THE EFFECTS OF ETHREL AS A FLOWERING INHIBITOR IN SUGARCANE

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Abstract

Two experiments were conducted to determine the retardation effect of Ethrel (1L/ha) on flowering and the possible reduction in sugar as a result of flowering of canes.

One trial comprised a split-plot design with three cane varieties and three different timings of Ethrel application replicated three times. Ethrel was applied when canes were 19, 20 and 21 weeks old respectively. The second trial consisted of one variety, which was planted at eight different estate locations with Ethrel applied at approximately 14 –18 weeks post-planting. In this trial, a Plant Growth Regulator (PGR) namely Evergreen was included in combination with Ethrel as one of the treatments to possibly counteract the assumed negative impact on plant growth from Ethrel.

Results of the impact of the treatments on flowering intensity, cane length and girth, sugarcane quality and cane yields are presented. Both sets of trials have indicated that timely application of Ethrel can delay the onset of flowering by as much as 4 weeks and result in floral inhibition of the order 15-32% in heavy flowering varieties.

KEYWORDS: Flowering intensity, inhibition, Ethrel.

INTRODUCTION

These trials were undertaken to assess the potential for improving flexibility of the planting time for varieties that flower, as well as being able to select varieties that may otherwise be high-yielding, pest, disease and lodging resistant but would have been rejected due to their flowering characteristics.

Flowering in sugarcane is a complex physiological process consisting of multiple stages of development, each stage having specific environmental and physiological requirements. For example, if the specific day length, temperature and moisture requirements are not satisfied, flowering is inhibited or the intensity is reduced. Under natural conditions, a day length being fixed at any given latitude and date, it is essentially the location (altitude), temperature, moisture stress and the nutrition level that affect the timing and intensity of flowering (Nayamuth *et al*., 2003).

The prevention of arrowing and the consequent economic losses resulting from flowering to be achieved on a commercial scale is not feasible by means of photoperiod manipulation. Hence, the need for chemical floral inhibitors like Ethrel. Ethrel was demonstrated to delay opening of the inflorescence of flagging canes (Eastwood and Davis, 1997). Other applications include reduction of vegetation growth (cereals) to flower induction (pineapples) or inhibition (sugarcane). It also promotes the whole complex ripening process including anthocyanin synthesis (fruits) and dehiscence.

The plant physiological activity of Ethephon was discovered in the mid sixties and since then an impressive amount of work has been carried out with regard to its mode of action and practical applications in agriculture (Rhone-Poulenc, 1990).Ethrel or Ethephon (2-chloroethyl phosphonic acid) is rapidly metabolized in plants, soils and animals via hydrolysis, producing ethylene gas, phosphoric acid and hydrochloric acid; these breakdown products are not toxic and are found naturally in all plants.

MATERIALS AND METHODS

Experiment 1

This experiment was conducted in the Agriculture Research Centre (ARC) field located at the La Bonne Intention (LBI) estate location. The trial comprised a split-plot design in a factorial arrangement. The main plot comprised of three "heavy flowering" varieties D 93409, D 15841 and WI79463 (factor A) planted in plots 4 rows x 7.2 m with the sub plot being the three applications of ethrel at one week intervals commencing July 12th 2007 (factor B) at a rate of 940 mL/hectare. These canes were planted in early March 2007 during the first crop. Ethrel (Ethephon) [2-chloroethyl phosponic acid, 48% w/v) was applied at the different times (12th to 26 th July) using a knapsack sprayer. Growth stations were established (two 1m-rows in each treatment) and monthly growth parameters measured from 36 weeks to emergence of panicle. Brix values were determined fortnightly up until anthesis using a hand-held digital refractometer. Flower intensity was assessed just prior to harvest.

Experiment 2

This was an unreplicated study conducted in a single field and repeated at eight different locations. Canes in this trial was also planted in March during the first crop and Ethrel was applied once only at 940 mls per hectares during the period late June to early July when canes were approximately 13 to 17 weeks old. Evergreen 7-7-7, a plant growth regulator and bio-fertilizer comprising 7% each of the elements nitrogen (N), phosphorus (P) and potassium (K) was also included in one treatment to counteract the assumed negative impact of Ethrel on plant growth.

The three treatments evaluated were **(i)** control (no Ethephon or Evergreen applied), **(ii)** Ethephon applied at 1.0 L/ha and **(iii)** Ethephon and Evergreen applied at 1.0 L/ha and 2.0 L/ha respectively. Applications of Ethrel were done towards the end of June or early July using the aircraft whereas the Evergreen was applied at the same time with knapsack sprayers. The variety used in this study was mainly D15841 with the exception of the Skeldon location which used D 93409.

Plant growth measurements commenced when canes were approximately 4 months old, while flower intensity assessments were done fortnightly from the time of flower initiation up until harvest; brix measurements conducted on the 5th internode from the top of the stalk commenced at 40 weeks and were repeated at 2 week intervals up to harvest. Gross cane yields (t/ha.) were determined at harvest.

RESULTS AND DISCUSSION

Experiment 1

Flowering Intensity

Statistical analysis of the data indicated no significant (P >0.05) interaction effect in flowering intensity between cane variety and timing of application of Ethrel. There were however significant differences in flowering intensity (averaged over varieties) for the different Ethrel application timings (Table 1a). Ethrel applied on the 19th and 26th July gave 32 and 15 percent reductions in flowering respectively.

Flowering intensity values for the various varieties (averaged over all application periods) were not significantly different (Table 1b).

Brix Readings

Mean field-brix values showed no significant (P > 0.05) interaction effect between Ethrel application periods and the various cane varieties. At each stage of measurement, the brix values of the Ethrel-treated canes were not significantly (P > 0.05) different from those of the control treatment (Figs 1a). However, mean brix values (averaged over application periods) were significantly (P<0.050 different among the three cane varieties (Fig 1b). The highest brix readings were obtained for D 15841, which also showed the lowest flowering intensity. It should however be noted that this variety has always exhibited better quality than the others.

Growth Measurements

Growth measurements including stalk population, height and girth were determined when canes were 20 and 28 weeks old respectively. Stalk population was influenced by Ethrel application only with regards to the timing of applications with the greatest stalk population obtained in 24 weeks old canes treated with Ethrel on July 12th 2007. Stalk height and girth were not influenced significantly by Ethrel application at any of the two stages of measurement.

Cane Yields

Timing of Ethrel application had no impact on plant cane yields with the various yields being 49.4, 51.0, 51.9 and 53.4 MT/Ha for the control, 12th, 19th, and 26th July application dates respectively. The mean yields for the various varieties (averaged over the application dates) were however significantly different and recorded values of 59.6, 38.1 and 56.5 MT/Ha for D 93409, D

15841 and WI79463 respectively. This low recorded cane yield for D 15841 corresponds with the lack of reduction of the flowering intensity with the application of Ethrel.

Experiment 2

Flowering Intensity

Maximum flowering intensity varied for the different trial locations (Table 2a). The mean maximum value for the control plots (averaged across the locations) was 59.6% and ranged from 97.6% at Albion (AN) to 19.8% at LBI. The mean maximum value (averaged across the locations) for the combined treatments of Ethrel-treated canes was 46.6% and ranged from 93.4% at AN to 8.2% at Wales (GV).

The effect of Ethrel in reducing flowering in canes (Table 2b) was observed at all the locations with the exception of Blairmont (BCF). The percentage reduction in flowering from Ethrel use varied for the different locations and ranged from a high of 80% at Wales to a low of 0.0% at Blairmont. Overall, there was a 22% to 27% reduction in flowering (averaged over the locations) attributed to the use of Ethrel.

Brix Readings

Brix readings for the various treatments taken just prior to harvest at ages ranging from 44 weeks to 50 weeks are outlined in table 3. There were generally no significant ($P > 0.05$) differences in brix readings at this late stage of testing among the various treatments at any of the trial locations, indicating no significant negative impact of Ethrel on the quality of canes. Mean Brix values (across the locations) 20.0, 19.5 and 21.5 for the control, Ethrel only and Ethrel plus Evergreen treatments respectively.

Growth Measurements

Measurements of stalk height and girth (circumference) were done at varying time intervals fat the different trial locations. However, only the latest measurements for each location are reported here. These measurements were done when canes were between the ages of 34 and 45 weeks old. Measurements of stalk height showed significant ($P < 0.05$) differences among the treatments at two locations only, Blairmont and Enmore. At these locations the stalks of Ethrel-treated canes were significantly shorter than those of the control plots indicating that the application of Ethrel may have retarded the growth of canes. However, the suggested stimulating effect of Evergreen application on cane growth was not evident (Table 4a).

Measurements of stalk girth showed no significant ($P > 0.05$) differences among the treatments at any of the locations (Table 4b).

Cane Yields

Plant cane yields at harvest showed great variation for the different locations (Table 5). In only two trials, at Enmore and Uitvlugt were there substantial reductions in cane yields between the Ethrel-treated and the untreated canes, which might lend credence to the view that the application of Ethrel to canes can negatively impact cane yields.Tthe more common experience is that Ethrel applications stimulate tillering at early stages of grow or initiate fresh growth in individual stalks applied at later growth stages (after an initial period of growth suppression). Cane yields are typically enhanced in either case. This occurred at four locations (SWR, RH, LBI and GV) with the enhanced effect on yield associated with the Ethrel + Evergreen treatment two out of the four times.

GENERAL DISCUSSIONS AND CONCLUSIONS

Evans and Bates (1966) suggested that the vagaries of the degree and timing of sugarcane flowering in Guyana can be explained by examining the rainfall data from the end of the previous year through to the mid year rains of the current year. Figure 2 illustrates the variation in rainfall obtained at the different locations from September 2006 to December 2007. P. H. Moore (1985) suggested that flowering in canes is dependent on the combined effects of moisture and temperature, which are closely related. High rainfall is associated with increased cloud cover, producing a lower daylight maximum temperature and a higher minimum night temperature. Therefore, observations on flowering intensity attributable to one of these environmental factors may, in fact, be the result of the other or to an interaction of the two. It is commonly observed that moist, cloudy weather favors flowering while hot, dry weather reduces flowering. In other areas, increased flowering is associated with high water tables or with soils having a high soil moisture content. Decreased rainfall or reduced irrigation during the month preceding induction commonly reduces the percent flowering.

As in Mauritius, where flowering occurred at all sites, the percentage of flowered varieties and the flowering intensity differed widely between years for the same environment and between environments for the same year (Nayamuth *et al.,* 2003*).*

Results from the two different sets of experiments conducted in Guyana indicated great variation in flowering intensities. The general observations were that canes treated with Ethrel showed reduced flowering intensity compared with untreated canes, while the amount of reduction varied from 0.0% to as much at 80%. Mean percentage reduction in flowering obtained in the two experiments were 15 to 32% and 22 to 27% respectively.

Plant growth parameters were not greatly affected by the application of Ethrel when applied to inhibit flowering and neither were juice quality and plant cane yields.

Table 1a: Percentage flowering intensity for canes treated with Ethrel at different dates

Date/age of Ethrel application	Flowering intensity (%)	Flower reduction (%)
Control	62.6	-
12th July (19 wks old)	42.5	32.1
19th July (20 wks old)	53.3	14.9
26th July (21 wks old)	64.4	+ 2.9

Table 1b: Percentage flowering intensity for different varieties treated with Ethrel

Cane Variety	Flowering intensity (%)	Flower reduction (%)
D 93409	48.4	21.0
D 15841	45.1	0.0
WI79463	73.5	+ 18.2

Table 2a: Maximum flowering intensity (%) attained at the different locations

Treatment	Skeldon	Albion	Rose Hall	Blairmont	Enmore	LBI	Wales	**Mean**
Control	72.1	97.6	94.5	56.9	35.0	19.8	41.3	**59.6**
Ethrel	47.6	93.4	77.8	59.3	23.1	16.8	8.2	**46.6**

Table 2b: Flowering retardation (%) at the different locations

Estate Location	Flower Retardation (%)
Skeldon (SWR)	34.0
Albion (AN)	4.3
Rose hall (RH)	17.7
Blairmont (BCF)	0.0
Enmore (EHP)	34.0
La Bonne Intention (LBI)	15.2
Wales (GV)	80.1
ICBU	**Not determined**
Mean	**26.5**

Table 3: Brix readings for the various treatments at the different locations

T/ment	SWR	AN	RH	BCF	EHP	LBI	GV	ICBU	Mean
Control	18.7	17.0	19.3	22.2	20.0	21.7	19.1	20.0	19.8
Ethrel	19.1	19.1	20.0	20.2	19.5	22.3	17.9	19.5	19.7
Ethrel + Evergreen	18.9	18.1	18.1	19.0	21.5	21.7	17.4	21.5	19.6

Table 4a: Plant height (cm) for the various treatments at the different locations

T/ment	SWR	AN	RH	BCF	EHP	LBI	GV	ICBU	Mean
Control	287	307	265	337	419	167	299	233	289
Ethrel	287	328	281	305	259	183	286	221	269
Ethrel + Evergreen	283	307	277	319	264	188	287	254	272
Sig (P<0.05)	ns	ns	ns	S	s	ns	Ns	ns	

ns – Not significant; s - significant

Table 4b: Plant girth (cm) for the various treatments at the different locations

T/ment	SWR	AN	RH	BCF	EHP	LBI	GV	ICBU	Mean
Control	9.7	7.8	10.2	10.6	Nd	Nd	9.5	Nd	9.6
Ethrel	9.4	8.0	10.6	10.9	Nd	Nd	9.1	Nd	9.6
Ethrel + Evergreen	9.9	8.3	10.2	11.5	Nd	Nd	9.1	Nd	9.8
Sig (P<0.05)	ns	ns	ns	Ns			Ns		

ND – Not determined

Table 5: Cane Yield (MT/Ha) for the various treatments at the different locations

T/ment	SWR	AN	RH	BCF	EHP	LBI	GV	ICBU	Mean
Control	94.9	85.5	72.5	98.1	108.0	42.2	88.0	69.7	82.36
Ethrel	121.1	108.1	73.7	91.9	103.5	38.2	105.6	50.6	86.59
Ethrel + Evergreen	97.5	69.6	80.1	99.5	102.0	47.0	98.5	56.4	81.33

Fig 1a: Brix readings for different application dates

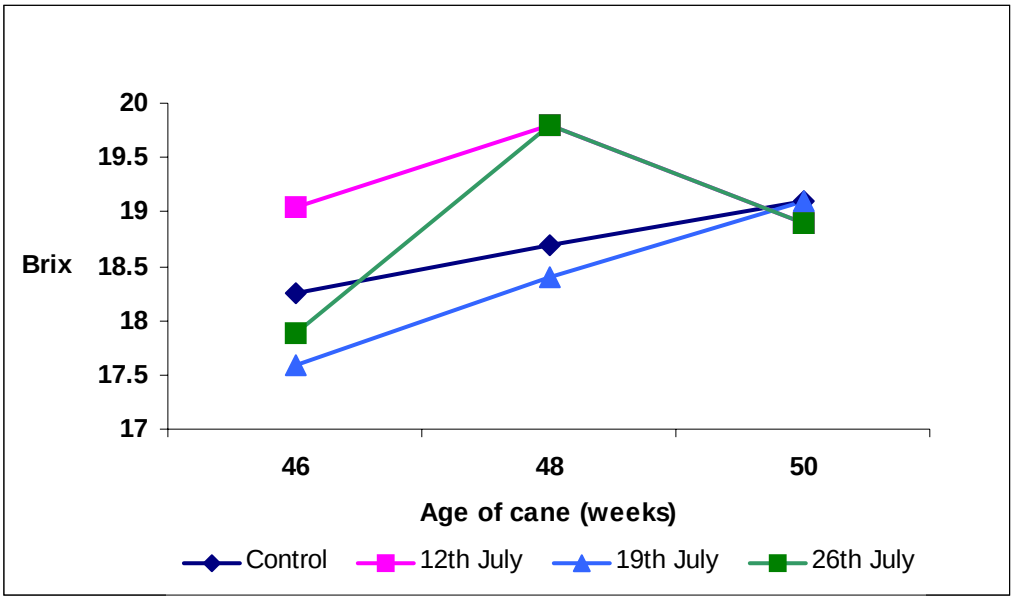


Fig 1b: Brix readings for the various varieties

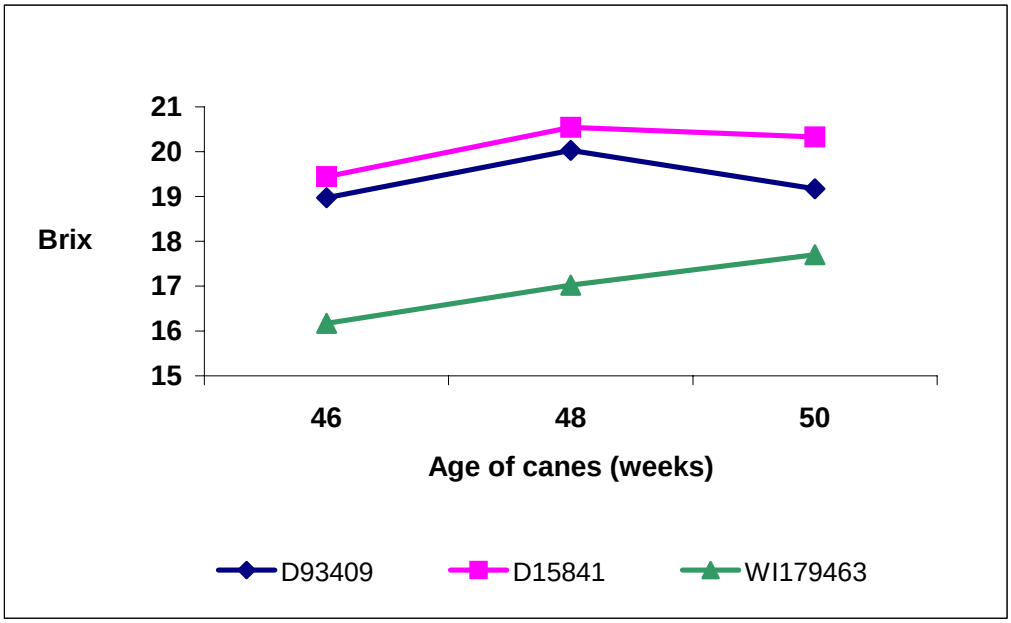
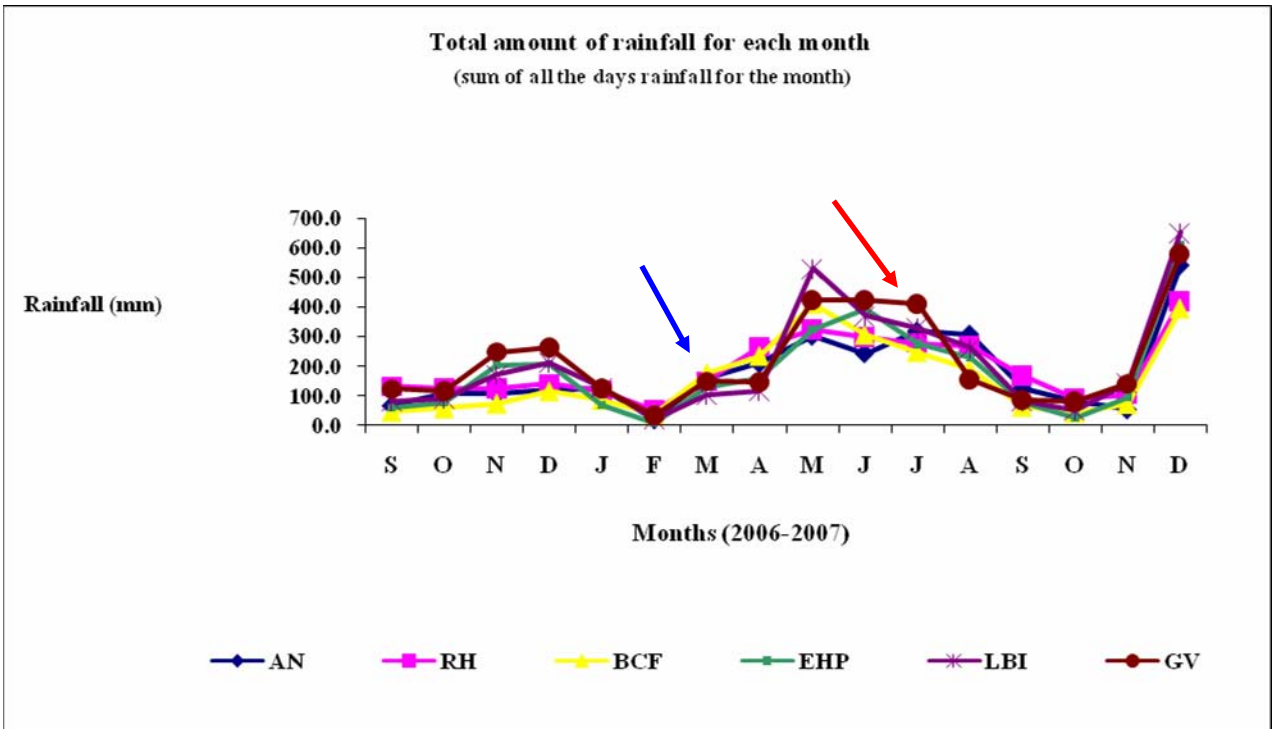


Fig 2: Monthly rainfall for six of the trial-locations



Note: The blue arrow indicates when the canes were planted and the red arrow indicates the time when the chemicals were applied.

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