RESPONSES FROM THE RIPENER FUSILADE SUPER WHEN USED ON DROUGHTED CANE

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Abstract

The effects of moisture stress on the responses to Fusilade Super were assessed using the sugarcane variety NCo376 grown in a deep sandy clay Hutton form soil. Moisture stress was induced by suspending irrigation that was applied through Perforain pipes. The higher cane quality (ers % cane) of plots subjected to long periods without irrigation was an indication that the cane in these plots had suffered moisture stress. Yields of harvested cane were no different between irrigation treatments despite indications that stress had developed where irrigation had been suspended early. Sucrose yields were improved by 1,6 tons sucrose per hectare by applying Fusilade Super to well irrigated cane. The response to the chemical ripener in stressed cane was 50% less than in the well irrigated cane. This indicates that improved sucrose yields from water stress and ripening with Fusilade Super are not additive.

Introduction

Chemical ripening is a valuable means of increasing sucrose yields when conditions favour rapid vegetative growth during the final two months before a crop is harvested. Farmers who have ripened their crops with chemicals have done so often without modifying drying off times. These are often sufficiently long to ripen sugarcane through moisture stress. Experiments conducted with glyphosate have shown that responses to this chemical are severely reduced by stress, which may develop when irrigation is suspended at the time of applying the ripener (Clowes and Inman-Bamber, 1980). Fusilade Super is a selective graminicide which is rapidly absorbed by the leaves and hydrolysed to fluazifop. At low rates (38 to 55 g active ingredient per hectare) it is an effective ripener of sugarcane. Sucrose yields of well irrigated cane have been raised consistently by Fusilade Super, sometimes by more than two tons per hectare. Smaller responses to Fusilade Super in commercial fields compared with experiment results led Sweet *et al.*, (1987) to suspect that excessive pre-harvest drying off could affect responses to Fusilade Super. Because sugarcane is grown in soils of widely differing moisture holding and releasing characteristics and depths, different degrees of stress will develop in crops which are not irrigated. Fusilade Super increases the sucrose content of vigorously growing sugarcane stalks, apparently at the expense of stalk mass. Since mild stress reduces cell growth, and rapid accumulation of sucrose is a reaction to more advanced stress (Hsiao, *et al.*, 1976), it is possible that ripening induced by moisture stress cannot be improved by the application of Fusilade Super. If the benefits of applying Fusilade Super as a ripener are to be assessed in an industry of widely varying conditions, such as those in southern Africa, it is necessary to measure the responses from Fusilade Super applied to cane subjected to varying degrees of moisture stress.

Materials and Methods

The experiments were conducted at the field station of the South African Sugar Association Experiment Station in Pongola. The soil in which the experiments were conducted is a Hutton sandy clay with an estimated water holding capacity (TAM) of 464 mm (Thompson, 1976). Other physical characteristics of the soil are shown in Table 1.

The experimental plots were planted on 16 October 1987 with seedcane from a nursery which had been planted with hot water treated seedcane of the variety NCo376. Fertilizer in the form of Saaifos 16+Zn at the rate of 500 kg/ha was applied in the planting furrow, and a top-dressing of KCl (300 kg/ha) + urea (250 kg/ha) was applied on 27 November 1987. The plots were kept free of weeds by regular hoeing.

Irrigation was applied through overhead sprinklers until April 1988, after which Perforain pipes were used to irrigate individual plots. These pipes were suspended from telescopic masts mounted in cement blocks standing in the centre of each plot. At each irrigation after April, the equivalent of 50 mm was measured with inline flow meters. Plots were irrigated only in calm conditions so that the distribution of water was optimal. Details of the treatments are given in Table 2. W1 plots were irrigated to within two weeks of the time of harvesting. Irrigation in W2 plots was suspended in April after which they were irrigated once in August. W3 plots were irrigated until June. W4 plots were irrigated until April.

A tractor mounted boom calibrated to spray 84 l/ha was used to apply Fusilade Super at 417 ml product/ha on 26 May 1988 to half the number of plots. Treatments were replicated seven times in a random block design.

Sixteen stalk samples were taken from each plot at spraying, and at 53, 89 and 106 days thereafter to monitor sucrose changes. The trash and green leaves were stripped from each stalk. During this cleaning process the immature top sections of the stalks broke off at the natural breaking point. Each

Table 1

Mechanical analysis and moisture characteristics of the sandy clay Hutton soil at the experiment site

Soil depth (mm)	Mechanical analysis %					Textural class	TAM (mm/m)
	Silt	Clay	Sand : fine	medium	coarse		
0 to 200	7	26	46	16	5	sandy clay loam	149
200 to 400	6	37	41	12	4	sandy clay	135
400 to 600	6	38	39	12	5	sandy clay	124
600 to 800	6	39	39	12	5	sandy clay	116
800 to 1000	7	39	39	11	4	sandy clay	152

sample was weighed before the stalks were shredded to extract the juice, which was clarified and analysed for soluble solids (Brix) and sucrose content (Pol). Dry matter and fibre content were determined in the conventional way.

Table 2

Summary of irrigation treatments

Treatment	Overhead sprinkler	Perforain pipes	Drying off period	Stress intended
W1	Oct to April	April to Sept.	2 weeks	Nil
W2	Oct to April	Once in August	7 weeks	"relieved"
W3	Oct to April	April to June	13 weeks	moderate
W4	Oct to April	Nil	20 weeks	severe

Before burning, the cane stalks in one net row were counted in each plot. Stalk populations per hectare for each plot were estimated from these counts. After burning the cane on 9 September 1988, the end effects of the net rows and the guard rows on either side of the net rows were removed. The cane in each net plot was harvested and weighed. Sixteen stalks were taken from harvested cane in each plot, weighed and processed as described before. From these parameters cane and sucrose yields per hectare were calculated.

Class A pan evaporation, minimum and maximum temperatures, and rainfall were obtained from a meteorological station situated about 50 m north west of the experiment site. The evaporation (Eo) data were converted to represent evapotranspiration (Et) according to the various stages of canopy cover. Eo was multiplied by 0,4 from day 1 to day 33; 0,55 from day 34 to day 60; 0,7 from day 61 to day 97; 0,85 from day 98 to day 133. After day 133 the canopy had closed and Et was regarded as being equal to Eo (Thompson, 1976). For each of the four irrigation treatments, the balance of moisture received through rainfall and irrigation and that lost through Et was estimated in a profit and loss account. Moisture differences are shown in Figure 1 as changes in soil moisture after June.

Results and Discussion

Irrigation

By June moisture levels in W1 and W3 plots were above those in W2 and W4 plots. A further irrigation of W1 plots at the end of June raised their moisture levels above those in W3 plots. Moisture levels in W2 and W4 plots were similar until August, when one irrigation of W2 plots raised the moisture in W2 plots to the same levels as those in W3 plots (Figure 1). Et was assumed to be equal in all plots, and because rates of Et are altered when soil moisture is depleted (Thompson, 1976, Moberly, 1974, Inman-Bamber, 1986), differences in levels of moisture presented may have been overestimated.

Irrigation applied after April was 250 mm to W1 plots and 50 mm to W2 and W3 plots. The relatively slow gain of fresh mass by stalks in well irrigated plots (W1) was associated with generally declining minimum temperatures up to mid August (Figure 2). After mid August temperatures rose steadily, to which the unstressed cane responded by gaining dry mass rapidly.

By 19 July the sucrose content (ers%c) of cane which had received no irrigation after April (W4) had risen by 0,6 ± 0,4 units above that of the well irrigated plots (W1). This was an indication of stress having developed in these W4 plots.

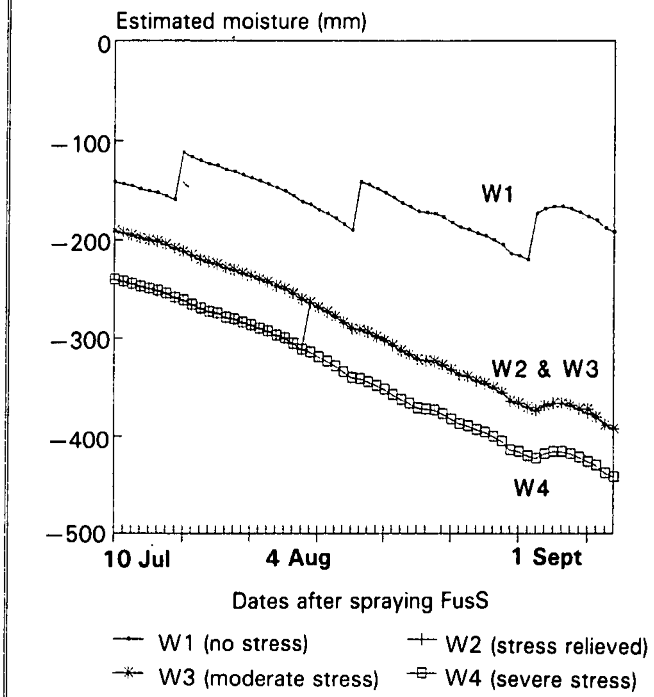

FIGURE 1 Soil moisture changes (irrigation and rainfall – Et)

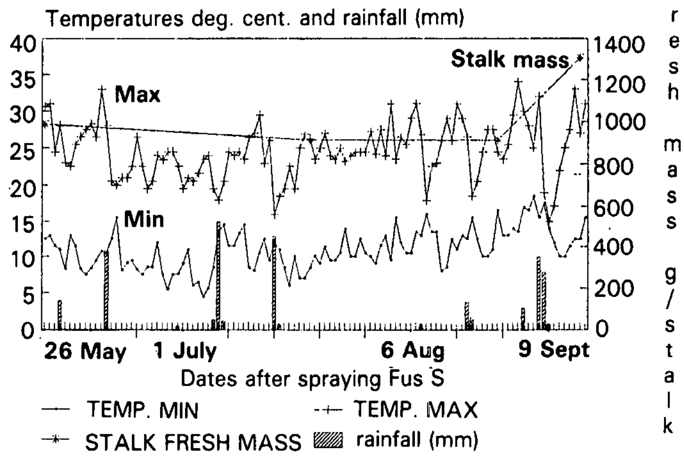

FIGURE 2 Temperatures, rainfall and stalk fresh mass of unstressed cane (W1)

When the crop was harvested on 9 September, stress had raised the sucrose content of W4 cane by 1,0 ± 0,31 unit above that of the unstressed W1 cane. In comparison, the moderate stress in W3 cane raised the sucrose content by 0,4 ± 0,31 ers%c above that of the unstressed cane. The one irrigation in August of stressed cane (W2) had no effect on sucrose content of cane sampled on 23 August. The effect of 'relieving' stress was however evident in samples taken on 9 September when ers%c was 0,4 ± 0,31 units lower than that of stressed (W4) cane.

Table 3

Sucrose content (ers%c) of unsprayed cane (Con) and responses to Fusilade Super (Fus-Con)

Date and days after spraying Fusilade Super

Treatments	26/5 0 Con	19/7 53 Con	Fus-Con	23/8 89 Con	Fus-Con	9/9 106 Con	Fus-Con
W1	4,8	8,2	+0,7	10,1	+0,8	9,6	+1,3
W2	5,1	8,6	+0,5	10,5	+0,7	10,2	+0,7
W3	5,2	8,5	+0,7	10,2	+0,5	10,0	+1,2
W4	4,5	8,8	+0,4	10,5	+0,7	10,6	+0,6
MEAN	4,9	8,5	+0,6	10,3	+0,7	10,1	+1,0
CV%		8,5		5,8		5,5	
SED ±		0,4		0,33		0,31	
LSD 0,05		0,8		0,89		0,84	

Table 4

Stalk mass (g) of unsprayed cane (Con) and effects of Fusilade Super (Fus-Con)

Date and days after spraying Fusilade Super

Treatments	26/5 0 Con	19/7 53 Con	Fus-Con	23/8 89 Con	Fus-Con	9/9 106 Con	Fus-Con
W1	988	916	−5	952	−81	1 336	−60
W2	862	979	+12	924	−20	1 361	−69
W3	925	953	−8	908	+19	1 360	−48
W4	895	895	+37	940	−66	1 364	−21
MEAN	917	936	+9	931	−37	1 355	−50
CV%		9,8		9,9		8,4	
SED ±		49,4		48,4		59,6	
LSD 0,05		99,7		97,6		120,2	

At the time of harvesting, although differences in cane quality indicated that stress had developed in W4 plots, stalk wet mass of all irrigation treatments were similar.

Yields at harvesting suggested also that suspending irrigation in April (W4) and June (W3) had not affected cane yields (Table 6). The slightly higher cane yields in W2 plots may have been due to rapid growth after stress was relieved (Inman-Bamber, 1986).

Suspending irrigation (of W4 and W2 plots) in April increased sucrose yields (ers tons/ha) by 1,2 tons (p=0,05) above those of the unstressed W1 plots when the experiment was harvested on 9 September. The shorter drying off period in W3 plots had little effect on sucrose yields. Similar trends in ers g/stalk can be seen in the data shown in Table 5 from the samples taken on 9 September.

Table 5

Sucrose yield (ers g/stalk) of unsprayed cane (Con) and responses to Fusilade Super (Fus-Con)

Date and days after spraying Fusilade Super

Treatments	26/5 0 Con	19/7 53 Con	Fus-Con	23/8 89 Con	Fus-Con	9/9 106 Con	Fus-Con
W1	38,1	75,0	+7,0	96,1	+1,7	128,1	+ 5,7
W2	40,6	83,9	+5,8	96,9	+6,9	138,6	+11,2
W3	47,3	81,3	+6,1	92,8	−0,9	135,9	+10,6
W4	39,5	78,4	+6,3	99,8	+4,3	145,3	+ 1,4
MEAN	41,4	79,7	+6,3	96,4	+3,0	137,0	+ 7,2
CV%	–	14,1		12,4		11,0	
SED ±		6,2		6,5		8,3	
LSD 0,05		12,6		13,1		16,7	

Effects of ripener on cane quality

Cane quality responses to the ripener on 19 July were 0,7 and 0,4 ± 0,4 ers units in unstressed (W1) and stressed (W4) cane respectively. When cane quality differences between unsprayed plots were more clearly evident on 9 September, responses to Fusilade Super were similar in unstressed to moderately stressed (W1 and W3) plots, and were substantially less (50%) in more severely stressed W2 and W4 plots.

Effects of ripener on yields

Cane yields suggest that Fusilade Super had little effect on cane growth (Table 6). It may be that during harvesting the cutters topped cane severely and the expected differences in cane mass due to stress or Fusilade Super could thus have been removed in the process. The higher sucrose yields were therefore a function of the effects that treatments had on cane quality. Sucrose yields were raised by 1,6, 1,3 and 0,8 ± 0,34 tons per hectare in response to Fusilade Super in W1, W3 and W4 plots respectively.

Table 6

Yield and growth parameters of NCo376 106 days after spraying Fusilade Super

Treatments	tons cane/ha	tons ers /ha	ripener response t ers/ha	stalk heights (cm)	stalk population (×1000/ha)
W1 Con	120,9	11,6		296	102
FusS	121,1	13,2	+1,6	291	94
W2 Con	125,9	12,8		281	101
FusS	124,3	13,5	+0,7	296	96
W3 Con	119,5	12,0		289	98
FusS	118,5	13,3	+1,3	290	97
W4 Con	120,1	12,8		288	96
FusS	120,6	13,6	+0,8	290	96
MEANS	121,4	12,8	+1,1	290	96
CV%	4,6	7,3		13,2	3,9
SE ±	2,1	0,34		4,8	4,3
LSD 0,05	6,0	1,0		13,8	12,2
LSD 0,01	8,0	1,4		18,5	16,4
Irrigation					
W1	121,0	12,4		293	98
W2	125,1	13,2		288	98
W3	119,0	12,6		289	98
W4	120,4	13,2		289	96
SE ±	1,48	0,25		3,0	3,4
LSD 0,05	4,2	0,72		8,6	9,8
Ripener					
CONTROL	121,6	12,3		288	99
FUS. SUPER	121,1	13,4		291	96
SE ±	1,05	0,25		2,1	2,4
LSD 0,05	3,0	0,72		6,1	6,9

General

Responses to Fusilade Super took an unusually long time to develop. This may have been due to declining temperatures immediately after applying the ripener, followed by rising temperatures which favoured more rapid growth during the final three weeks before harvesting. There is evidence of this in the substantial gain in stalk mass and decline in cane quality during the final 19 days before harvesting.

While samples are in preparation, the top sections of stalks which break off are large in well grown cane, which has long immature tops. Tops also break easily at the necrotic rings, caused by Fusilade Super when the surrounding leaf sheaths are removed. Differences in stalk growth, which may have developed due to the irrigation and ripener treatments, could have been masked by stalks breaking at different points below the stalk apex. The stalk populations calculated for each treatment indicate that unsprayed plots of W1 and W2 treatments had slightly higher values than the sprayed plots of these treatments and of all W3 and W4 plots, but differences were not statistically significant (p=0,05) (Table 6). However, NCo376 is known to sucker freely, particularly after lodging (Gosnell, 1967). It is possible that bull shoots (suckers) were produced in plots being irrigated (W1 and W2) when temperatures were rising in August. Such bull shoots do not form part of the millable crop and would therefore not affect yields, but may have been counted as part of the stalk population. It is also possible that Fusilade Super had suppressed the emergence of bull shoots where it was applied in W1 and W2 plots, which would account for the slightly lower numbers in these plots.

It is of interest that although responses to Fusilade Super were greater in the unstressed cane, sucrose yields were highest in cane which had been stressed and sprayed with Fusilade Super.

Conclusions

The sucrose yields of NCo376 grown in a deep sandy clay Hutton form soil, were raised by 1,6 tons sucrose per hectare by the application of Fusilade Super, 106 days before harvesting a well irrigated crop on 9 September. Sucrose yields of stressed cane were raised by 0,8 tons per hectare in response to the application of Fusilade Super, which was 50% less than the response of unstressed cane. Sucrose yields were not affected where stress was relieved shortly before harvesting, and responses to Fusilade Super were similar to that of the stressed cane. The mild stress that developed when irrigation was suspended in June improved cane quality and sucrose yields slightly. The response to Fusilade Super was 20% less in these moderately stressed plots than in the well irrigated cane.

A more detailed study of the effects that these treatments may have, particularly on growth, stalk mass and the accumulation of sucrose, to assess their true effects on sucrose yields is in progress.

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