EFFECTS OF ETHEPHON APPLIED TO TWO SUGARCANE VARIETIES TO PREVENT FLOWERING

RA DONALDSON

South African Sugar Association Experiment Station, P/Bag X02, Mount Edgecombe, 4300

Abstract

Flowering in sugarcane occurs sporadically in areas of Kwazulu-Natal and more regularly in the Mpumalanga lowveld. The general perception is that sucrose yields of crops harvested annually in November/December are adversely affected by flowering. Flower initiation was disrupted experimentally by extending the photoperiod with lights and also by applying ethephon in February 1994 and again in 1995 at Mount Edgecombe. The percentage of stalks that flowered in control plots during 1994 were 37 and 48 for the varieties N17 and N23, respectively. Both the light treatment and the application of ethephon prevented flowers from emerging during 1994. Stress, borer damage and lodging in the experiments confounded interpretation of treatment effects. There was no evidence of any benefit from the application of ethephon. Flowering did not affect yields of N17 adversely, and the effects of flowering on yields of N23 were not clear because borer damage was high.

Keywords: Flowering, ethephon, lights

Introduction

Sugarcane flowers profusely every year in many countries such as Hawaii, Malawi and Sudan. When sugarcane is harvested at the age of 24 months, as in Hawaii, flowering during the first year will severely limit sugar yields. Hardy *et al.* (1986) have suggested that sucrose yields are limited by flowering when the period after initiation is longer than about four or five months, and flowering would therefore affect annually harvested sugarcane. This situation is most acute when the plants are old enough to respond to the induction signals (about three months) but are still many months (nine) from being harvested. In South Africa, sugarcane grown in areas where flowering is likely to occur will seldom be harvested after 14 months because of the devastating damage that can be caused in older cane by the stalk borer, *Eldana saccharina* (Walker). In the South African scenario, sugarcane harvested at the age of 14 months would be most severely affected by flowering when harvested between October and December.

Ethephon [(2-chloroethyl)phosphonic acid] has been used in Hawaii, Brazil and Malawi to suppress flowering. The benefits from spraying ethephon just before floral induction have been demonstrated at Kenana in Sudan (Hardy *et al.*, 1986) and in Hawaii (Moore and Osgood, 1986). At Dwangwa in Malawi the practice was discontinued in 1986 because of inconsistent results (Whitbread, 1991). At Kenana in Sudan and in Hawaii between 80 and 100% of the stalks produce flowers. In most South African varieties flowering is not normally profuse (Nuss, 1989) and incidents of more than 50% flowering are infrequent. Flowering cannot yet be predicted accurately before floral induction, which is the time when ethephon must be applied. Advocating regular annual applications of ethephon would mean spraying cane in some years when there would be no flowering. Valid comparisons of flowered versus non-flowered cane have been made by Julien and Soopramanien (1976), Nuss (1989) and Nuss and Maharaj (1992). These authors suggest that flowered cane, harvested timeously, can yield more sucrose than unflowered cane. Studies of flower suppression with ethephon, notably those by Moore and Osgood (1986) and Hardy *et al.* (1986), compared ethephon treated cane with flowered cane. As yet no valid comparison has been made of the effects of ethephon on flowered and non-flowered cane. The main objective of the experiments described in this paper was to compare yields from cane treated with ethephon at a young age with yields from flowered and non-flowered cane.

Materials and methods

Two sugarcane varieties that are known to flower freely, N17 and N23, were grown at the Central Field Station of the SASA Experiment Station near Umhlanga (29° 43' S, 31° 4' E), in a sandy Hutton form soil derived from wind blown sand. On 7 October 1991 four rows each 14,0 m long were planted 1,0 m apart in each plot. This experiment was initiated after harvesting the first ratoon on 16 October 1993. The duration of the experiment was from 16 October 1993 to 8 December 1994 (experiment 1) and it was repeated over the period 8 December 1994 to 8 December 1995 (experiment 2). After each harvest, a granular nematicide (aldicarb) and fertiliser (N at 120 kg/ha and K at 120 kg/ha) were applied to the rows as side dressings over the trash blanket. A ferrous sulphate solution (200 g in 20 litres of water) was sprayed at 300 litres per hectare onto the cane foliage, on 3 December 1993 and 18 January 1995, to correct an iron deficiency caused by the high pH of the soil. When deemed necessary, water was applied through drippers to avoid excessive stress.

Lights

Incandescent globes (100 Watt), spaced 1 m apart, were suspended over the interrows of half the plots. The lights were always about 1,5 m above the cane canopy (Nuss, 1989) and were switched on at 04:30 and off at 07:00 each morning from 1 February to 30 April.

Ethephon

An overhead boom with two TK 1,0 floodjets linked to a pressurised knapsack delivering 65 litres/ha was used to apply ethephon to the cane foliage on 25 February 1994 (experiment 1) and 24 February 1995 (experiment 2). The rates of ethephon applied were 2,0 and 1,5 litres/ha for experiments 1 and 2, respectively (Hardy *et al.*, 1986; Whitbread, 1991). Ethephon was applied to half the number of illuminated plots and to half the number of unlit plots. These eight treatments were replicated four times (randomised block design) in the main part of the experiment. There were an additional two replications of treatments in an unlit area. The additional plots were used to monitor the effects of ethephon for several months before harvest in experiment 1. Initially 20 and later 16 stalks from each of these plots were cleaned, weighed and analysed for dry mass, soluble solids (brix) and sucrose content. The number of flowered stalks and total number of stalks were counted in one row of each plot in the main part of the experiment in March, June, July and August and in two rows at harvest in December. The area of each leaf on 10 ethephon treated and non-flowered stalks from unlit plots of similar height was measured with an area meter (LI-COR, Inc., Lincoln, Nebraska; Model 3000) on 14 July in experiment 1. Dead leaves that were still attached to the lower part of the stalks were also measured. Suckers (bullshoots) in ethephon treated and control plots were counted in July, August and December. Bullshoots and stalks of less than 0,5 m in length were excluded from samples and plot yields. In experiment 2, stalks were taken from the two outer rows of each plot in the main section of the experiment.

The cane in two net rows of 12 m in each plot of four replications were harvested in December and weighed to determine cane yields. Sixteen stalks per plot were weighed and analysed in the conventional manner. Fifty stalks from each plot were split lengthwise and assessed for borer damage.

Results

Experiment 1

Incidence of flowering

Tiller numbers peaked in June (N23) and July (N17) and then declined to December (Figure 1). Flowers emerged earlier in N23 than in N17 and flower emergence was complete by the end of August. A count at the time of harvesting indicated that 48% of N23 and 37% of N17 stalks had flowers.

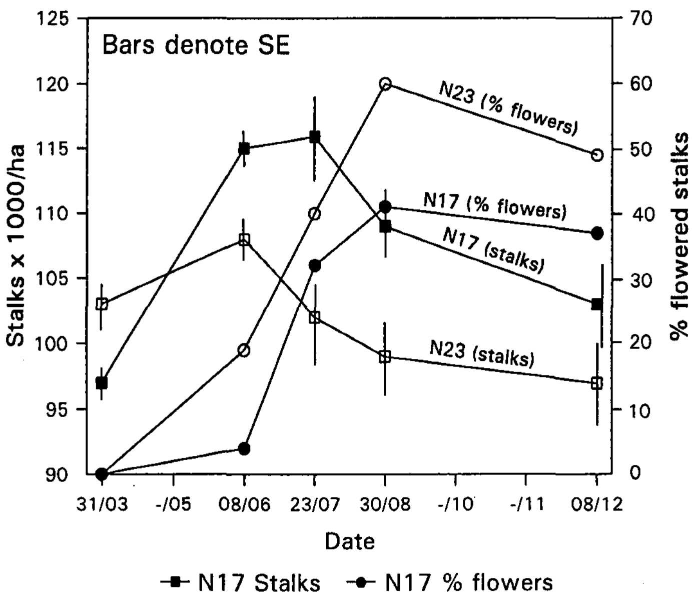

FIGURE 1: Total stalk numbers and percentage flowered stalks in control plots

Effects of ethephon

On 14 July, 140 days after ethephon was applied in experiment 1, stalks of N23 and N17 with no flowers had 7,2 ± 0,133 and 11,6 ± 1,078 green leaves, respectively. The number of green leaves on stalks of N17 was highly variable and ranged from 6 to 18 per stalk in this sample. Stalks with large numbers of green leaves also had dead spindles, which could be an indication that flowers had been aborted in these stalks. The number of green leaves on ethephon treated stalks (8,2 ± 0,25) were similar for the two varieties. The effect of

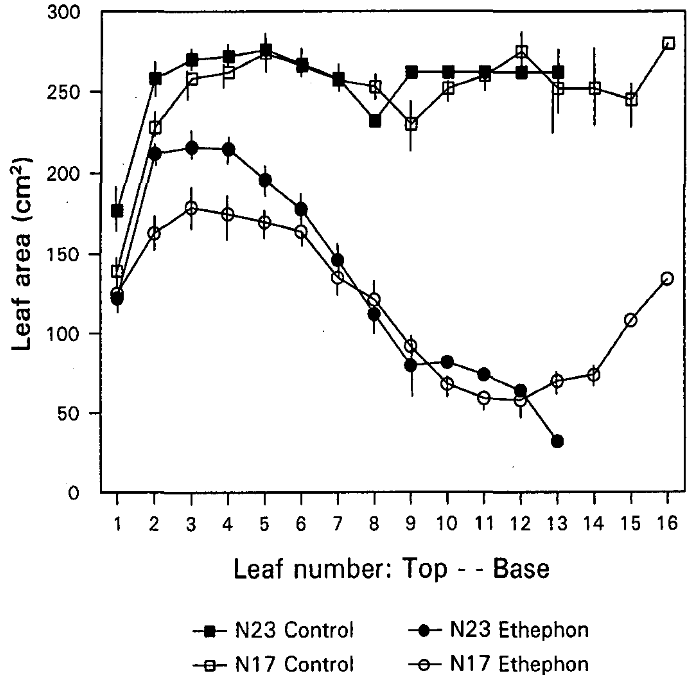

FIGURE 2: Effect of ethephon on leaf size. Leaf area was determined 140 days after ethephon application

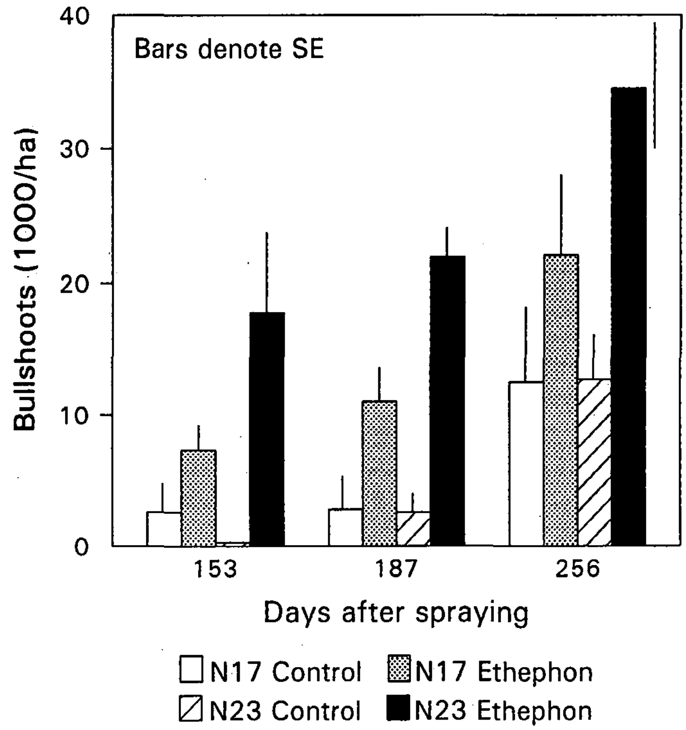

FIGURE 3: Number of bullshoots in control and ethephon treated plots 153, 187 and 256 days after spraying ethephon

ethephon on leaf size is shown in Figure 2. Because leaves were progressively smaller (leaves 16 to 12 of N17) it was assumed that the lowest leaf that was still on the stalk (leaf 16) was formed immediately after spraying with ethephon. After leaves had been reduced to 20% of their normal size there was a recovery from the effects of ethephon and leaves became steadily larger. However, fully developed leaves at the top of the stalk, particularly in N17, had not fully recovered from the effects of ethephon applied 140 days earlier. The drastic reduction in size of successive leaves is likely to have opened canopy cover and reduced light interception. The greater amount of light penetrating to the base of the stalks could have been the reason for the larger number of bullshoots that appeared in ethephon treated plots (Figure 3). By December, the population of bullshoots in untreated and treated plots was 12 600/ha and 28 250/ha, respectively. Figure 4 shows the effects of ethephon on sucrose yields in N17 (a) and N23 (b). Data for the control treatments shown in Figure 4(a) and 4(b) are from samples which had flowered and non-flowered stalks. The effects of ethephon are not clear from these data, but they suggest that the untreated N17 stalks were producing more sucrose than the ethephon treated stalks after October. This is substantiated by the harvest data (Table 1). The lower yields in the ethephon treated cane were associated with significantly higher (P=0,05) borer damage, and the reduction can therefore not be attributed wholly to the effects of the chemical. For N23, the trend showed higher sucrose yields in untreated stalks until November, and thereafter was similar to that shown in ethephon treated stalks. Harvest data show that sucrose yields (and eldana borings) were similar in control and ethephon treated plots of N23 in December (Table 1).

Effects of flowering on yield

Because of the significantly higher (P=0,01) borer damage in flowered N23 it is not clear how much of the sucrose yield reduction (3,5 tons/ha, P=0,05) was due to flowering. Flowering had no adverse effect on sucrose yields of N17.

Experiment 2

No flowers were formed during this experiment, thus data from all ethephon treated plots were compared with the mean of all unsprayed plots for each variety. Dry mass accumulation was restricted by ethephon after October (data not shown). The sucrose yields of stalks treated with ethephon were consistently less than those of untreated stalks and were on average 18% lower in December (Figure 5(a) and 5(b)). However, harvest data show little evidence of yield reductions due to ethephon (Table 2). Early lodging may have limited yields of better grown cane (Muchow *et al.*, 1995) and could therefore have reduced differences between treatment yields.

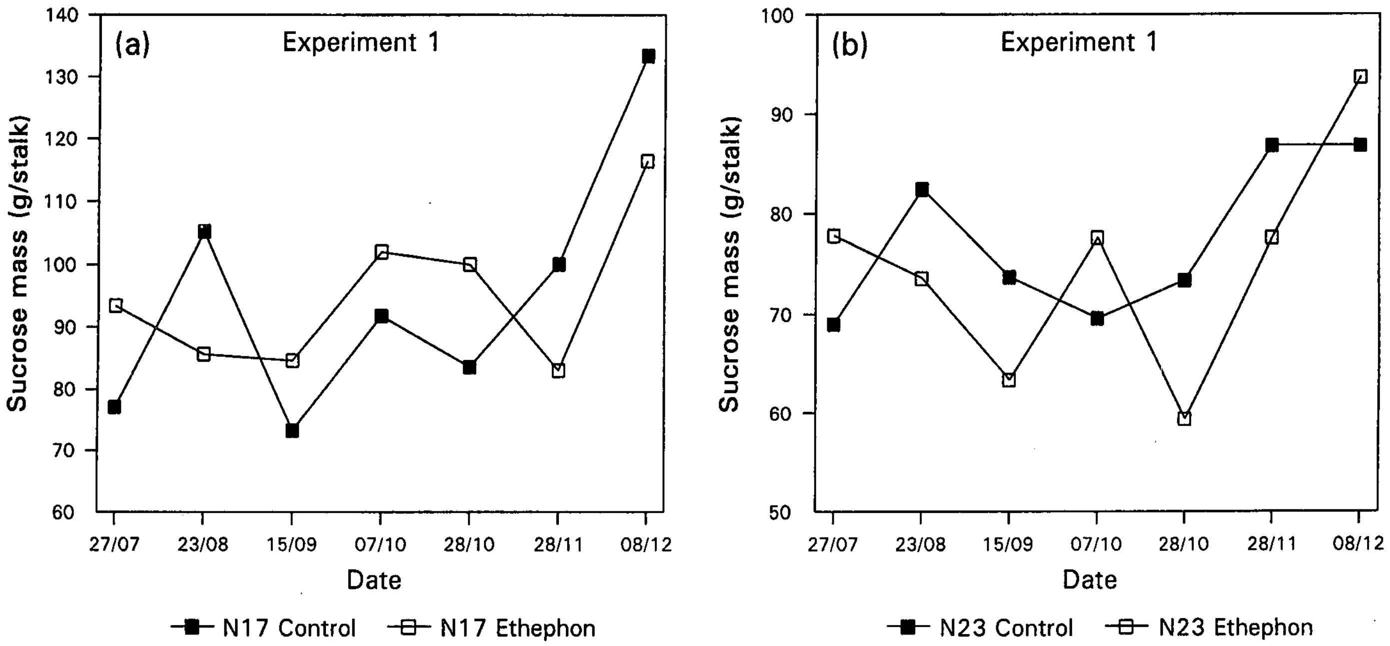

FIGURE 4: Effects of ethephon on sucrose yields of N17 (a) and N23 (b) in experiment 1

Table 1

Summary of yield characteristics and flowering – experiment 1 (1994)

Treatment	Cane t/ha	Ers%c	Ers t/ha	Flowering (% stalks)	% damaged stalks
			N17		
Control	111	14,3	15,9	37	19
Lights	106	13,6	14,4	0	24,5
Ethephon	94	13,7	12,9	0	34
Eth + lights	98	13,1	12,8	0	37
			N23		
Control	85	12,3	10,5	48	43,5
Lights	108	13	14	0	24,5
Ethephon	77	13,8	10,6	0	37
Eth + lights	79	13,4	10,6	0	39
SED ±	9,3	0,52	1,45		7,8
LSD 05	21,1	1,18	3,29		17,7

Table 2

Summary of yield characteristics – experiment 2 (1995)

Treatment	Cane t/ha	Ers%c	Ers t/ha	% damaged stalks
		N17		
Control	119	11,5	13,6	39,4
Ethephon	114	11,5	13,1	39,4
		N23		
Control	104	11,7	12,1	35
Ethephon	98	12,1	11,8	33,8
SED ±	4,8	0,2	0,57	6,8
LSD 05	10,5	0,43	1,24	14,9

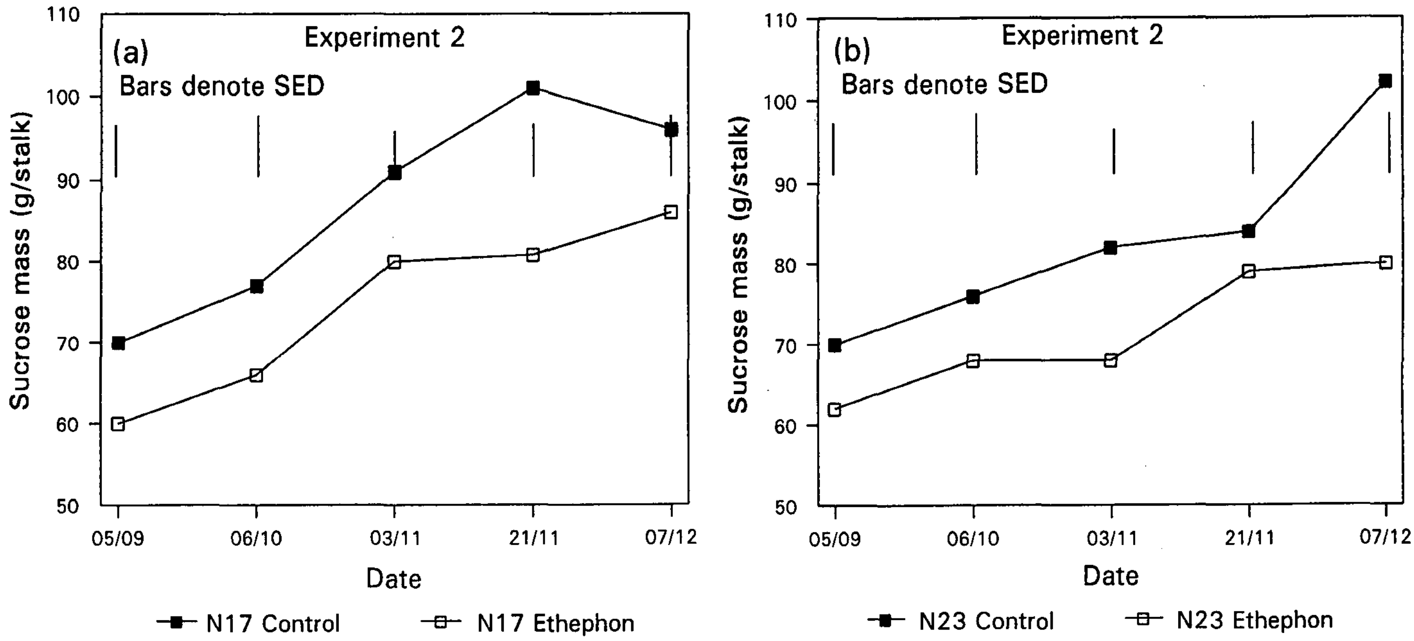

FIGURE 5: Effects of ethephon on sucrose yields of N17 (a) and N23 (b) in experiment 2

Discussion

The yield reductions from applying ethephon to N23 were associated with stress and relatively high numbers of stalks which were damaged by eldana. Moore and Osgood (1986) suggest that yield losses from applying ethephon can be expected when sugarcane is subjected to stress after the chemical is applied. Yield reductions from applying ethephon as a ripener are unlikely (Rostron, 1973; Clowes, 1978). However, the possibility that yields may be reduced by spraying ethephon on to sugarcane that is more than five months old followed by a long delay before harvesting, has been questioned for some time (Anon, 1982; Anon, 1983). The lack of benefit from treating N17 with ethephon is similar to the findings of Colet *et al.* (1986) in a 14 month old crop in Sao Paulo, Brazil. Until the effects of flowering on the yields of each variety harvested in late summer is known and flowering can be predicted during the third week of February, the use of ethephon should not be recommended.

Acknowledgements

The assistance of Mr A Moonsamy in conducting the experiments and taking measurements is gratefully acknowledged.

REFERENCES

Anon (1982). Growth regulators – flower suppression. *A Rep S Afr Sug Ass Exp Stn* 1981-82: 24.

Anon (1983). Flower inhibition in sugarcane at Dwangwa. *Proc of the Ethrel on Sugarcane Workshop*, Harare, February 1983, p 30.

Clowes, M St J (1978). Early and late season chemical ripening of sugarcane. *Proc S Afr Sug Technol Ass* 52: 160-165.

Coleti, JT, Lorenzetti, JM, Garla, JH and Campponenez, A (1986). The inhibition of flowering by ethephon and its influence on sugarcane quality in Brazil. *Proc int Soc Sug Cane Technol* 19: 298-304.

Hardy, G, Dove, H and Awad, M (1986). The use of ethephon for prevention of flowering in sugarcane in Sudan. *Proc int Soc Sug Cane Technol* 19: 305-316.

Julien, MHR and Soopramanien, GC (1976). The effect of flowering on yield in sugarcane. *Rev agric et sucr Ile Maurice* 55: 551-158.

Moore, PH and Osgood, RV (1986). Use of ethephon to prevent flowering of sugarcane in Hawaii. *Proc int Soc Sug Cane Technol* 19: 258-262.

Muchow, RC, Wood, AW and Robertson, MJ (1995). Does stalk death set the yield ceiling in high-yielding sugarcane crops? *Proc Aust Soc Sug Cane Technol* 17: 142-148.

Nuss, KJ (1989). Effects of flowering on sucrose content and sucrose yield in five sugarcane varieties. *Proc S Afr Sug Technol Ass* 63: 181-185.

Nuss, KJ and Maharaj, A (1992). Flowering in sugarcane and its effects on quality and yield components, four to eleven months later. *Proc S Afr Sug Technol Ass* 66: 38-40.

Rostron, H (1973). The effect of chemical ripeners on the growth, yield and quality of sugarcane in South Africa and Swaziland. *Proc S Afr Sug Technol Ass* 47: 191-200.

Whitbread, MW (1991). Selection of late season varieties under conditions of heavy flowering at Dwangwa, Malawi. *Proc S Afr Sug Technol Ass* 65: 109-112.