of 27% in sucrose mass and 30% ERC (estimated recoverable crystal) mass. Peak response occurred when accumulated TT10 = 500 º C days, ETref =165 mm and Rad = 820 MJm^{-2}. These values were different for the extended data set.

Keywords: Ripening responses, Fusilade Super, ERC, RV, sucrose mass, response times.

Introduction

Under the RV (relative value) system revenue to the farmer will be increased by agronomic practices that a) maximise sucrose content and b) minimise non-sucrose and fibre content in sugarcane stalks. Hilton *et al.* (1980) reported that an increase of 4.8 tons sucrose per hectare was accompanied by 10% reductions in fibre levels in stalks treated with the ripener Mon 8000 (glyphosate). Mon 8000 also reduced invertase activity that resulted in less CO2 being fixed in invert sugars. Fusilade Super has been reported to raise the sucrose yields of four varieties by 0.76 to 2.45 tons per hectare (Donaldson, 2001). The effects on fibre and non-sucrose have not been quantified. Thus, the effects of Fusilade Super on the accumulation of sucrose, non-sucrose and fibre in sugarcane stalks were evaluated with the specific objective (1) of assessing the benefits from chemical ripening under the RV system. A surrogate for RV is ERC (estimated recoverable crystal) and a comparison of responses in terms of sucrose mass and ERC mass is deemed appropriate for this study. Non-sucrose and fibre detract from the manufacturing of sugar. Similar to RV, fibre and non-sucrose contents are also considered in the ERC% cane formula. Thus: ERC%cane = 0.978 S – 0.539N – 0.019F, where S is sucrose, N is the non-sucrose content of the soluble solids in juice and F is the fibre content which is the insoluble content of stalks. A second objective (2) was to determine the relationship between responses and weather factors like thermal time (TT10; ºC days), solar radiation (Rad; MJm^{-2}) and evapotranspiration (ETref; mm) in a

Pongola experiment and, as confirmation, to compare the results with those from an analysis done on an extended data set. A spray to harvest schedule, based on the weather parameter with the best fit, will be more appropriate for extrapolating to other areas than the existing recommendations that were developed on data from Swaziland and are based on calendar days (Leibbrandt, 1989).

Method

Pongola experiment

Details of the experiment have been presented previously (Donaldson and Van Staden, 1995) and are briefly reported here. The variety NCo376 started growth as a ratoon crop on 26 July 1989 at Pongola (27° 24' 56" S, 31° 35' 37" E) in sandy clay soil (deep Hutton) during 1990. The crop was well irrigated and leaf water potentials showed little evidence of stress. The ripener Fusilade Super was applied at 330 mL/ha (41.25 g a.i./ha), 50 cm above the leaf canopy, with a handheld boom through two TK 1 floodjets under constant pressure (1.75 kPa) from CO_2 gas. Plots were 109.8 m^{-2} and treatments were replicated seven times. A sample of 16 adjacent stalks was taken from each plot 2, 26, 54 and 96 days after spraying (DAS), weighed and analysed by DAC (direct analysis of cane).

Because the variation in data from early samplings was large, the mass of each stalk component from each sampling event was expressed as a fraction of the mass recorded at time zero (2 DAS) for each treatment. The data were then normalised by multiplying these fractions by the mean mass of the treatments at time zero. The adjusted mass of sucrose, fibre and non-sucrose were also expressed as contents of the adjusted stalk dry mass. A response was constituted by the ripener value minus the control value and was expressed as a percentage of the control value. Response time was expressed in terms of TT_{10}, Rad and ETref (derived from the Penman-Montheith equation (McGlinchey and Inman-Bamber, 1996)) accumulated from time zero. Polynomial curves were fitted to the plotted data to estimate the peak responses in relation to each of these weather variables.

Extended data set

A total of 13 experiments conducted over a period of 7 years at four sites were included in an enlarged data set on timed response to Fusilade Super application. Experiments in which there was obvious stress, flowering or lodging were excluded from the data set. Flowering (Leibbrandt, 1989), lodging (unpublished data) and stress (Donaldson and Van Staden, 1992) have an adverse effect on the responses to ripeners. The experiments were conducted on a range of eight varieties and treatments were replicated 4-6 times. Sucrose mass data were analysed in the same way as previously described for the Pongola experiment.

There was large variation in the extended data set possibly due to the range of varieties in the data set, poor control of topping height and stress that may have developed in these experiments. Because no meaningful trends were apparent in the raw data, responses were grouped into arbitrary categories of 200 ºC days of TT_{10}, 200 MJm^{-2} of Rad, 70 mm of ETref and 15 calendar days that had accumulated after spraying.

Results

The results from the Pongola experiment indicated that:

- ERC mass responded by 30% and sucrose mass by 27% to application of Fusilade Super at 54 DAS. The peaks of the fitted curve were at 58 DAS.
- Sucrose content was raised by 15% and fibre and non-sucrose content were lowered by 10% each at 65 DAS for the fitted curve.

- The peak sucrose mass response of the fitted curve coincided with the accumulation of 500ºC days of thermal time (r^2=0.99) (Fig. 1), 165 mm of evapotranspiration (r^2=0.9503) and 820 MJm^{-2} of radiation (r^2=0.9629).

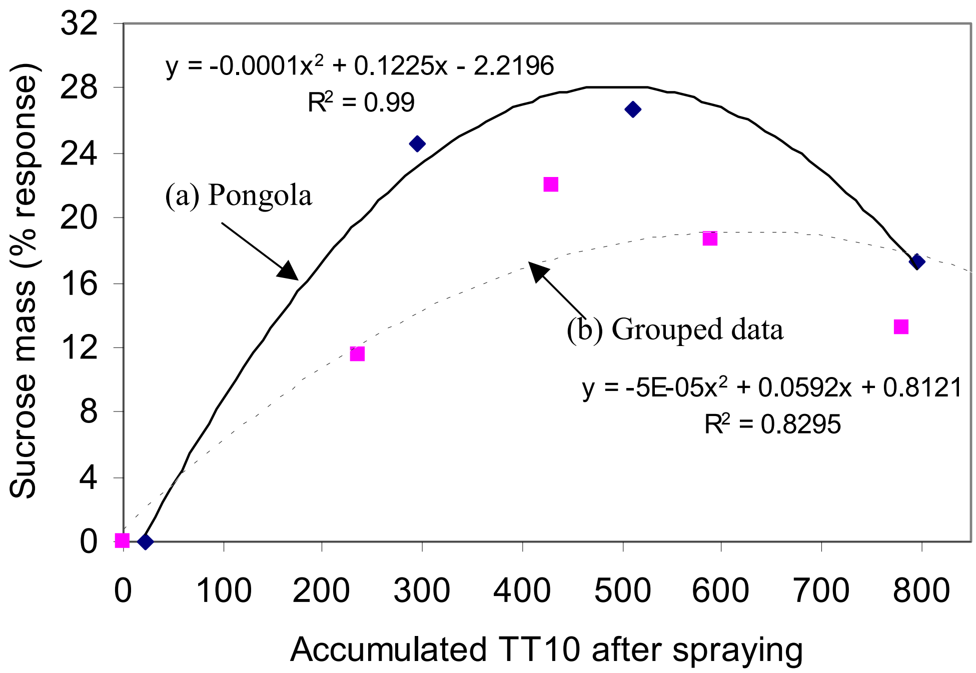

Figure 1: Regression curves showing sucrose mass responses to Fusilade Super in relation to thermal time (°C days-base10°C) accumulated after spraying in (a) the Pongola experiment and (b) grouped data from 13 experiments across 7 years.

Results from the analysis of the extended data set suggest that:
The response in sucrose mass peaked in the fitted curve when accumulated TT_{10} = 600 º C days, ETref = 230 mm , Rad = 940 MJm^{-2} and 60 calendar days . The highest average observed responses were TT_{10}=430°C days, ETref=273 mm, Rad=710 MJ^{-2} and 39 days.

General

- The flatter response curves of the extended data set was probably due to categorisation of data, other varieties peaking either earlier or later than NCo376 and mild stress altering peak response times. These effects could not be dealt with adequately because of the large variation of the data in the extended data set. When designing chemical ripening experiments, consideration should be given to parameters like variety, soil moisture status, solar radiation and temperatures, that strongly influence sucrose accumulation. Sampling procedures that reduce variation in data should also be considered.
- The possibility that thermal time, solar radiation or evapotranspiration could provide more appropriate recommendations than the current schedules, should be further investigated.

Acknowledgements

The author thanks Dr MA Smit and Dr A Singels for their guidance in data analysis and appraisal of the manuscript. Carel Buizdenhout is thanked for providing weather data.

REFERENCES

Donaldson, RA (2001). Effects of Fusilade Super and Ethephon as single and tandem treatments on four sugarcane varieties. *Proc Int Soc Sug Cane Technol* 24: 196-198.

Donaldson, RA and Van Staden, J (1992). Responses from the ripener Fusilade Super when used on droughted cane. *Proc S Afr Sug Technol Ass* 66: 63-66.

Donaldson, RA and Van Staden, J (1995). Some effects of the ripener Fusilade Super and drought stress on stalk components and leaf emergence of sugarcane. *Proc S Afr Sug Technol Ass* 69: 41-45.

Hilton, HW, Osgood, RV and Maretzki, A (1980). Some aspects of Mon 8000 as a sugarcane ripener to replace Polaris. *Proc Int Soc Sug Cane Technol* 17: 652-662.

Leibbrandt, NB (1989). Chemical responses and recommendations for irrigated NCo376 and N14 in Swaziland. *Proc S Afr Sug Technol Ass* 56: 174-180.

McGlinchey, MG and Inman-Bamber, NG (1996). Predicting sugarcane water use with the Penman-Monteith equation. *Proc of Evapotranspiration and irrigation scheduling. American Society of Agricultural Engineers*, pp 592-597.