OBSERVATIONS ON THE SUPPRESSION OF SUGARCANE FLOWERING USING ETHEPHON ON THE KWAZULU-NATAL SOUTH COAST

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Abstract

Flowering in sugarcane crops in the coastal and coastal hinterland areas of the South Coast region of KwaZulu-Natal has been abundant in recent seasons of relatively high rainfall. This has reduced cane yields and cane quality in crops harvested late in the season or carried over for harvest early in the following season. In field-scale observation trials, Ethrel (ethephon 48%) applied to crops at a rate of 1.0-1.5 l/ha in February was found to be highly effective in suppressing flowering. This had beneficial effects on the yield of crops harvested after September or carried over to the next season, and no obvious detrimental effects. Using Ethrel to suppress flowering is suggested as a standard practice for such crops, if weather early in the year is conducive to flower initiation. Further studies are necessary to determine the optimum timing and rates of application, and the effect of application on cane that does not flower.

Keywords: sugarcane, flowering, ethephon

Introduction

Flowering is a yearly occurrence in sugarcane grown in the more tropical parts of the world, such as Malawi, Hawaii and Florida. In these regions, cane yields of 140 tons/ha from annually harvested crops are commonplace, whether the cane flowers or not. When a sugarcane stalk initiates a flower bud, the production of internodes ceases, 'capping' the further growth of that stalk. The climate and conditions in the cane growing areas of KwaZulu-Natal, in particular the South Coast, are much less favourable. The milling season is comparatively long and irrigation is rare. On most farms in this area, 'carry-over' cane is essential to give a crop age at harvest of at least 13 or 14 months, necessary to maximise economic returns.

During February 1997, Ethrel (ethephon 48%) was applied as a ripener to cane to be harvested in May on Finningley Estates in the Scottburgh area of the South Coast. A portion of an adjacent field destined to be cut much later in the year was also sprayed by accident. In September 1997, the entire field adjacent to the one that had been ripened had flowered with the exception of the portion accidentally sprayed with Ethrel in February. These unflowered stalks were noticeably longer and greener than the flowered stalks.

This observation prompted a series of field-scale trials on the South Coast during the 1998-99 to 2000-01 seasons to determine the benefit of using Ethrel to prevent flower induction on cane due for harvesting late in the season (after October) or carried over and harvested at the beginning of the following season. The emphasis was on carry-over cane. In most instances, unsprayed fields near the coast that were intended for carry-over flowered so profusely that they had to be harvested within the same season.

In general, cane that flowers profusely and is cut between June and the end of September will produce a higher sucrose yield than non-flowered cane as a result of the natural ripening effect of flowering (Gosnell and Long, 1973). The effect of flowering on the yield of cane from crops harvested before the end of September is negligible, as June to September is a period of slow vegetative growth on the South Coast.

Near the coast, cane that has flowered and is to be harvested after October usually produces side shoots and both cane quality and yield deteriorate. Some flowered stalks do not side shoot and most of these eventually die, especially in crops grown at higher altitudes away from the coast. It was estimated that reductions in cane yield of up to 30 t/ha and up to three percentage points in sucrose % cane occurred in flowered cane.

The effectiveness of Ethrel in preventing flowering is well documented (Clowes, 1980; Osgood *et al.,* 1983). A trial conducted in Malawi on NCo376 showed that the major benefit from preventing flowering was increased cane yield, although an improvement in cane quality was also observed (King, 1982). The cane in question was harvested on a 12-month cycle with no carry over.

Flower initiation on the South Coast occurs between 8 and 30 March (KJ Nuss[1], personal communication) provided night temperatures during this period do not fall below 18°C for more than two consecutive nights or for a total of eight days during this period, in which case the incidence of flowering percentage is reduced (Gosnell, 1973; Brett *et al.*, 1975).

The objectives of the field-scale trials were to determine the effect on flower suppression of Ethrel applied at a rate of 1.0-1.5 l/ha in February, just before the time of flower initiation, and to determine whether there were any obvious detrimental effects of applying these rates of Ethrel to cane due for harvest 8 to 14 months after application.

Methods

The trials were conducted on a practical 'farm level' basis, using carefully calibrated spray equipment and pacers to regulate the walking speed of the operators, and were unreplicated (i.e. they were field-scale observation trials). Whole fields or large portions of fields were sprayed using the standard spraying equipment available on the farms. This comprised CP3 20L or

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Jacto 15L knapsack sprayers fitted with either APM blue or APM green flood jets delivering 300 and 270 l/ha water respectively at a walking speed of 50 m in 42 seconds. The spacing between rows in all instances was 1.0 m.

Spraying was conducted by the operator walking down each interrow with the spray lance held over his shoulder, spraying directly behind. The APM blue and green flood jets have swath angles of 140° and 130° respectively and give a consistent spray pattern out to 1 m laterally, provided they are held high enough above the cane. The cane sprayed was a maximum of six months old, short enough to walk through easily, and even spray coverage of the crop was obtained. Spraying in this manner also minimised operator contact with the spray mist.

The Ethrel was sprayed between 14 and 28 February, mostly at rates of 1.0 or 1.5 l/ha. One trial received 0.5 l/ha. All the crops sprayed were rainfed and were actively growing at the time of application and all were ratoon crops. Plant crops at the time of spraying did not appear to be physiologically old enough to initiate flowers. All the crops sprayed were between three and six months old at the time of application. Ratoon cane less than three months old in mid-February was too young to flower.

In two fields on Drumdarroch farm in the Umkomaas area, a tractor-mounted mist blower operating in the contour roads and with a swath width of 25 m was used to apply the ethephon in 110 l/ha water.

In most instances, the variety used in the trials was N12, which is regarded as a comparatively slow maturing, long cycle variety with moderate resistance to eldana and is therefore widely grown for carry-over purposes. Fields of NCo376 and N55/805 planned for harvesting in the last two months of the season or to be carried over, were also sprayed. NCo376 and N55/805 are varieties known to flower profusely.

In those fields surveyed by Local Pest, Disease & Variety Control Committee (LPD&VCC) teams, levels of flowering were estimated by counting the number of flowered stalks in 50 m lengths of cane row and expressing this as percentage of the total number of stalks. In other fields, flowering was estimated by selecting 100 stalks at random from each field and cutting the stalks longitudinally to identify both emerged and unemerged flowers.

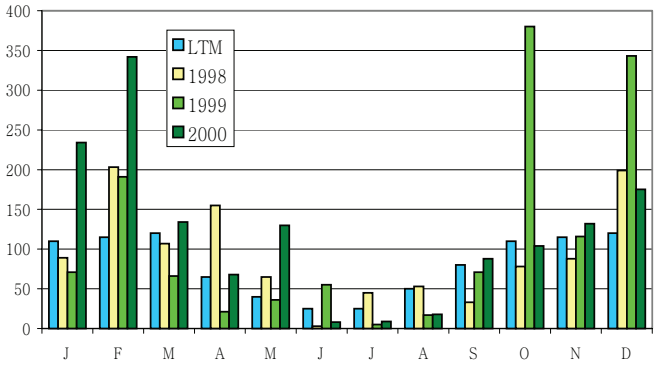

Figure 1. Annual rainfall at Scottburgh, 1998-99 to 2000-01 seasons (totals: LTM, 975 mm; 1998-1999, 1 118 mm; 1999-2000, 1 372 mm; 2000-2001, 1 442 mm).

Results

Flowering was profuse along the entire South Coast in the 1998-99 to 2000-2001 seasons. This was due to relatively favourable growing conditions, with rainfall being well distributed and exceeding the long term mean (LTM) in all three seasons. (Figure 1). Mean minimum temperatures in February exceeded the LTM in all three years. Mean minimum temperatures at the critical period of flower initiation, in March, were particularly favourable in 1999 and 2000 (Figure 2).

Effects on growth

Within 10 days of the application of Ethrel the lower leaves of the stalks turned yellow and eventually 'browned off'. The length of the top 6-8 leaves was reduced and they assumed a more horizontal habit. Two or more internodes that were elongating rapidly at the time of application became shortened and a visible 'kink' in one of these internodes was often observed. In some cases, the buds of these shortened internodes swelled but did not produce side shoots. Where 1.5 l/ha Ethrel was applied, adventitious roots occasionally appeared on the shortened internodes, this being most apparent on the edges of the fields and probably caused by over-application. In the 1998 trials, the cane recovered rapidly from these symptoms and normal growth resumed approximately two months after application. Winter and early spring rains in 1998 were normal (Figure 1).

In the trials sprayed in 1999 and 2000, treated cane was slower to recover, in particular cane that was five or more months old at the time of application. The 1999-2000 season was characterised by a 5-month period from autumn to early spring that was drier than normal (200 mm compared with the LTM of 325 mm). The months of June to early September 2000 were also much drier than usual (Figure 1). Cane growing on shallow, Dwyka soils that was sprayed in February exhibited the most severe reaction to treatment and took the longest to recover. However, by November in both 1999 and 2000 all sprayed fields were growing normally, were greener and had longer millable stalks than flowered cane of a similar age and growing in similar soils.

Cane sprayed with 1.5 l/ha Ethrel was slower to recover than cane sprayed with 1.0 l/ha. The one trial area that was sprayed with 0.5 l/ha Ethrel showed no obvious effects of treatment and flowered profusely.

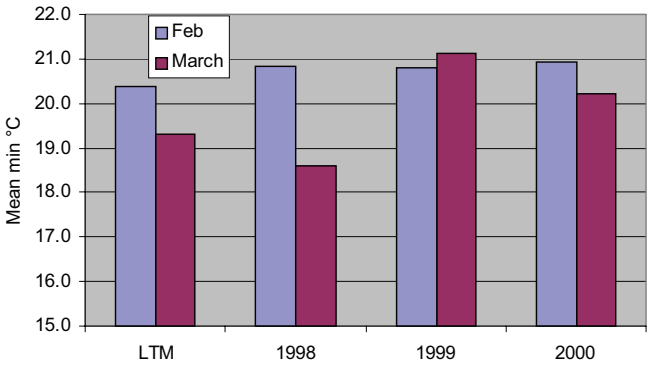

Figure 2. Mean minimum temperatures at Sezela in February and March 1998-2000, compared with the LTM.

Effects on flowering

The degree of flower suppression in all fields sprayed with 1.0 or 1.5 l/ha Ethrel between 14 and 28 February 2000 varied between 80 and 100%. Using knapsack sprayers, the 1.0 l/ha rate gave the highest degree of flower suppression in NCo376 but was sometimes slightly less effective in N12. In some instances on older cane, the lower rate of Ethrel suppressed flowering less than the higher rate. This was possibly due to poorer coverage with 1.0 l/ha in taller cane with a denser leaf canopy (Table 1). Application using the tractor-mounted mist blower was less effective than application with knapsack sprayers, because of poorer penetration (Table 1).

Effects on cane yield and quality

In the 1999/2000 trials, it was possible to quantify the benefits of the flower suppression on varieties NCo376 and N55/805 on Ellingham Estates (Table 2). The yield of cane of N55/805 and NCo376 was substantially increased by suppressing flowering with 1.0 l/ha Ethrel, and sucrose % cane and recoverable value of NCo376 were markedly improved (Table 2).

In the 2000/2001 season, a comparison was made between cane of variety N12 that was sprayed with 1.0 l/ha Ethrel to suppress flowering in February and harvested as carry-over cane in April/May 2001, and cane that was not sprayed, flowered profusely and was also harvested as carry-over cane (Table 3). The mean incidence of flowering in eight treated fields on three farms was 9%, compared with 75% in five fields on two other farms. Mean cane yield in the treated fields was 93 t/ha at 12.54 sucrose % cane, compared with 73 t/ha at 8.25 sucrose % cane in the heavily flowered, untreated fields. Sucrose yield was therefore almost doubled by suppressing flowering (Table 3).

Discussion

Conditions were generally favourable for flowering in all three seasons (Figures 1 and 2). Crops near the coast that had flowered in 1999 and were cut during April-May 2000 yielded well in terms of cane yield but sucrose content was the lowest recorded for many years. In many cases this was accompanied by non-sucrose values of close to 3% (Table 4). These crops were of greatly reduced value to both growers and millers.

Table 1. Extent of flowering in November/December 2000 in fields sprayed with Ethrel in February 2000, on three coastal farms on the KZN South Coast*.

Farm (District)	Treatment and rate (l/ha)	Variety	Age at survey (months)	% stalks flowered
Drumdarroch (Umkomaas)	Ethrel, 1.0	N12	11	12
	Ethrel, 1.0	N12	11	10
	Ethrel, 1.0	N12	11	14
	Ethrel, 1.0	N12	11	15
	Ethrel, 1.0	N12	11	36**
	Ethrel, 1.0	N12	11	28**
	Nil	N16	11	37
The Wolds (Port Shepstone)	Ethrel, 1.0	N12	12	0
	Ethrel, 1.0	N12	12	0
	Ethrel, 1.0	N12	12	0
	Ethrel, 1.0	NCo376	12	0
	Ethrel, 1.0	NCo376	14	0
	Nil	NCo376	14	85
	Nil	NCo376	12	90
Shibumi (Port Shepstone)	Ethrel, 1.0	N12	12	20
	Ethrel, 1.0	N12	12	1
	Ethrel, 1.5	N12	11	0
	Nil	N12	11	80
	Nil	N12	11	84
	Nil	N12	11	79

* Data from LPD&VCC surveys. Field 46B on The Wolds was burnt the day before the survey and the actual flowering percentage was estimated.

** Fields sprayed with a tractor-mounted mist blower, spraying from contour roads with a 25 m spray swath.

Table 2. Effect of Ethrel at 1.0 l/ha sprayed in February 1999 on flowering in November 1999 and cane yield and quality at harvest, Ellingham Estates.

Variety	Treatment	% stalks flowered	Date of harvest	Age at harvest (months)	Cane (t/ha)	Sucrose % cane	Non-sucrose % cane
N55/805	Ethrel	0	Nov 1999	13.7	45.5	12.1	2.5
	Nil	95	Nov 1999	13.0	29	9.7	2.6
NCo376	Ethrel	0	April 2000	19.0	72	9.4	2.5
	Nil	80	May 2000	20.0	45	7.4	2.9

Note: Flowering % was determined from counts made in November 1999 with the assistance of the farm staff.

Table 3. Flowering and yield and quality of carry-over cane on coastal farms on the South Coast either (a) treated with Ethrel (1.0 l/ha) in February 2000 or (b) untreated. Flowering recorded in Nov-Dec 2000; all fields harvested in April and May 2001 at a crop age of 16-18 months.

a) Fields treated with Ethrel						
Farm	Variety	Yield (t/ha)	Sucrose % cane	Non-sucrose %	Fibre (%)	% stalks flowered
The Wolds	N12	120	14.05	2.05	14.31	Nil
The Wolds	N12	101	12.98	2.06	15.69	Nil
The Wolds	N12	97	12.45	1.83	15.21	Nil
Shibumi	N12	85	12.65	1.82	16.24	20
Shibumi	N12	80	11.85	2.26	15.64	Nil
Drumdarroch	N12	85	12.50	2.05	15.55	12
Drumdarroch	N12	89	11.96	2.21	16.99	14
Drumdarroch	N12	95	11.87	2.16	17.62	28
b) Untreated						
Injambili	N12	75	8.01	3.62	15.72	80
Injambili	N12	75	7.65	3.22	15.82	78
Injambili	N12	65	8.54	3.08	16.06	80
Injambili	N12	75	8.17	3.11	14.94	75
Bembridge	N12	70	8.87	2.92	15.39	65

Note: Data from Cane Testing Service results, LPD&VCC surveys and farm records. The Wolds, Shibumi, Injambili and Bembridge farms have similar soil types and are in the same geographical location in the Umzimkulu mill group area.

Crops in the coastal hinterland (alt 300-500 m) in 1999-2000, flowered more profusely than for many years. Most flowered stalks did not produce side-shoots and subsequently died, resulting in reduced cane yields and a high incidence of bull shoots. Associated with this was a low sucrose content at harvest. These flowered crops, especially in the Paddock and Braemar areas, were stressed because of the dry winter and early spring and consequently were prone to eldana.

An 18-month cutting cycle is normal in the coastal hinterland. The high eldana counts, disappointing yields and poor quality of cane harvested in the first four months of the 2000-2001 season reflect the consequences of carrying-over flowered cane. The preferred variety for the hinterland areas is N12. Flowering, particularly in N12, can manifest itself in a number of ways: a flower bud can develop and fully emerge; an incipient flower can form at the apical meristem, grow a few centimetres and then die without ever emerging; flower induction can occur and hardly develop further and the only indication that flowering has indeed happened is when the topmost internodes begin to sideshoot. When determining the degree of flowering

Table 4. Extent of flowering and cane yield and quality in individual fields of carry-over cane at harvest in April-May 2000 at Ifafa Lagoon Estates and Endymion Farm.

Farm	Variety	Age at harvest (months)	Cane (t/ha)	Sucrose % cane	Non-sucrose % cane	Flowering
Ifafa Lagoon	N12	19	139	7.36	2.8	Severe
		19	125	7.3	2.7	Mod/severe
		17	132	7.6	2.7	Mod/severe
		15.5	128	6.9	3.1	Severe
		16.5	150	7.4	2.7	Moderate
	NCo376	16.5	130	7.4	2.7	Severe
Endymion	NCo376	16.8	80	6.6	2.9	Severe
	NCo376	16.5	77	8.4	2.8	Severe
	N12	18	107	10.0	2.6	Moderate

within a field it is important to cut longitudinally the meristems of a large number of sticks chosen at random and examine them for 'delayed' and 'aborted' flowers, and not just count the number of flowers emerged.

Following a very dry winter and early spring in 1999, eldana levels were high in some crops grown on shallow soils. On one farm where part of a field of N12 was sprayed with 1.3 l/ha Ethrel to suppress flowering, higher levels of eldana were recorded in the treated cane (42 e/100 stalks compared with 8 e/100 stalks in untreated cane). It is well known that prolonged moisture stress, particularly on older cane, favours the development of eldana. When Ethrel was applied to crops growing on these shallow soils and a dry winter followed, it is conceivable that the cane had not fully grown out of the effects of the treatment before the drought set in, causing increased stress (Moore and Osgood, 1986). However, in the trials on deeper soils, eldana levels were low late in the season in all the fields sprayed with Ethrel in February. Nevertheless, cane growing on shallow Dwyka soils should usually be cut seasonally. If the field is to be planted to N12 or other slow maturing variety, a change to N21 may be advisable.

No detrimental effects of applying Ethrel for flower suppression were observed in the three years of this study. However, without treatment the cane in all the fields would have flowered because of the favourable conditions early in the year. No information was collected on the effect of Ethrel on cane that would otherwise not have flowered profusely. This topic requires investigation.

Conclusions

A single application of ethephon at a rate of 1.0-1.5 l/ha between 14 and 28 of February on cane to be cut in November, December and January, or carried over and cut at the beginning of the following season, was highly effective in preventing flowering and had limited negative effects on cane growth. At harvest, there were substantial increases in cane yield and cane quality, especially with carry-over cane, compared with untreated cane of the same age and variety that had flowered profusely. These results are sufficiently promising to warrant further investigation of the suppression of flowering for late season and carry-over crops.

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