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CHEMICAL RIPENING RESPONSES AND RECOMMENDATIONS FOR IRRIGATED NCo376 AND N14 IN SWAZILAND

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Abstract

Small plot ripener trial results for irrigated NCo376 and N14 have been reviewed. Varietal responses to Ethrel (ethephon 480 g ai/l), Fusilade Super (fuazifop-butyl 125 g ai/l) and combinations of these products have generally been diverse with NCo376 being the more responsive variety. Acceptable responses have been achieved with 0,30 l/ha (37,5 g ai/ha) of Fusilade Super on NCo376 while N14 requires a higher rate for comparable gains. Results from Ethrel treated NCo376 have been positive but its efficacy on N14 at rates up to 2,5 l/ha (1,2 kg ai/ha) was inferior. Exceptional ripening responses have been achieved when Ethrel and Fusilade Super were applied in combination onto early season NCo376, but sucrose yield improvements on N14 were minimal with slight benefits being attributed to Fusilade Super alone. Ethrel sprayed on N14 to suppress flower initiation had little influence on ripening or flowering for early cut cane, but was more successful later in the season. The accumulated ripener data have been used to compile practical recommendations for growers in the Swaziland Sugar Industry.

Introduction

The use of chemical ripeners in the Swaziland Sugar Industry has increased dramatically over the past few years. During 1988, the four largest sugar estates in Swaziland artificially ripened 72% of their total crop over an area of 18 400 ha. This represents an overall increase of 19% since the 1985/86 season. From September to March Swaziland experiences excellent growing conditions which, coupled with total irrigation, results in prolific growth and poor cane quality during the start and end of the milling season. Interest in the use of chemical ripeners has been further stimulated by developments emanating from more recent research and commercial findings in the Swaziland Sugar Industry.

With the increasing use of ripeners, the Swaziland Sugar Association endorsed an extensive small plot trial programme to determine optimum product usage, combinations of products, and timing of application for the predominant varieties in the industry. Most trials were conducted during the sucrose incline phase when the potential for ripener-related increases is greatest.

NCo376: The trend in the Swaziland Sugar Industry has been to replace N14 with NCo376 during the early season and ripener work for the latter variety was focused on this period. Rostron (personal communication) advised that an Ethrel rate of 1,5 l/ha (or 1,35 l/ha when used with Downrite) provided acceptable ripening and has become the industry standard. The combination Ethrel/Fusilade concept was initially conceived by Rostron[4] and introduced commercially in 1986 with very encouraging results, particularly on NCo376 (Sweet *et al*[6]). Three trials were directed at verifying reported cumulative Ethrel/Fusilade responses. The possibility of lowering Ethrel rates under these circumstances was also investigated. In addition, varying rates of Fusilade Super were tested on this variety to determine an optimum rate for when it is used alone.

N14: Due to insufficient ripener data for this variety, an extensive programme comprising 11 trials was undertaken to establish optimum use of Ethrel, Fusilade Super and Ethrel/Fusilade combination treatments. The susceptibility of N14 to flowering led to the inclusion of flower suppression treatments with Ethrel. This was to avert late season post flower deterioration associated with hot climatic conditions (Gosnell and Julien[2]), and thereby to provide a more suitable crop for further ripening with Fusilade Super.

Results for ripener trials with NCo376 and N14 are presented and reasons for differing chemical ripener requirements are discussed. The accumulated information has provided the basis for practical guidelines for ripener use on these varieties in Swaziland.

Method

The replicated small plot ripener trials were of random block or Latin square design and were established in commercial cane fields. Whole plots comprised 4 cane lines 17 m long while net plots were the inner 2 lines 15 m long. Sites were chosen in actively growing cane with at least 8 green leaves and elongated internodes at the top of the stalk. Pre-spray maturity testing was done to confirm the crop's suitability for ripener assessment. The ripener treatments pertaining to each trial are shown in Table 1 and the range in maturity status prior to ripening is listed in Table 2. In certain trials, spray to harvest delays for Ethrel treatments were abnormally long and were intended to intercept flowering. In addition to the formal ripener trials, observations were made also on some released variety trials.

All ripener spraying was accomplished with a constant pressure CO_2 gas-operated groundrig, that delivered approximately 48 l of liquid per ha at 220 kPa pressure through two rear facing TK 1,5 nozzles situated approximately 0,5 m above the canopy. Four cane lines were sprayed simultaneously.

Sucrose samples comprised 20 stalks per plot taken at the time of initial ripener application and subsequently at intervals up to the time of harvest. Stalks were hand trashed and tops broken off at the natural breaking point (NBP), or at the cauterised position in Fusilade-treated cane and delivered to a laboratory for full cane analysis. Cane from each net plot was hand cut and weighed with a tractor-mounted offset boom and grab.

Results

The reported trials were designed primarily to determine optimum ripener treatments for the two varieties. Spray to harvest delay requirements for Ethrel-treated NCo376 had been established earlier (Rostron[5]) but at the commencement of these trials little information was available for Fusilade-treated cane.

Table 1
NCo376 and N14 ripener trial treatments

Variety	Ranges of treatments		Trial numbers													
	Product	Rate (l/ha)	17	18	24	6	7	8	10	11	13	14	22	23	25	27
NCo376	Ethrel	1,00	*		*											
		1,50	*	*	*											
	Fusilade	0,30		*												
		0,45	*	*	*											
		0,60		*												
	Ethrel + Fusilade	1,00 + 0,45	*		*											
		1,50 + 0,45	*	*	*											
N14	Ethrel	0,50				*		*								
		1,00				*		*								
		1,50				*		*				*	*	*	*	
		2,00										*				
		2,50										*	*	*	*	
		0,30				*	*		*	*	*					
		0,45					*	*	*	*	*					
		0,60					*		*	*	*	*	*	*	*	*
		0,75					*		*	*	*					
		1,00														*
	Ethrel + Fusilade	0,50 + 0,30				*										
		0,50 + 0,45						*								
		1,00 + 0,30				*										
		1,00 + 0,45						*								
		1,50 + 0,30				*										
		1,50 + 0,45						*								
		1,50 + 0,60										*	*	*	*	
		2,00 + 0,60										*				
		2,50 + 0,60										*	*	*	*	

Table 2
Ranges of maturity sampling data for NCo376 and N14 trials prior to ripener spraying

Variety	Trial categories	Ers % cane	Juice purity %	Moisture % cane
NCo376	All trials	1,9 - 5,1	50 - 67	77 - 81
N14	Trials including Ethrel	1,3 - 7,0	46 - 76	77 - 83
	Trails with Fusilade only	6,3 - 11,0	72 - 87	75 - 79

Released variety trials

Additional results were obtained from certain released variety trials, where Fusilade Super ripener treatments provided information on different rates of response to this chemical. The change in estimated recoverable sugar (Ers, g/stalk) from spray to harvest for one early season trial (Figure 1) shows increases approaching significance 3 to 5 weeks after spraying NCo376 and later for N14. Fusilade reaction rates at other sites were similar.

Further observations showed early season NCo376 to be more prone to cane yield losses if Fusilade spray to harvest periods were extended (Table 3). Despite some considerable cane yield reductions when Fusilade was applied to NCo376, t ers/ha increases were generally higher for this variety than for N14.

NCo376 ripener trials

Sucrose sample results The changes in ers % cane after spraying the three trials are shown in Figures 2, 3 and 4 and have been arranged for ease of comparison between control, Ethrel or Fusilade, and their combinations.

Data for two trials were 1,0 and 1,5 l of Ethrel per ha were compared alone and in conjunction with 0,45 l of Fusilade Super per ha (Figures 2 and 3) generally showed greater ers % cane increases when 1,5 l product/ha was used. (Results for 1,0 l/ha Ethrel have been omitted from Figures 2 and 3). Ethrel was outperformed by the combinations in all three

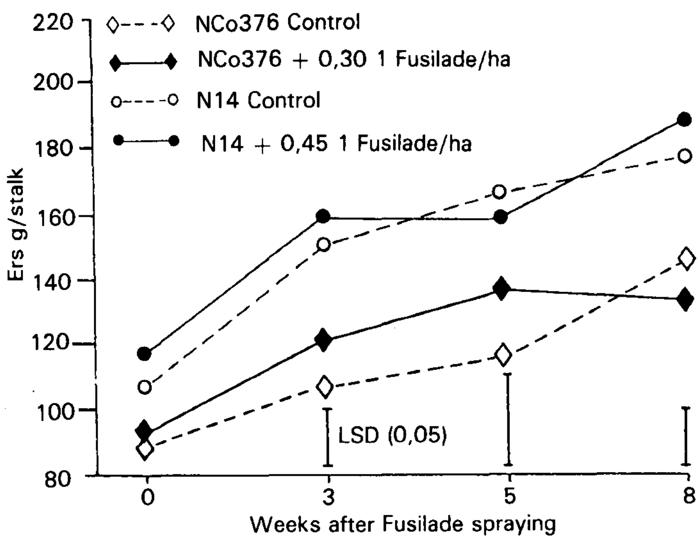


FIGURE 1 Change in g ers/stalk after application of Fusilade Super on NCo376 and N14.

trials cut between May and July but significant differences were achieved only in Trial 17 (Figure 3). Cane quality responses suggest that Ethrel at 1,0 l/ha in the combination treatments is as efficient at 1,5 l/ha for an early harvest (Figure 2), but that the higher rate was required later in the season (Figure 3).

Table 3

Tons cane/ha yield losses and t ers/ha gains for May cut NCo376 and N14 at intervals after spraying Fusilade Super

	7 weeks		9 weeks		11 weeks	
	tc/ha	t ers/ha	tc/ha	t ers/ha	tc/ha	t ers/ha
NCo376	-2	+2,3	-13	+1,4	-23	+3,2
N14	0	+1,4	- 1	+1,4	- 7	+3,4
LSD (0,05)	16	2,1	15	1,5	21	2,6
LSD (0,01)	23	2,8	21	2,1	29	3,5

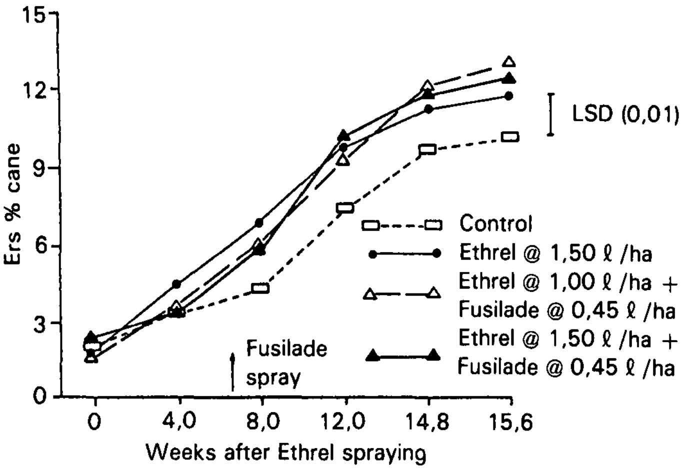


FIGURE 2 Change in ers % cane after application of Ethrel and combination treatments on NCo376 (Trial 24, May harvest).

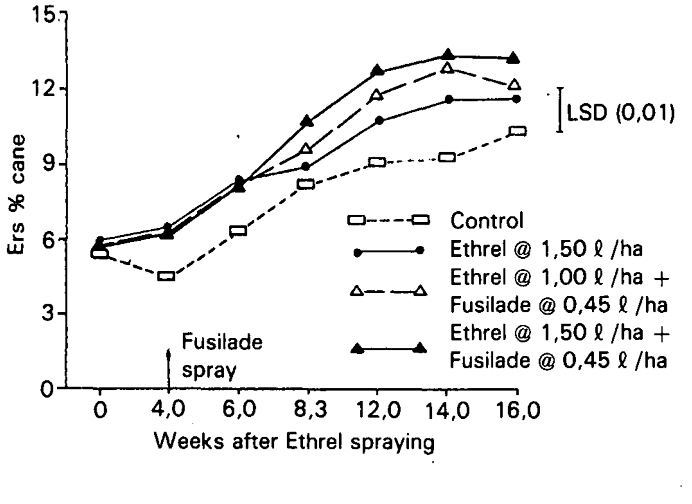


FIGURE 3 Change in ers % cane after application of Ethrel and combination treatments on NCo376 (Trial 17, July harvest)

Responses to 0,3 l, 0,45 l, and 0,60 l of Fusilade per ha in Trial 18 in terms of ers% cane were all very similar. Combination treatments in each experiment caused ers% cane to increase more than when the equivalent rate of Fusilade was used alone, but statistical significance was reached only in Trial 24 (Figure 4).

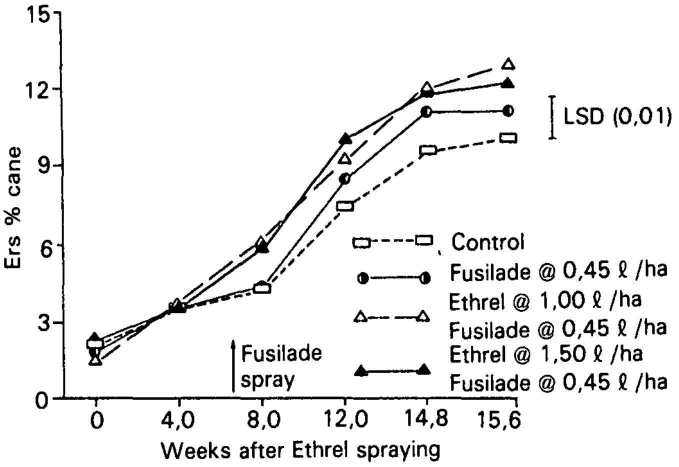


FIGURE 4 Change in ers % cane after application of Fusilade and combination treatments on NCo376 (Trial 24, May harvest).

Harvest results: Although delays for Fusilade-treated cane were considered excessive, cane yield losses of only 6 tons/ha were recorded in the May trial (Table 4). It is likely that growth in the June and July trials had slowed sufficiently to prevent cane yield suppressions. None of the Ethrel or combination treatments caused cane yields to decrease significantly in any of the trials. The unexpected cane yield increase in Trial 18 could be attributed to field variability.

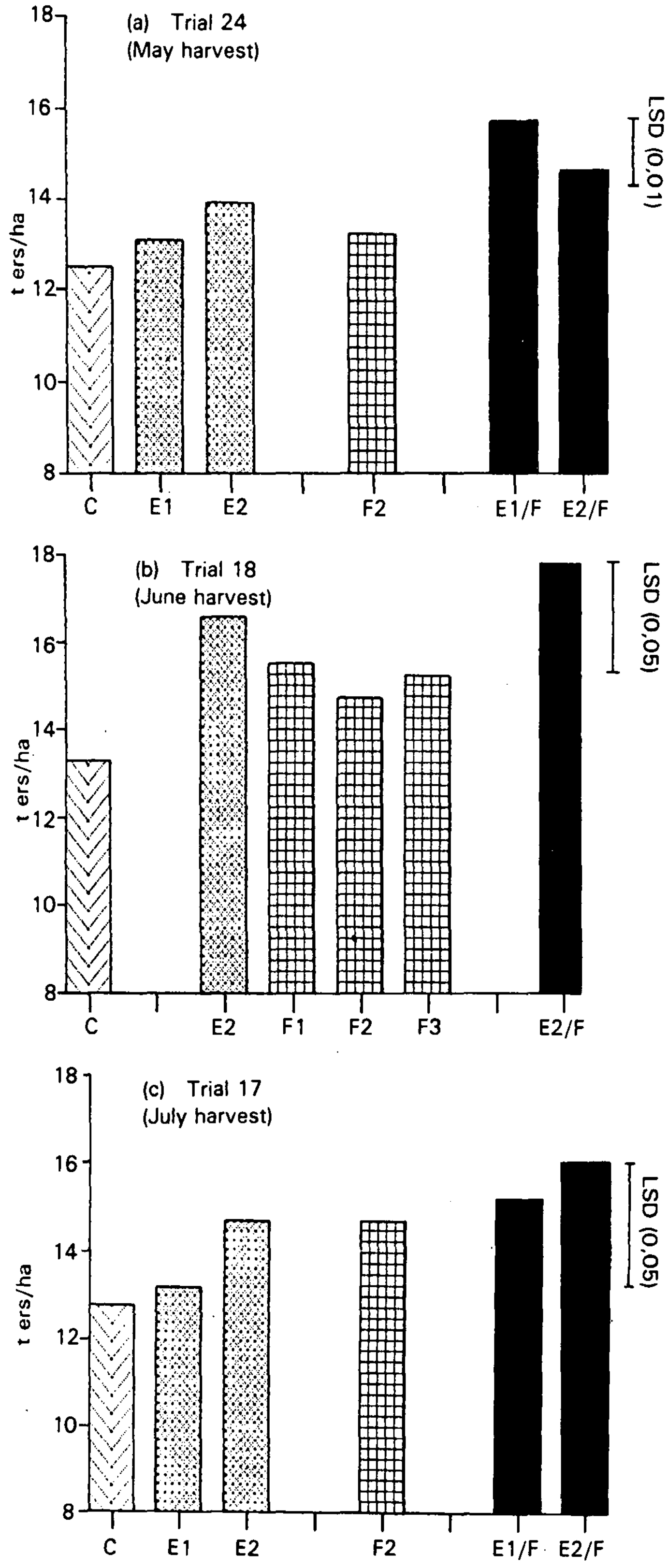
Table 4

Effects of Fusilade application to harvest delay periods on NCo376 cane yields compared with control

Trial No.	Harvest month	Delay (weeks)	Fusilade rate (l/ha)	Tc/ha difference
24	May	9	0,45	- 6
18	June	9	0,30	+14
			0,45	- 1
			0,60	+11
17	July	12	0,45	0

The treatment response trends evident from pre-harvest sampling were confirmed by yields of ers/ha at the time of harvesting. Ethrel at 1,5 l/ha was more productive than at 1,0 l/ha when applied alone (Figure 5), particularly later in the season. Since responses to the various Fusilade rates were similar, the indications are that 0,3 l/ha is sufficient when used alone on this variety. Tons ers/ha yield comparisons between Ethrel or Fusilade Super treatments proved not to be significant in all three experiments.

The combination treatments in all cases produced the highest yields (t ers/ha) which were significantly greater than control except where 1,0 l of Ethrel per ha was used in a combination treatment in Trial 17 (Figure 5). Yield benefits attributable to the combination treatments were greatest in the May cut trial (Figure 5) where the highest yielding Ethrel/Fusilade treatment significantly outyielded all single product treatments (p = 0,01).



C = Control
E1 = 1,0ℓ Ethrel/ha
E2 = 1,5ℓ Ethrel/ha
F1 = 0,3ℓ Fusilade/ha
F2 = 0,45li Fusilade/ha
F3 = 0,6ℓ Fusilade/ha
E1/F2 = 1,0ℓ Ethrel + 0,45 ℓ Fusilade/ha
E2/F2 = 1,5ℓ Ethrel + 0,45 ℓ Fusilade/ha

FIGURE 5 Effects on t ers/ha at harvest due to Ethrel, Fusilade and Ethrel/Fusilade combination treatments on NCo376.

There is evidence that treatments with Fusilade are more likely to lead to sucrose yield losses due to low topping than occurs with non-ripened or Ethrel-treated cane. These losses were evident in Trial 24 which was topped under commercial conditions and the discarded portions analysed separately (Table 5). The results indicate that more economical returns could be obtained from high topping of cane ripened with Fusilade or Ethrel/Fusilade combinations.

Table 5
Ers % cane and gers/top for NCo376 in Trial 24

Treatment	Ers % cane, tops only	gers/ top
Control	0,9	1,5
Ethrel @ 1,00 L/HA	0,4	0,5
Ethrel @ 1,50 l/ha	0,3	0,4
Fusilade @ 0,45 l/ha	2,6	3,1
Eth @ 1,00 l/ha + Fus @ 0,45 l/ha	2,6	3,5
Eth @ 1,50 l/ha + Fus @ 0,45 l/ha	2,5	3,3

N14 ripener trials

Responses to Ethrel: Ethrel application rates were tested in 6 of the 11 trials on N14. In three trials, which were sprayed with up to 2,5 l of Ethrel per ha in February, changes in ers % of cane produced weak responses, which were typical in Trial 22 (Figure 6). In spite of the initial suitability of cane in Trials 22 and 23, ers % cane was at no stage improved significantly during the prolonged sampling period (33 weeks in Trial 23). Ethrel at up to 2,50 l/ha applied before floral initiation to enhance later Fusilade ripening suppressed flower initiation by 55%. It was sprayed when the crop was 3,6 months old in Trial 23, but little control was evident in Trial 22 sprayed when the crop was 7,5 months old. This observation confirms the importance of cane age at the time of spraying for successful flower control (Hardy and Dove[3]).

Tons ers/ha yields were not affected significantly by the rates of Ethrel applied although there appeared to be some improvement in Trials 8, 22 and 25 (Table 6). In addition to the slight improvements in ers % cane due to Ethrel in Trial 8, cane yields appeared to be marginally increased and contributed to the t ers/ha response (n.s.). It is possible that N14 falls into the category of varieties that were observed by Clowes[1] to undergo growth stimulation after Ethrel applications. The effects of Ethrel on cane yields were generally

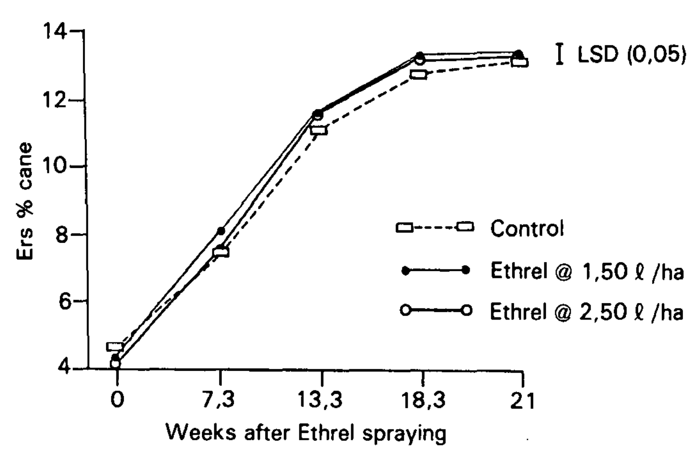


FIGURE 6 Ers % cane for Control and Ethrel-treated plots after spraying N14 (Trial 22, July harvest).

Table 6
Differences in t ers/ha for rates of Ethrel compared to control on N14

	Trial 8 (May)	Trial 14 (June)	Trial 22 (July)	Trial 25 (July)	Trial 6 (July)	Trial 23 (October)
Ethrel rates (l/ha)	t ers/ha	t ers/ha	t ers/ha	t ers/ha	t ers/ha	t ers/ha
0,50	+ 0,5				− 2,8	
1,00	+ 0,7				− 0,1	
1,50	+ 0,7	+ 0,4	+ 0,7	+ 0,4	− 2,4	+ 0,5
2,50		− 1,2	+ 0,5	+ 0,5		+ 0,2
LSD (0,05)	2,2	2,3	1,8	1,7	3,3	2,2
Significance	n.s	n.s	n.s	n.s	n.s	n.s
CV %	13,8	17,5	11,7	9,6	19,3	10,0
Spray/harvest delay (weeks)	14	14	21	16	13	33
Age at time of spraying (months)	9,5	8,0	7,5	8,5	8,8	3,6

negligible but inexplicable losses approached significance in Trial 6. The Ethrel rate of 2,00 l/ha has been excluded as results showed little relationship between increments of Ethrel and t ers/ha yields.

Responses to Fusilade: Responses to rates of Fusilade Super on N14 were examined in 4 trials (Table 7). Apart from Trial 13 where a prolonged spray to harvest interval nullified ripener responses, significant t ers/ha yield increases were registered in Trials 10 and 7 in the early and late season. Greater increases were achieved at rates in excess of 0,30 ℓ of Fusilade per ha while differences between the higher rates were not significant.

Fusilade at 0,60 ℓ/ ha did appear to result in slightly better t ers/ha responses in Trial 10 harvested during the early season. Results for the 0,75 ℓ/ ha treatment are not presented as differences were negligible compared to the 0,60 ℓ/ ha rate. An additional trial using up to 1,00 ℓ/ ha of Fusilade was established to determine the feasibility of ripening heavily sideshooted N14 late in the season. Fusilade proved ineffective under these circumstances. Typical ers % cane responses after Fusilade application on N14 are represented graphically (Figure 7) where the 0,30 ℓ/ha rate proved the least effective in ripening N14.

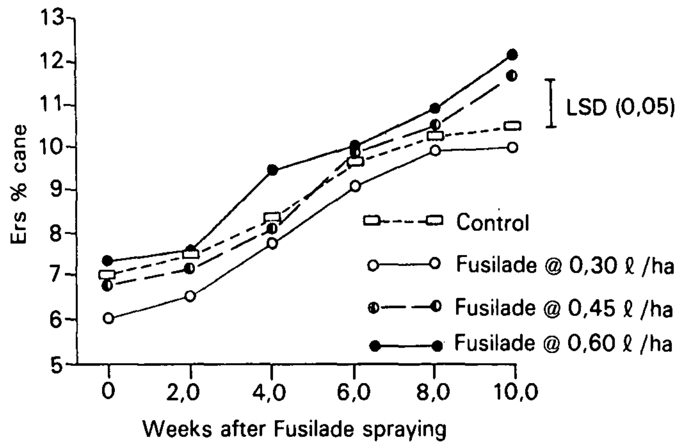


FIGURE 7 Ers % cane for control and Fusilade Super-treated plots after spraying N14 (Trial 10, June harvest).

Responses to Ethrel/Fusilade combinations: Ethrel/Fusilade combination treatments were included in the same 6 trials where Ethrel rates were evaluated. Tons ers/ha yields for Trials 8, 22 and 23 cut in May, July and October are given in Table 8 for Fusilade and the combination treatments relative to control. Results from the remaining trials were inconclusive.

Table 7
Differences in tons cane/ha and t ers/ha for rates of Fusilade compared to Control for N14

	Trial 10 (June)		Trial 11 (Sept.)		Trial 13 (November)		Trial 7 (December)	
Fusilade rates (ℓ /ha)	tc/ha	t ers /ha	tc/ha	t ers /ha	tc/ha	t ers /ha	tc/ha	t ers /ha
0,30	− 5	− 0,3	+ 4	+ 0,6	+ 6	+ 1,3	− 2	+ 1,5
0,45	− 5	+ 1,7	− 1	0	+ 2	0	− 5	+ 2,4
0,60	− 1	+ 2,4	+ 6	+ 0,6	− 1	+ 0,3	− 2	+ 2,3
LSD (P = 0,05)*	15	1,7	18	3,2	15	2,3	8	1,4
Significance	n.s	*	n.s	n.s	n.s	n.s	n.s	*
CV %	9,5	9,9	9,4	11,1	6,7	8,1	5,2	7,7
Spray/harvest delay (weeks)	10		8		11		7	

The t ers/ha yield increases in trial 8 showed little difference between the combinations and Fusilade treatments. Bearing in mind the weak response to Ethrel at this site (Table 6), it is assumed that the resultant t ers/ha yield benefits due to the combination treatments were attributable to the Fusilade Super component. This observation is substantiated by the similarity in ers % cane changes due to Fusilade and the Ethrel/Fusilade combination treatments in this trial (Figure 8), as well as by the t ers/ha yields in Trial 22 (Table 8).

Ethrel appeared not to ripen N14 even when applied to a very immature crop to suppress flower initiation. However, flowering was reduced and leaf senescence retarded, which resulted in the crop being sustained in a condition conducive to further ripening with Fusilade Super. This resulted in the combination treatments being marginally more efficient than Fusilade alone for ripening N14 in Trial 23 harvested in October (Table 8).

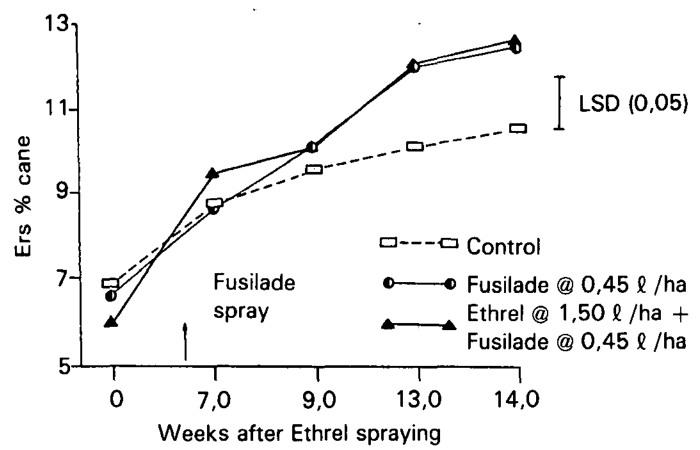


FIGURE 8 Ers % cane for Control, Fusilade and combination treatment plots after spraying N14 (Trial 8, May harvest).

Table 8

Differences in t ers/ha for rates of Fusilade Super and Ethrel/Fusilade combination on N14 compared to control

Treatments	Rates ℓ (ℓ /ha) Eth.	Fus.	Trial 8 (May) t ers/ha	Trial 22 (July) t ers/ha	Trial 23 (October) t ers/ha
Fusilade		0,45	+ 2,1		
		0,60		+ 1,4	0
Combination	0,50	0,45	+ 2,4		
	1,00	0,45	+ 1,8		
	1,50	0,45	+ 1,9		
	1,50	0,60		+ 0,6	+ 0,9
	2,50	0,60		+ 0,8	+ 1,0
LSD (P = 0,05)*			2,2	1,8	2,2
Significance			n.s	n.s	n.s
CV %			13,8	10,9	11,9

Ratoon regrowth

There is some resistance in Swaziland to the use of desiccants such as Polado and Roundup for ripening cane owing to occasional adverse effects on subsequent ratoons. For this reason, a growth monitoring exercise was conducted on ratoons following crops previously ripened with Fusilade Super. Results showed that Fusilade had no detrimental effect on following young ratoons which confirms earlier observations (Rostron[4]). On the contrary, one variety trial treated with Fusilade on three successive crops produced 50% more tillers in NCo376 and 29% more tillers in N14, 6 weeks after the third harvesting. This effect was temporary as populations became similar as the crop aged.

Discussion

The experimental results show that responses to chemical ripeners vary for NCo376 and N14. NCo376 is more sensitive to Fusilade Super, significant responses being achieved with as little as 0,31 ℓ /ha. Sweet *et al*[6] reported that a rate of 0,3 ℓ /ha of Fusilade was at times inadequate for NCo376. To ensure consistent responses, 0,45 ℓ /ha has been recommended for ripening NCo376 during the early and late seasons in Swaziland. Maximum ripening of NCo376 with Fusilade Super usually occurs approximately 5 weeks after spraying in the early season, but progressively longer spray to harvest intervals are required in the cooler months. This trend is reversed during the sucrose decline phase, but delays are generally shorter to avert unnecessary cane yield losses that may result during more favourable growth conditions in spring. Recommendations for the timing of applications of Fusilade Super in Swaziland have been produced (Appendix 2). However, the effects of extended spray to harvest delays on NCo376 cane yields are often compensated for by good ers % cane responses, particularly during the early season. High topping of ripened cane would further offset this effect.

Ethrel can be applied up to the end of April when the crop is very immature (Appendix 1). An 8 to 12 week spray to harvest interval during the early season can be extended up to 20 weeks under good growing conditions for cane harvested up until September (Rostron – personal communication).

Ethrel at 1,50 ℓ /ha is sufficient to ripen NCo376 but there is evidence that the rate may be reduced to 1,00 ℓ /ha when in combination with Fusilade Super in the early season. The Ethrel/Fusilade combination treatments consistently outyielded single product treatments on NCo376, and they are highly recommended for well grown cane cut between May and July. A 4 to 6 week delay between application of the two chemicals is recommended (Appendix 3). Chemical ripening of crops harvested during the peak sucrose period in September is not recommended.

Chemical ripening responses on N14 were less marked compared with NCo376. Fusilade at 0,45 ℓ /ha increased ripening significantly during the early and late season, but responses may be further improved with 0,60 ℓ /ha at the start of the season. For this reason the higher rate of 0,60 ℓ /ha is optional for use on this variety. Spray to harvest delay requirements are longer for N14 and intervals have been increased by approximately 2 weeks in the early season, but are the same as those for NCo376 for the late season harvest (Appendix 2).

Ethrel up to 2,50 ℓ /ha had little ripening influence on N14 and its use on this variety is discouraged. Combination treatments on N14 have produced disappointing responses and for this reason are not recommended for commercial use. It appears that the full artificial ripening potential of this variety can be realised with Fusilade Super alone, but that certain benefits may result from combination treatments if the Ethrel applications are scheduled to inhibit flowering on late season crops.

Surveys done in the released variety trials show N14 to accumulate g ers/stalk at a greater rate than NCo376 during the early season. This trend is shown for three crops of naturally ripened NCo376 and N14 (Figure 9). Although differences in g ers/stalk were not significant between the two varieties, trends appear to be real and may contribute to the poorer responses of N14 to ripeners.

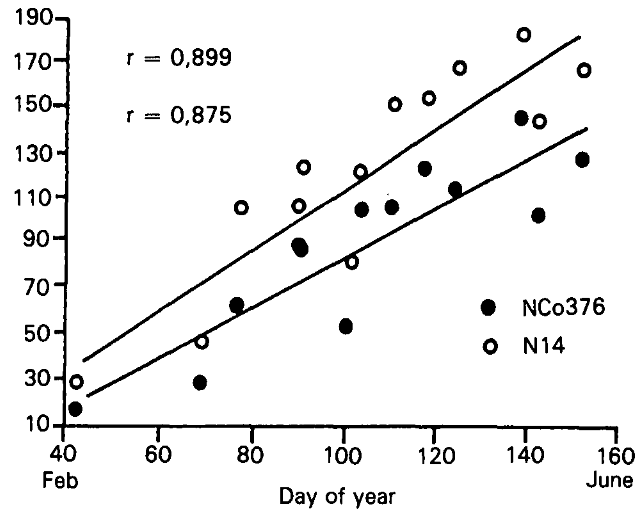


FIGURE 9 Relationship between g ers/stalk and time for non-ripened early season harvested NCo376 and N14.

The conclusion is that chemical ripening, particularly during the early part of the season, is indispensible in the quest to maximise sugar yields in Swaziland. To achieve this aim however, different procedures for optimum chemical ripening of NCo376 and N14 need to be followed.

Acknowledgements

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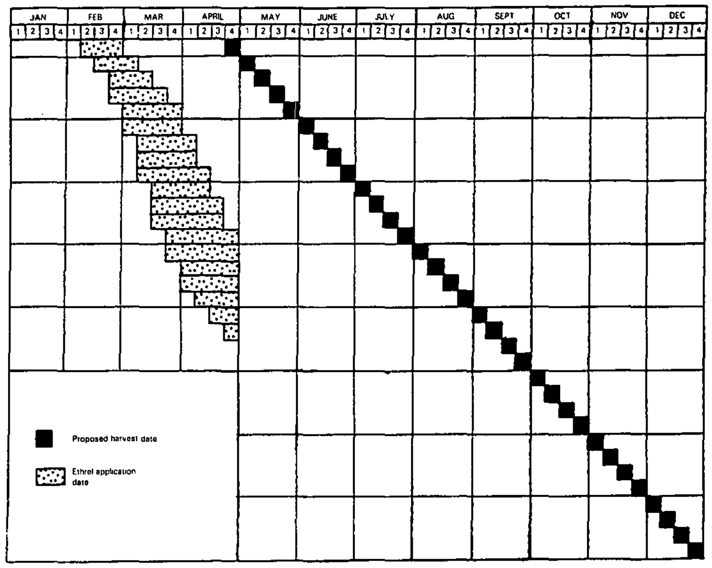
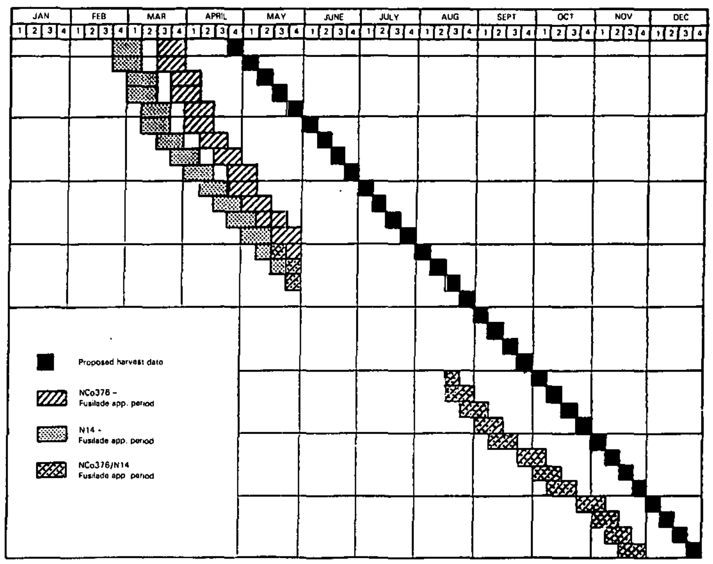
APPENDIX 1

Timing of Ethrel application



APPENDIX 2

Timing of Fusilade Super application on NCo376 and N14



APPENDIX 3

Timing of application of Ethrel and Fusilade Super when used in combination