SHORT NON-REFEREED PAPER

RESPONSE OF SELECTED SOUTH AFRICAN COASTAL SUGARCANE VARIETIES TO CHEMICAL RIPENERS: ACTIVE INGREDIENT EFFECTIVENESS AND ASSOCIATED IMPACTS ON GROWER AND MILLER SUSTAINABILITY

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Introduction

Chemical ripening is an established strategy to increase cane quality (Donaldson, 2001; van Heerden and Hoffman, 2017). The magnitude of response to ripeners depends on the chemical used and prevailing environmental conditions (van Heerden *et al*., 2014). Under rainfed conditions intermittent episodes of drought stress typically induces natural ripening, which can significantly reduce chemical efficacy (Clowes, 1980; Rostron, 1985).

It is also well established that sugarcane varieties respond differently to chemical ripeners (Donaldson, 2001; Ngxaliwe and van Heerden, 2015). Hence, evaluation of varietal responses to ripeners is a necessary sugarcane research function, especially under rainfed conditions where maturity state at product application might influence ripening benefit.

This paper underlines this research necessity through analyses of data from a coastal rainfed trial conducted over two ratoons from a range of ripener treatments and varieties.

Methods

Field trial

A trial was established at Mount Edgecombe, South Africa. The trial was a complete randomised design with four treatments per variety: (i) unsprayed control (Con), (ii) Ethephon® (Eth), (iii) Fusilade Forte® (FF) and (iv) Ethephon® + Fusilade Forte® combination (Eth+FF). Three varieties released for the coastal rainfed region (N55, N56 and N58) were evaluated with each treatment replicated five times. The treatment plots consisted of six rows, 8 m long and spaced 1.2 m apart. The first and second ratoon crops were harvested in May of 2017 and 2018 at an age of 12 months.

Chemical ripener application

Ethephon® and Fusilade Forte® was applied 12 and 6 weeks before harvest, respectively, either as single treatments or in combination, where both products were applied to the same plots on the two dates. Products were applied with a hand-held spray boom fitted with two TK SS1 stainless steel flood-jet nozzles. A CO_2 pressurised knapsack was used to apply the products at a rate of 1.5 L/ha (Ethephon®) and 0.2 L/ha (Fusilade Forte®) at 175 kPa and in a water volume of 67 L/ha.

Measurements and yield determination

On the two ripener application dates, and at harvest, samples of 12 stalks were collected from each plot for laboratory determination of juice purity (JP) and recoverable value per cent

(RV%). At harvest, the two inner rows in each plot were cut manually and weighed to determine cane yield (t/ha, TCH). RV yield (t/ha, TRVH) was calculated as the product of TCH and RV%. Data were statistically analysed using Genstat® (18th edition).

Economic analyses

Ripening costs for the coastal region and South African Cane Growers' Association-recommended harvesting and transport costs, together with the May 2018 RV price, were used to estimate gross margins (GMs) for each treatment. A Sugar-Juice-Molasses (SJM) balance calculation (Rein, 2007), and applicable domestic sugar price, was used to estimate potential financial implications of JP-driven influences on factory sucrose recovery.

Results and Discussion

Since there were no significant (F>0.05) year x treatment interactions, data obtained over the two ratoon crops were combined per variety (because of significant variety x treatment interactions). The lack of significant year x treatment interactions can be explained by very similar climatic conditions in both years.

In both ratoons JP at the time of Ethephon® application was 78% (N58), 79% (N56) and 81% (N55) (results not shown), which is indicative of natural ripening increasing maturity to a level above the recommended JP threshold of 75% for using this chemical. To the contrary, at Fusilade Forte® application, JP was below the recommended JP threshold of 85% for using this chemical (van Heerden *et al*., 2014).

At harvest, all the treatments achieved a significant increase in RV% over the controls, except the Ethephon® treatments in varieties N55 and N56 (Table 1). Despite a positive response to Ethephon® in variety N58, the Fusilade Forte® and combination treatments resulted in larger increases in RV%. These findings support the current recommendation of not applying Ethephon® when JP exceeds 75% (van Heerden *et al*., 2014). Only in variety N58 did the combination treatment increase RV% significantly more than both individual treatments (Table 1).

Table 1. Effects of ripener treatments (Trt) on RV%, juice purity (JP), cane yield (TCH) and RV yield (TRVH) in variety (Var) N55, N56 and N58. Different uppercase letters within each column indicate significant differences (p<0.05) between the control and ripener treatments per variety. Least significant difference (LSD) values are provided per variety. NS = not significant. The ∆ columns next to each parameter show the magnitude of response to the treatments. The effect of treatments on gross margins (GM), relative to the controls, are also shown.

Var	Trt	RV	Δ_{RV}	JP	Δ_{JP}	TCH	Δ_{TCH}	TRVH	Δ_{TRVH}	GM increase
		(%)		(%)		(t/ha)		(t/ha)		(R/ha)
N55	*Con*	12.1^{a}		86.2^{b}		92.6^{a}		11.2^{a}		
	Eth	11.9^{a}	NS	84.1^{a}	-2.1	96.7^{a}	NS	11.5^{a}	NS	277
	FF	14.1^{b}	+2.1	89.3^{c}	+3.1	88.2^{a}	NS	12.5^{a}	NS	5093
	Eth+FF	14.1^{b}	+2.1	88.6^{c}	+2.4	88.3^{a}	NS	12.5^{a}	NS	4688
LSD		*0.78*		*1.98*		*10.4*		*1.50*		
N56	*Con*	11.6^{a}		83.4^{a}		79.4^{a}		9.2^{a}		
	Eth	12.2^{a}	NS	84.6^{ab}	NS	77.7^{a}	NS	9.5^{a}	NS	765
	FF	13.1^{b}	+1.5	87.4^{c}	+4.0	71.9^{a}	NS	9.5^{a}	NS	1258
	Eth+FF	13.6^{b}	+2.0	86.6^{bc}	+3.2	73.0^{a}	NS	9.9^{a}	NS	2548
LSD		*0.83*		*2.12*		*9.7*		*1.51*		
N58	*Con*	10.5^{a}		84.4^{a}		80.7^{a}		8.5^{a}		
	Eth	11.5^{b}	+1.0	85.5^{ab}	NS	85.1^{a}	NS	9.8^{ab}	NS	4196
	FF	12.4^{c}	+1.9	87.4^{bc}	+2.9	84.0^{a}	NS	10.4^{b}	+2.0	6756
	Eth+FF	13.7^{d}	+3.2	88.4^{c}	+4.0	81.8^{a}	NS	11.2^{b}	+2.7	9634
LSD		*0.83*		*2.28*		*10.3*		*1.55*		

Ethephon® treatment did not alter JP in varieties N56 and N58, However, in variety N55 Ethephon® resulted in a significant reduction in JP of 2.1 percentage units (Table 1). The loss of maturity in response to Ethephon® supports previous observations in mature cane of certain varieties (Clowes, 1980). The Fusilade Forte® and combination treatments resulted in substantial increases in JP in all three varieties (Table 1).

None of the treatments resulted in significant effects on cane yield (TCH). Only the RV yield (TRVH) increases achieved in the Fusilade Forte®, and combination treatments in variety N58 was significant (Table 1). These findings support conclusions derived from other ripener trials that TRVH, in contrast to RV%, is not a sufficiently sensitive indicator for developing robust variety-specific ripening recommendations (van Heerden and Hoffman, 2017).

In terms of GMs, Ethephon® was the least profitable treatment in all three varieties (Table 1). Fusilade Forte® increased GM by R5 093/ha (N55), R1 258/ha (N56) and R6 756/ha (N58). The combination treatment led to the largest increases in GM of R2 548/ha and R9 634/ha in N56 and N58, respectively.

An often overlooked element of how chemical ripening impacts grower and miller profitability is the potential financial implications of JP-driven influences on factory sucrose recovery. The Fusilade Forte® and combination treatments increased JP by up to 4 percentage units in N56 and N58 (Table 1), which the SJM balance calculation (Rein, 2007) estimated as a potential (in absence of other factors limiting milling performance such as the mixing of cane of varying quality) revenue gain at mill level of R40-R64/t of ripened cane processed using an applicable domestic sugar price (results not shown). Conversely, the adverse effects of Ethephon® on JP in N55 led to estimated potential revenue loss of R21-R33/t of ripened cane processed.

Conclusion

The results reported in this paper revealed that chemical ripening led to substantial increases in gross margins in the selected coastal varieties grown under rainfed conditions, but that there were also large varietal differences in response to ripener treatments. These differences affected both grower and miller profitability. Research enabling informed matching of suitable ripener treatments with variety is therefore an important contributor to industry sustainability.

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