CHEMICAL RIPENING OF SUGARCANE WITH FUSILADE SUPER

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Abstract

Fusilade Super (fluazifop-butyl, 125 g ai ℓ^{-1}) was compared with the standard sugarcane ripeners Ethrel (ethephon, 480 g ai ℓ^{-1}) and Polado (glyphosate, 750 g ai kg^{-1}) under both irrigated and rainfed conditions in three large-scale experiments and eight small-scale experiments. Fusilade Super produced consistent improvements in sucrose percent cane fresh mass and juice purity in ten of the experiments, resulting in mean yield increases of 1,1 tons sucrose per hectare and 1,5 tons estimated recoverable sucrose per hectare. Conditions were too dry for chemical ripening to occur in the remaining experiment. Results with Fusilade Super at much lower rates of active ingredient per hectare were either similar to or better than those of the standard ripeners. None of the chemicals had any effect on ratoon regrowth. Fusilade Super reduced cane moisture content and restricted leaf and stalk growth more than the standard ripeners. The implications of these effects on cane transport costs are discussed.

Introduction

Sugarcane producers often assess their crop in terms of sugarcane production per hectare, rather than tons sucrose produced per hectare per unit time. This is, however, changing rapidly in South Africa for reasons such as the tendency to cut the crop at a younger age, the reduced profitability of sugarcane and the removal of transport subsidies. As a result, there is renewed interest in the use of chemical ripeners to increase the sucrose content of sugarcane crops, enabling them to be harvested either earlier, or at the normal time with a higher sucrose content. The introduction of Fusilade Super (fluazifop-butyl, 125 g ai ℓ^{-1}), which overcomes some of the disadvantages of other ripeners, is therefore timely. Fusilade Super is a grass herbicide that has shown promise as a chemical ripener at low rates of application (Anon,[1] Dusky[2]).

The results of 11 field experiments in which Fusilade Super was compared with the standard ripeners, Ethrel (ethephon, 480g ai ℓ^{-1}) and Polado (glyphosate, 750 g ai ℓ^{-1}) are reported in this paper. Experiments were carried out under a wide range of conditions. There was one screening experiment, seven small plot experiments and three large plot (mill) experiments. Work was done on irrigated crops initially and then extended into rainfed areas.

Materials and Methods

Relevant details of the experiments are given in Table 1. The condition of the crops at the time of spray application and the treatments used are given in Table 2. There were five or six replicates in each experiment and standard crop management practices were followed. The cane in irrigated experiments was dried off in the normal estate manner. Ratoon regrowth was carefully monitored in all experiments. Shoots per 42 m² per plot were counted and the height of 20 stalks per plot measured 56 days after harvest in Experiment 2, after 91 days in Experiment 7, and after 143 days in Experiment 6.

Small-plot experiments

A plot size of 83 to 110 m² (4 rows per plot) was used in Experiments 2, 3 and 7 to 10. In the screening experiment (number 6) adjacent single rows of sugarcane (17 m²) were sprayed with increasing rates of Fusilade Super. There was some drift of chemical from one row to another but this did not affect relative comparisons between rates, and guard rows ensured that there was no contamination of control and standard ripener plots. Five varieties were included in Experiment 6 but results for variety NCo 376 only will be presented here. The sugarcane in Experiment 8 varied in growth from one side of the experiment to the other so three replicates of good and three of poor cane were used.

TABLE 1

Experimental details

Experiment and site	Type	Date treated	Variety	Crop	Harvest date & age in months
Irrigated early season					
1 Mhlume	Large	9 Apr 1984	NCo 376	6 ratoon	11-18 June (11)
2 Mhlume	Small	14 Mar 1984	N 14	Plant	23 May (13)
3 Simunye	Small	26 Apr 1984	NCo 376	4 ratoon	18 July (10,5)
4 Ubombo	Large	9 May 1984	NCo 376	6 ratoon	21-23 Aug (11)
5 Cane-lands	Screen	18 May 1983	NCo 376	Plant	Not harv. (13)
6 Umgeni	Small	30 Mar 1984	NCo 376	1 Ratoon	18 June (12)
Rainfed early season					
7 Gingind-hlovu	Small	3 May 1984	NCo 376	Plant	10 July (12,5)
8 Sinkwazi	Small	15 May 1984	NCo 376	4 ratoon	28 Aug (17,5)
9 Emoyeni	Small	3 May 1984	NCo 376	3 ratoon	7 Aug (14)
Irrigated late season					
10 Simunye	Small	29 Sept 1983	N 14	3 ratoon	24 Nov (10)
11 Ubombo	Large	10 Nov 1983	NCo 376	1 ratoon	18-22 Dec (12,5)

TABLE 2

Treatments applied and crop condition at spraying

Exp. Fusilade Super (mℓ/ha)	Ethrel (mℓ/ha)	Polado (g/ha)	Crop condition at spraying		
			Age (months)	Estimated tc/ha	Purity %
Irrigated early season					
1. 350	1500*	560	8	80	69
2. 304, 352, 408, 688	—	481	11	100	79
3. 312, 352, 424, 776	—	541	8	79	73
4. 300	1500	560	8	81	72
5. 101, 189, 317, 405	—	515	9	68	74
6. 350	1500	500	9	70	50
Rainfed early season					
7. 280, 320, 360	800	502	10	88	74
8. 250, 300, 350	1500	500	14	85†	80
9. 280, 336, 376	1700	537	11	108	88
Irrigated late season					
10. 139, 277, 411	—	507	8	70	81
11. 300	—	560	11	114	77

* With and without either Fusilade Super or Polado
† Good sugarcane only

Chemicals were applied with a carbon dioxide pressurised sprayer fitted with an overhead boom. The rate of spray application varied from 50 to 219 ℓ ha⁻¹, depending on nozzle size and the number of rows sprayed at one pass.

Large-plot experiments

Replicated blocks of sugarcane with discard areas between were sprayed by fixed wing aircraft fitted with boom and nozzles and calibrated to apply 30 or 35 ℓ ha^{-1}. Plots were one swath of 18 m wide and were between 0,36 and 0,79 ha in size. A lower rate of Ethrel plus additives was also tested in Experiment 4. These treatments were not effective and the results will not be presented.

Cane in the experiments was burnt at harvest and hand-harvested in the normal estate manner. The cane harvested from the centre portion of each plot was labelled, weighed at the mill weighbridge, and analysed for quality in the conventional manner. The amount of recoverable sugar was estimated using the following formula:

$$ers = sucrose - 0{,}485\ non\text{-}sucrose - 0{,}056\ fibre.$$

Sampling procedures

Samples of 12 (Experiment 5) or 16 stalks were taken from each plot just before spraying and at intervals thereafter to assess treatment effects. Stalk samples were topped either at the natural breaking point or, in the case of Fusilade Super treatments, where the stalk had been blackened by the chemical. All trash was removed. A comparison was made in Experiment 3 between samples taken before and after commercial harvesting because hand-sampled stalks were not topped in the same manner as commercially harvested sugarcane.

Cane samples were analysed, either in factory laboratories or in the laboratories of the Experiment Station of the South African Sugar Association at Mount Edgecombe and Pongola. The samples were chaffed, sub-samples taken, and the material disintegrated so that sucrose and moisture contents could be determined by standard methods. An estimate was made of the amount of sugar that could be recovered from the samples.

Results

Ripening effects of Fusilade Super were similar to, or better than those of the standard ripeners, Ethrel and Polado in 10 of the experiments where growing conditions were suitable for the chemicals to be effective. Experiment 9, in which there was no response to any chemicals because the sugarcane was stressed, will be referred to only briefly. Improvements in sucrose percent cane fresh mass (s % c), juice purity, estimated recoverable sugar percent cane (ers % c), cane dry matter percentage and sucrose percent cane dry mass showed similar patterns of response to the chemicals. The results will be discussed therefore mainly in terms of estimated recoverable sugar. For convenience the experiments have been grouped into irrigated and rainfed categories and then divided according to whether the experiments were carried out at the beginning (early) or at the end of the milling season (late).

Too much reliance should not be placed on results from any one sampling occasion because of the natural variation occurring from one sampling occasion to another, particularly in fresh mass of cane. There was good agreement, however, in results amongst experiments, amongst rates of chemical and generally from one sampling occasion to another within the same experiment. There was also good agreement between sample and harvest data.

Visual symptoms on the crop

All sprayed chemicals produced marked symptoms when the sugarcane was young and growing well at the time of application (Experiments 1 to 3, 5 to 7, and 10). Symptoms were not as obvious in Experiments 4, 8 and 9 where the sugarcane was not growing as well either because it was older or because soil moisture was inadequate.

Typical symptoms of Ethrel and Polado ripening were seen in most experiments. Ethrel caused a temporary check in stalk growth, indicated by the shortening of one or two internodes and axillary bud development (side shooting) in this region. Polado checked growth more severely and side shooting was more pronounced. Both chemicals reduced the size of upper leaves.

Fusilade Super caused death of one or more of the youngest spindle leaves but it did not affect older leaves. There was a greater effect at higher rates of application and when sugarcane growth was vigorous. Where symptoms were marked there was also a blackening of young upper internodes which eventually resulted in a ring-barking or cauterization of one or more internodes. Later, the removal of leaf sheaths whilst hand-sampling resulted in the top two or three internodes of some stalks breaking off. There was, however, no rotting within the stalks, even at high application rates. The loss of this top portion of the stalk did not reduce sucrose yield unless harvest was delayed too long (Table 3) because this is the part of the stalk that is removed when topping at harvest. Side shooting of buds was not as marked in cane treated with Fusilade Super as in cane treated with Polado, and the higher the rate of Fusilade Super, the less developed were the side shoots. This is contrary to the effect of Polado which increases side shoot development at higher rates of application and when harvesting is delayed.

TABLE 3

The response to Fusilade Super in terms of cane yield (tc/ha) and mass of estimated recoverable sugar (ers) measured from sample and harvest date

	Ers% Cane			Tc/ha			Ters/ha		
	Cont	Fusil	Response	Cont	Fusil	Response	Cont	Fusil	Response
Experiment 1									
10 wk sample	10,1	12,6	+2,5‡	114†	103†	−11	11,5	13,0	+1,5*
12 wk sample	11,6	14,8	+3,2‡	110†	86†	−24‡	12,8	12,7	−0,1
12 wk harvest	10,1	11,8	+1,7‡	121	108	−13*	12,2	12,7	+0,5
Experiment 2									
8 wk sample	10,9	12,8	+1,9‡	135†	122†	−13	14,7	15,6	+0,9
10 wk sample harvest	11,5	13,2	+1,7‡	134†	122†	−12	15,4	16,1	+0,7
Experiment 10									
6 wk sample	6,5	7,9	+1,4‡	86†	83†	−3	5,6	6,6	+1,0*
8 wk sample	6,6	9,3	+2,7‡	86†	83†	−3	5,7	7,7	+2,0‡

† Estimated from stalk population and mass per stalk.
* Statistically significant (P = 0,05).
‡ Statistically significant (P = 0,01).

Harvest interval

The time between spraying and harvesting was deliberately extended beyond the expected optimum period in some experiments in order to determine what effect this would have on ripening response. Ripening effects were maintained for a longer period of time when cane was growing slowly (Experiments 4, 8 and 9) than when conditions were more favourable for rapid growth (Experiments 1, 2 and 10). In these latter experiments improvements in cane quality due to Fusilade Super were maintained until harvest but cane tonnage was reduced relative to unsprayed sugarcane. Ethrel and Polado had no effect on cane yield.

It is illustrated in Table 3 how large reductions in cane yield did not necessarily negate sucrose yield increases (Experiments 2 and 10). There was, however, a reduction of the improvement in sucrose yield in Experiment 1 between 10 and 12 weeks. This may have been due to the rapid stalk elongation and breakage of tops in the plots treated with Fusilade Super when sampling took place, resulting in significant sucrose losses (Table 4). This loss did not occur following commercial harvesting because the tops were held in place by the leaf sheaths and they did not break off. Broken tops were also weighed and analysed in Experiment 6 but there was no difference between treatments, possibly because stalk growth was restricted by low temperatures from 9 weeks after spraying.

TABLE 4

The effect of ripeners on the mass and quality of stalk tops taken before and after harvesting in experiment 1

Treatment	Pre-harvest			Post-harvest
	Stalk top (g/Stalk)	Ers % c	Ers (g/Stalk)	stalk top (g/Stalk)
Control	16,0	0,3	0,05	1,36
Fusilade Super	42,6*	8,3	3,54	0,90
Polado	6,0	1,3	0,08	1,35
Ethrel	8,0	—	—	1,30

* Statistically significant (P = 0,01)

Note 1. Pre-harvest stalks tops excluded leaf sheaths and the foliage had not been burnt.

2. Post-harvest samples were taken from 10 m² in one plot per treatment after burning. Leaf sheaths were included.

Pre- and post-harvest sampling

Because of the effects observed in Experiment 1, one set of samples was taken before harvest in Experiment 3 and one set after harvest, when the stalks had been cut and topped in the conventional manner. Although absolute values were lower from post-harvest sampling (Figure 1), the pattern of ripening response relative to control was similar for both sets of samples. Unlike Experiment 1, and similar to Experiment 6, there was only moderate stalk elongation between spraying and harvesting in this experiment and this probably accounts for the similarity between sample and harvest data. The pattern of growth in Experiment 3 was more similar to that in other experiments and dissimilar to that observed in Experiment 1. It was concluded that sampling prior to harvest was acceptable under most conditions.

Sample and harvest results

At harvest, all chemicals produced similar statistically significant improvements in s % c, ers % c and juice purity in the 10 experiments where crops were growing actively, with the exception of Polado in Experiment 3. Fusilade Super resulted in a larger overall mean response of 1,5 tons estimated recoverable sugar (t ers ha^{-1}), compared with 1,2 t ers ha^{-1} for Ethrel and 1,0 t ers ha^{-1} for Polado, because it had a greater effect on both s % c and juice purity (Table 5). The mean yield response to both Fusilade Super and Polado would probably have been higher if Experiment 1 had been harvested earlier than 12 weeks after spraying (Table 3). It is interesting to note that similar ripening responses were obtained under irrigated and rainfed conditions, and in the cooler midlands region (Experiment 6).

A typical pattern of ripening response with time for Experiment 2 is presented in Figure 2. Ripening effects tended to occur earlier with higher rates of Fusilade Super application. There were also consistent increases in mass of ers but few of these were statistically significant because of experimental variability. The mean response to Fusilade Super, measured from sampling, in the nine experiments that were harvested was 1,2 t ers ha^{-1} and this compared favourably with the mean yield increase of 1,5 t ers ha^{-1} measured at harvest. Ethrel and Polado gave similar results in most experiments.

TABLE 5

Increases at harvest in juice purity, tons sucrose (ts/ha) and tons estimated recoverable sugar (ters/ha) due to treatment with the three ripeners in nine experiments.

	Fusilade			Polado			Ethrel		
	Purity	Ts/ha	Ters/ha	Purity	Ts/ha	Ters/ha	Purity	Ts/ha	Ters/ha
Irrigated Early Season									
A 1	3,8†	0,0‡	0,5‡	3,6	1,1	1,5*	2,9†	0,9	1,2*
2	3,8	0,4	1,0	4,2	0,7	1,3	—	—	—
3	1,9	0,8	1,2	0,3	-0,4	-0,5	—	—	—
A 4	2,6†	0,3	0,6	1,6	0,5	0,6	2,9†	0	0,2
6	3,8*	1,3	1,6*	4,9*	0,6	1,1	5,0*	1,2	1,5*
Mean	3,2	0,6	1,0	2,7	0,5	0,8	3,6	0,7	1,0
Rainfed Early Season									
7	2,4†	1,2	1,3	0,9	0,6	0,7	1,7*	0,8	0,9
8 good	2,5	1,7	1,8	0,9	1,6	1,7	2,2	2,1	2,3
Mean	2,4	1,4	1,6	0,9	1,1	1,2	2,0	1,0	1,6
Irrigated Late Season									
10	9,1†	2,4*	3,0†	1,8	1,2	1,2	—	—	—
A 11	4,1†	2,0*	2,1*	2,2	1,1	1,2	—	—	—
Mean	6,6	2,2	2,6	2,0	1,2	1,2	—	—	—
Overall Mean	3,7	1,1	1,5*	2,2	0,8	1,0	2,9	1,0	1,2

A Aerial trial - commercial mill data
‡ Low because of delayed harvesting
* Statistically significant (P=0,05)
† Statistically significant (P=0,01)

Rates of Fusilade Super: Summarised results of samples taken from experiments comparing rates of Fusilade Super are presented in Table 6 and harvest data are given in Table 7. The optimum rate in terms of ers % c was between 300 and about 400 mℓ ha⁻¹ and the optimum rate for mass of ers appeared to be between 250 and 360 mℓ ha⁻¹, except in Experiment 10. This experiment involved young cane of variety N14 which was possibly growing more vigorously than other crops, and gave a positive linear response in both ers % c and mass of ers up to the highest rate of 411 mℓ ha⁻¹. There was no additional response to rates of 688 and 776 mℓ ha⁻¹ in Experiments 2 and 3 respectively.

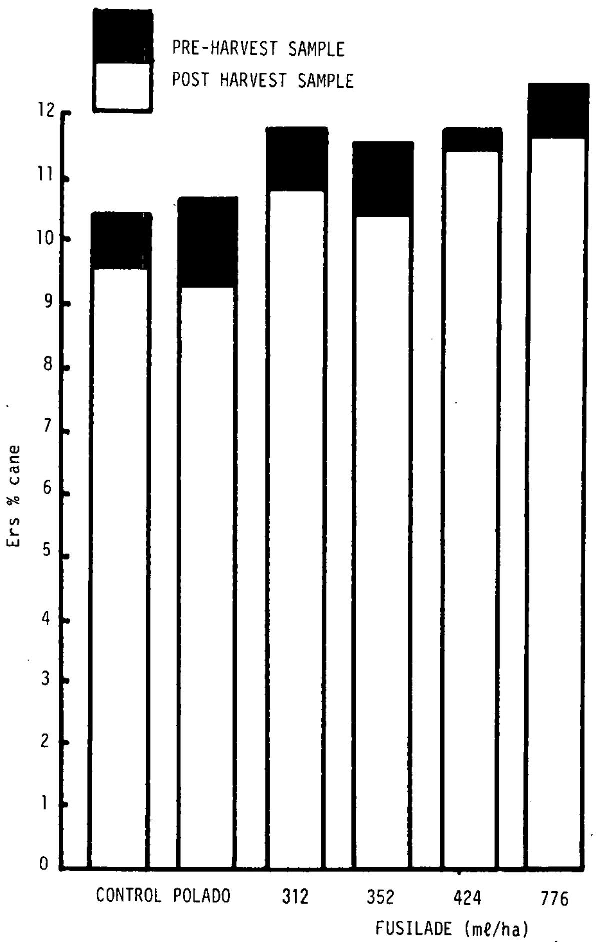

FIGURE 1 The effect of sampling either before or after harvest on percentage estimated recoverable sugar (ers% cane) in Experiment 3

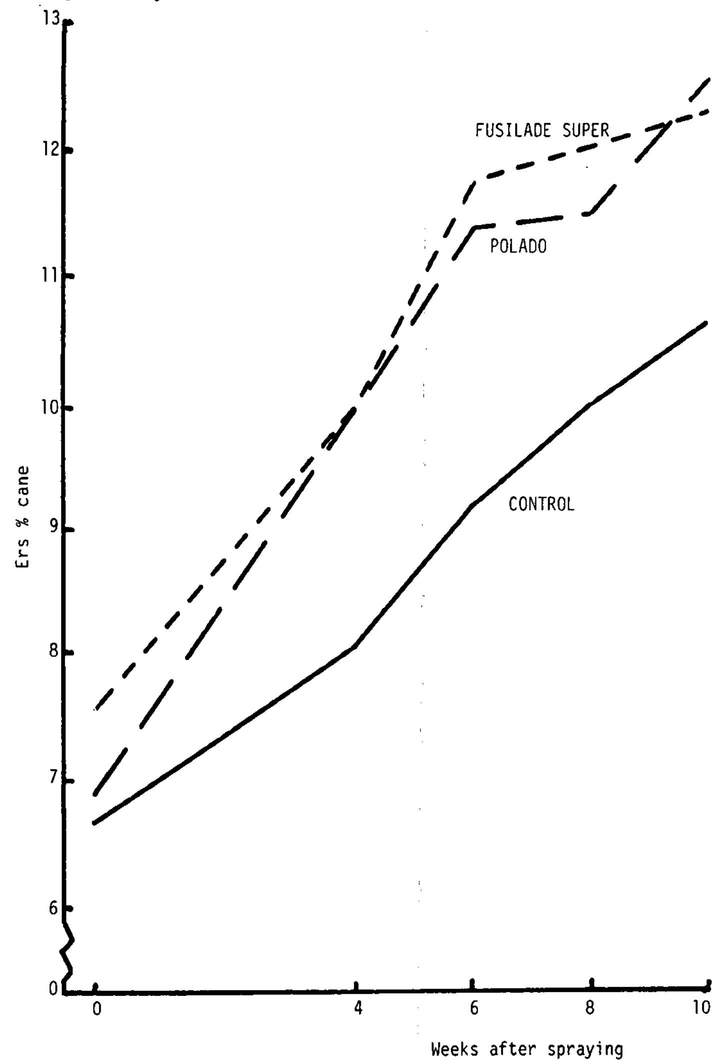

FIGURE 2 Typical effects of Polado and Fusilade Super on changes with time in percentage estimated recoverable sugar (ers% cane) in Experiment 2

TABLE 6

Mean increase over control in estimated recoverable sugar percent cane (ers % c) in cane samples resulting from the application of varying rates of Fusilade Super.

Measure	Irrigated early season														
	Experiment 2 (weeks 6–10)*					Experiment 3 (weeks 6–12)					Experiment 5 (weeks 7–13)				
	Control (actual)	Fusilade (mℓ/ha) 304	352	408	688	Control (actual)	Fusilade (mℓ/ha) 312	352	424	776	Control (actual)	Fusilade (mℓ/ha) 101	189	317	405
Ers % cane	10,9	1,6	1,9	2,3	2,2	9,6	1,2	0,8	1,2	1,4	9,9	0,6	0,9	1,2	1,4
Mass Ers (g/stalk)	150,1	7,5	9,5	5,0	11,0	83,7	11,0	3,0	6,0	2,2	61,0	2,8	8,0	10,5	7,5

Measure	Rainfed early season								Irrigated late season			
	Experiment 7 (weeks 6–10)				Experiment 8 (weeks 7–13)$				Experiment 10 (weeks 6–8)			
	Control (actual)	Fusilade (mℓ/ha) 280	320	360	Control (actual)	Fusilade (mℓ/ha) 250	300	350	Control (actual)	Fusilade (mℓ/ha) 139	277	411
Ers % cane	10,4	1,3	1,2	1,4	10,8	1,1	1,5	1,3	7,3	0,4	1,4	2,1
Mass Ers (g/stalk)	76,6	7,0	6,3	10,0	82,8	10,0	4,8	3,0	52,0	8,0	12,0	21,5

* Weeks 8–10 for mass Ers
$ Good cane only

TABLE 7

The effect of increasing application rates of Fusilade Super on sugarcane yield and quality at harvest in Experiments 2, 3 and 10

Rate of Fusilade (mℓ/ha)	Ers%c	Response	Tc/ha	Response	Ters/ha	Response
Experiment 2						
0	11,5		143		16,4	
304	12,6	+1,1*	133	-10	16,7	+0,3
352	13,3	+1,8†	130	-13	17,4	+1,0
408	13,6	+2,1†	133	-10	18,1	+1,7
688	13,4	+1,9†	126	-17	17,0	+0,6
Experiment 3						
0	9,8		133		13,0	
312	11,0	+1,2†	129	- 4	14,2	+1,2
352	10,7	+0,9†	128	- 5	13,7	+0,7
424	11,6	+1,8†	129	- 4	15,0	+2,0
776	11,7	+1,9†	117	-16†	13,7	+0,7
Experiment 10						
0	6,4		116		7,3	
139	7,4	+1,0	112	- 4	8,2	+0,9
277	8,6	+2,2*	113	- 3	9,7	+2,4*
411	10,0	+3,6†	102	-14	10,3	+3,0†

* Statistically significant (P=0,05)
† Statistically significant (P=0,01)

Fusilade Super reduced cane yield appreciably at high rates of application (Table 7) but this was statistically significant only in Experiment 3. There appeared to be some reduction in yield of ers in Experiments 2 and 3 but the ripening response was not completely lost, despite reductions of 17 and 16 tc ha^{-1} respectively. The largest yield increase in Experiment 10 was obtained at a rate of 411 mℓ ha^{-1} despite a reduction of 14 tc ha^{-1}.

Growing conditions, variety and ripening: There were large differences amongst experiments in the time taken to obtain a ripening effect, which appeared to be related to growing conditions rather than to either variety or time of year (Tables 8 and 9). The ripening response of variety NCo 376 when sprayed in May was detected only 7 weeks after spraying in Experiment 5, compared with 4 weeks for Experiments 7 (sprayed in May), 1 and 6 (sprayed in March). Variety N14 also responded to Fusilade Super 4 weeks after treatment when sprayed in either March or November (Experiments 2 and 10). Fairly mature sugarcane in Experiment 8 also took 7 weeks to show some ripening effects. Nevertheless, the sample data meaned over a time interval indicated large responses in all experiments except where growth was not active (Experiment 4, 8 (poor), and 9). There was good agreement between yield response determined from sample and harvest data (Table 9).

Combined ripener treatments: Interesting results were obtained in Experiment 1 where either Fusilade Super or Polado was sprayed onto sugarcane that had been treated with Ethrel one month previously (Figure 3). All treatments produced statistically significant improvements in ers % c from 28 days after spraying until harvest after 84 days. There was little change in ers % c from treating with Polado after 56 days, at a time when side shoots were developing rapidly, resulting in a loss after 84 days of the increase in mass of ers evident at the 70-day sampling (Figure 4). Similarly, the response to Fusilade Super in mass of ers at 70 days was also lost, but this was because of a reduction in stalk mass.

Combination treatments of Ethrel and either Fusilade Super or Polado further improved cane quality and increased sucrose yield. These additional yield increases were statistically significant after 70 days when compared with those due to the Ethrel treatment alone. The additional response to Fusilade Super was almost statistically significant at the 5% level after 84 days.

Ratoon regrowth

There was no sign of any adverse effect of any of the chemicals on the appearance or the growth of the following ratoon crop in any of the experiments and there was no difference between rates of Fusilade Super. Fifty-six days after harvest in Experiment 2, plots treated with 688 mℓ Fusilade Super ha^{-1} had 2% more shoots which were 19% taller than those in control plots. Similarly, 91 days after harvest in Experiment 7 plots treated with Fusilade Super had an average of 6% more shoots which were 4% taller. Shoot counts were 12% higher 143 days after harvest in Experiment 6. Observation of subsequent growth indicated that these differences were of no consequence but they warrant fuller investigation.

TABLE 8

Percentage response in estimated recoverable sugar percent cane (ers % c) in cane samples to similar applied rates of Fusilade Super.

Category	Irrigated early season						Rainfed early season				Irrigated late season	
Experiment Rate (mℓ/ha)	1 350	2 352	3 312	4 300	5 317	6 350	7 320	8 (good) 300	8 (poor) 300	9 280	10 410	11 300
Weeks												
0	- 8	15	0	0	- 7	6	-17	12	11	- 4	- 2	0
3					- 6			2	- 4			
4	29†	21†	0	3		23*	8†			4	18*	
5					3			2	6			
6	33†	22†	13†	5			12†			3	32*	24†
7					12†	64†		13	1			
8	34†	14†	7	0			10†			7	52†	
9					6	41†		16	- 4			
10	25†	16†	18†	6*			10†			5		
11						51†		10	- 1			
12	27†		12*	3	17†	27†				- 1		
14				6†				18†	3			
15					11†							
Mean (weeks)	30 (6-12)	17 (6-10)	12 (6-12)	4 (6-12)	12 (7-15)	46 (7-11)	10 (6-10)	10 (5-15)	1 (5-15)	3 (6-12)	34 (4-8)	24 (6)

* Statistically significant (P=0,05)
† Statistically significant (P=0,01)

TABLE 9

Response in tons estimated recoverable sugar (Ters/ha)$ in sample and harvest data to similar applied rates of Fusilade Super

Category	Irrigated early season						Rainfed early season				Irrigated late season	
Experiment Rate (mℓ/ha)	1 350	2 352	3 313	4 300	5 317	6 350	7 320	8 (good) 300	8 (poor) 300	9 280	10 410	11 300
Sample week												
0	—	—	0	0	-0,4	-1,0	-0,6	0,7	0,5	0,5	0,7	-1,1
3					-1,1			-1,2	-0,7			
4	—	—	-0,6	-0,2		0,7	1,4*			-0,9	0,8*	
5					0,7			1,1	-0,2			
6	—	—	1,2	0,7			1,1			0	1,6	1,5
7					1,0	2,3*		1,2	0,3			
8	—	0,7	0	0,4			0,8			0,2	2,6†	
9					0,8	2,8*		-1,2	-1,6			
10	1,5	1,2	2,0	0,7			0,2			-1,1		
11						1,8†		0,3	-1,8			
12	0		1,3	-1,8	2,4†	0,1				0,6		
14				0,8								
15					0,7			1,6	1,1			
Mean Sample (weeks) data	0,8‡ (10–12)	1,0 (8–10)	1,1 (6–12)	0,6§ (6–14)	1,2 (7-15)	1,8 (7-11)	0,7 (6–10)	0,6 (5–15)	-0,4 (5–15)	-0,1 (6–12)	1,7 (4–8)	1,5 (6)
Mean Harvest data	0,5‡	1,0	1,2	0,6	—	1,6	1,3	1,8	-0,5	0,1	3,0	2,1

$ Derived from Ers % c and a calculated tons cane using mass per stalk and assuming a stalk population per hectare of 120 000 for variety NCo 376 and 100 000 for N 14
‡ Harvested too late for optimum yield
§ Excluding week 12
* Statistically significant (P=0,05)
† Statistically significant (P=0,01)

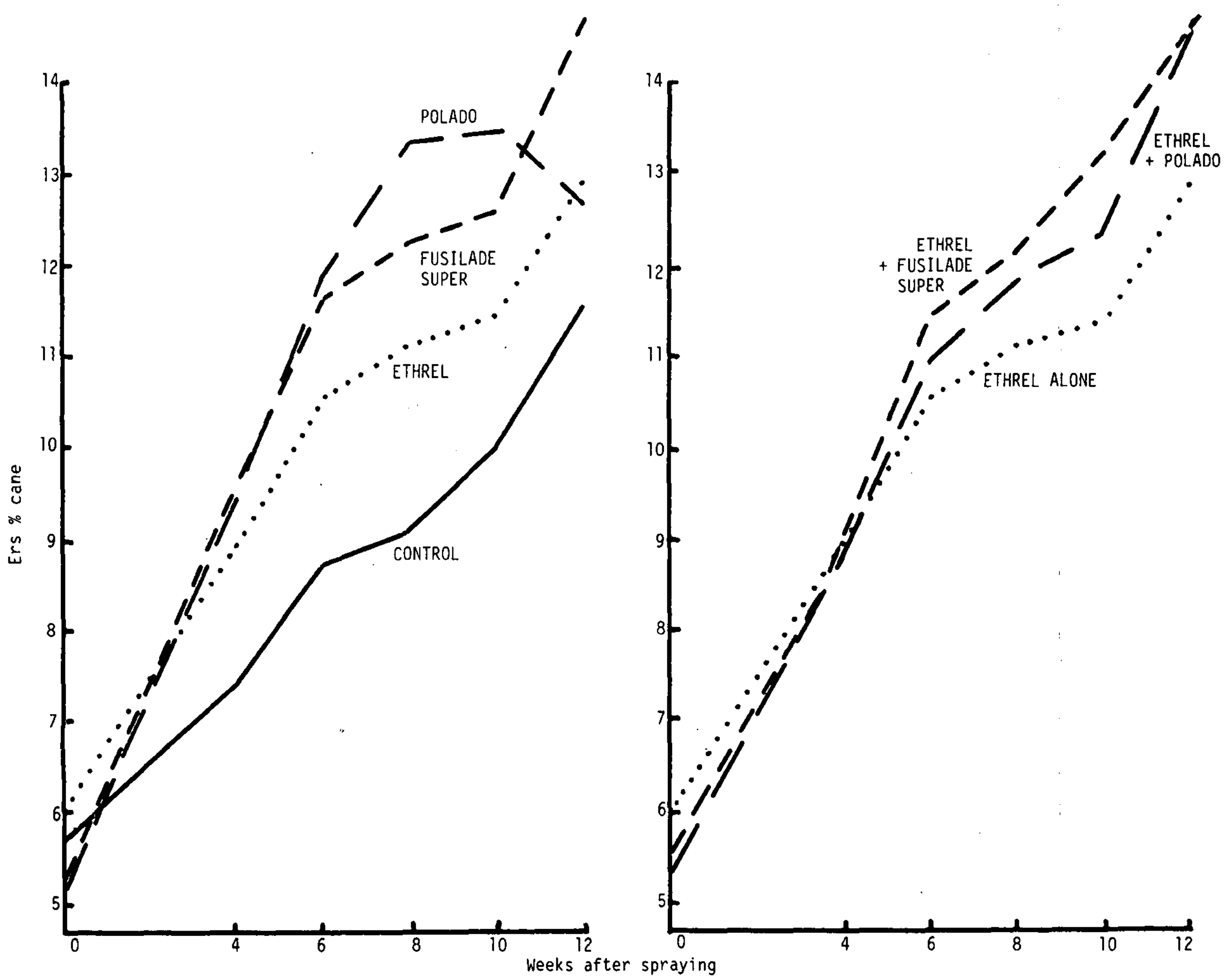

FIGURE 3 Changes in percentage estimated recoverable sugar (ers % cane) with time in Experiment 1

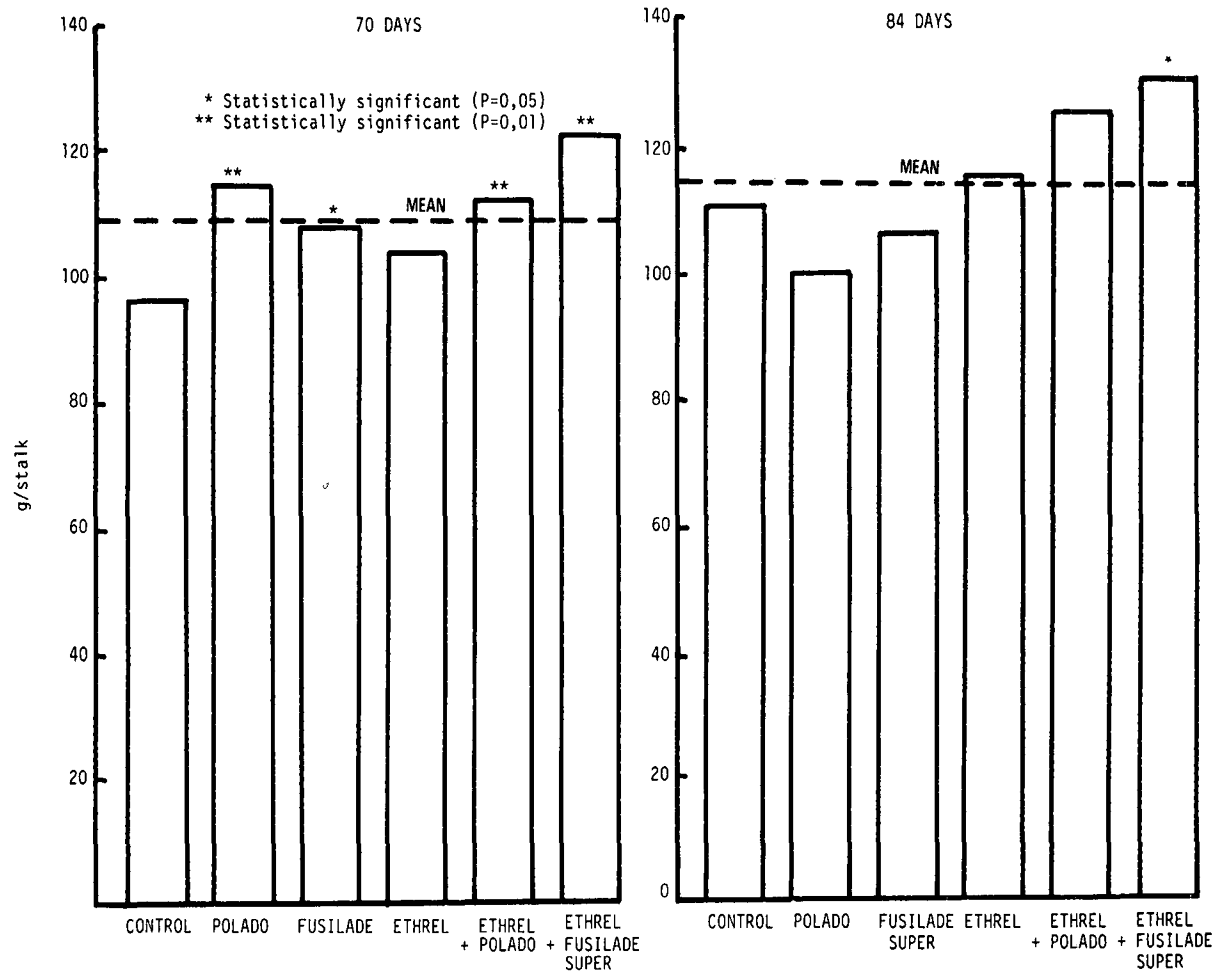

FIGURE 4 Sample mass of estimated recoverable sugar (g/stalk) 70 and 84 days after spraying in Experiment 1

Discussion

The results of these experiments show that Fusilade Super is a successful sugarcane ripener when applied to actively growing sugarcane. There was no benefit, nor were there any adverse effects from treating a crop that was not growing actively. Large and statistically significant improvements in s % c, juice purity and ers % c were measured from 4 to 7 weeks after application in most experiments and these improvements were maintained until harvest, which in some instances was up to 12 weeks after spraying. There were also consistent but often statistically non-significant increases in mass of sucrose which were generally better than those obtained from the standard ripeners Ethrel and Polado. The mean response to Fusilade Super in the nine experiments harvested under a wide range of conditions was 1,1 ts ha^{-1} or 1,5 t ers ha^{-1}.

Fusilade Super is an efficient sugarcane ripening agent. Very good results were obtained at rates between 38 and 50 g ai ha^{-1} (300 to 400 mℓ product ha^{-1}), compared with rates of 380 to 720 g ai (800 to 1 500 mℓ product ha^{-1}) for Ethrel and 338 to 420 g ai (450 to 560 g product ha^{-1}) for Polado. The optimum rate appeared to be about 300 mℓ product ha^{-1} when applied by ground sprayer. Fusilade Super is therefore an inexpensive means of improving sucrose yield. In the experiments reported here, where sucrose yield increases were obtained over a period of 2 to 3 months, the return on investment at current prices would have been between 5 and 12 times the total cost, including that for application.

The large margin of safety with Fusilade Super, which had no effect on the growth of the following ratoon crop even at very high rates of application, is encouraging. In commercial practice one cannot always select the most likely fields to be ripened and application rates are not always exact.

Fusilade Super restricted the growth of both young spindle leaves and cane stalks to a greater extent than other ripeners, increasing cane dry matter percentage and often causing a reduction in cane fresh mass. These effects were observed in several experiments but sucrose yield was not reduced unless harvest was delayed too long. Care will be needed in commercial practice to optimise the sucrose yield response to Fusilade Super. It was necessary to have a shorter time between spraying and harvest when soil and climatic conditions favoured rapid crop growth (Experiments 1, 2 and 10) than when growth was slower (Experiments 4, 8 and 9).

Multiple applications of Ethrel can further increase sucrose yield (Rostron[3]) and experiments in Swaziland, that have not been reported, indicated that spraying with Polado after treatment with Ethrel also increased sucrose yield.

However, Experiment 1 is the only known instance where this additional response has been statistically significant. This may be due to chance or it may be because of crop or weather conditions pertaining at the time as the response to all ripeners was quicker than is normally expected at this time of the year. Further experimentation is needed to explore this means of extending the use of chemical ripeners.

Sugarcane production costs are largely determined by the area under cultivation and the mass of sugarcane harvested and transported. In contrast, gross income is determined by the mass of sucrose delivered to the sugar factory, and its price.

It is therefore desirable to have as high a concentration of sucrose in the crop at harvest as possible, especially when it is harvested at a young age and has to be transported long distances. By reducing cane tonnage and increasing sucrose yield per hectare Fusilade Super provides a useful means of reducing costs per ton of sucrose transported.

The response to all ripeners is greater in terms of tons estimated recoverable sugar than tons sucrose because of improved juice purities and this should result in better overall sucrose recovery in the factory. Chemical ripening of sugarcane therefore provides an attractive means of increasing the profitability of sucrose production under conditions where natural cane quality is low.

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REFERENCES

1. Anon (1984). Screening of chemical ripeners. *Rep Exp Stn S Afr Sug Ass* 1983/84: 20.
2. Dusky, JA (1984). Plant growth regulators and sugarcane ripening. A preliminary evaluation of 10 new compounds. *Jour ASSCT* 3: 11–13.
3. Rostron, H (1977). Prolonged ripening of sugarcane following multiple applications of Ethrel. *Proc int Soc Sug Cane Technol* 16: 1605–1618.