RESULTS FROM GLYPHOSATE USED AS A RIPENER AT FELIXTON

By A. N. MILLS
Martin and Barnes (Pty) Limited
P.O. Box 22, Felixton, 3875

Abstract

Glyphosates (MON 8000 and Roundup) were tested as chemical ripeners on cane growing on a farm situated on the Umhlatuze flats. The soils are alluvial and most of the cane grown was variety NCo 376. Good ripening responses to glyphosate in field trials encouraged the commercial testing of glyphosate over two seasons. A comparison of a large number of treated and untreated cane fields indicated a substantial improvement in cane quality particularly at the beginning and end of the milling season. There was no evidence to suggest that yields of either the treated crop or the following ratoon were reduced by the application of glyphosate. Over-application of glyphosate, however, could be damaging to the following crop. Other benefits accruing from the use of glyphosate included : a better burn, more efficient cane topping, fewer tops and less trash on cane delivered, a reduction in fibre % cane and increased payloads. Glyphosates are playing a major role in increasing profitability on the estate.

Introduction

The farm is situated on the Umhlatuze flats opposite the Huletts Sugar Mill (Felixton). The annual rainfall is approximately 1 500 mm. Rich fertile alluvial soils make up about 75 per cent of the area used for cane production. Cane growing on these soils seldom shows drought symptoms; however, drainage is required to cope with periods of heavy rainfall. The water table on soils producing the best cane varies from 0,75 m to 1,5 m below the soil surface. These factors result in vigorous, healthy growth of sugarcane which is cut on a 12 to 14 month cycle. This cane has a low sucrose content and juice purity, particularly early and late in the season and consequently there is potential for improving cane quality using chemical ripeners. In January 1978 a commercial representative sought our co-operation in conducting ripener trials using glyphosate. Fields with well grown cane and not suffering from moisture stress were initially selected as sites for glyphosate application. Promising results, particularly early and late in the season, resulted in the commercial testing of glyphosate on 86 hectares at the end of a season after "restricted use" registration had been obtained for glyphosate. The following season 170 hectares were treated with glyphosate.

Materials and Methods

Figure 1 shows the layout of the farm and fields treated with glyphosate in 1978 and 1979. Most of the cane treated was NCo 376, but about 11 hectares of NCo 310 were also treated.

In 1978 trials on NCo 376 were carried out in the early, middle and late parts of the milling season. Commercial testing of glyphosates on a field scale was started in October

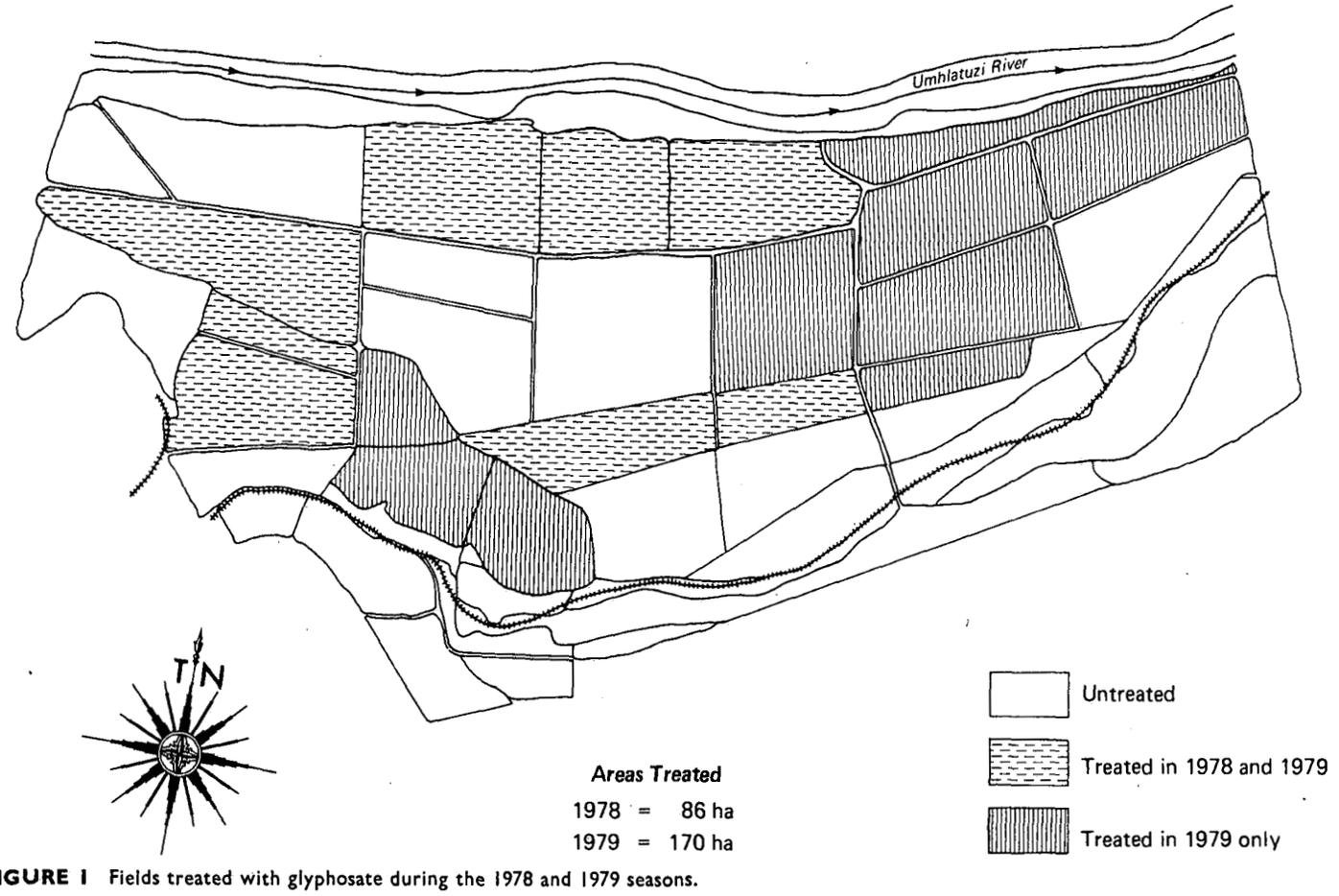

FIGURE 1 Fields treated with glyphosate during the 1978 and 1979 seasons.

TABLE 2

Mean monthly rainfall, sucrose % cane and age of cane at harvest (months) during the milling season, commencing in 1974 and showing results for treated and untreated cane during the last two seasons

MONTH	SEASON																				
	1974			1975			1976			1977			1978					1979				
	Rain-fall	Sucrose % cane	Age	Rain-fall	Sucrose % cane	Age	Rain-fall	Sucrose % cane	Age	Rain-fall	Sucrose % cane	Age	Rain-fall	Control Sucrose % cane	Age	Treated Sucrose % cane	Age	Rain-fall	Control Sucrose % cane	Age	Treated Sucrose % cane	Age
May	103	11,6	16	—	—	—	151	9,8	16	41	10,3	17	34	9,5	11	9,6	10	81	9,9	17	10,8	11
June	79	10,8	15	—	—	—	12	10,7	14	0	10,5	13	75	9,8	11	9,9	11	42	10,1	16	11,5	13
July	42	12,8	14	66	12,2	14	27	11,8	13	52	9,1	13	100	10,3	11	—	—	—	10,7	14	11,0	12
August	46	12,1	12	70	13,2	13	53	11.0	17	11	10,8	13	42	11,7	11	—	—	58	11,0	12	11,7	12
September	35	13,3	14	158	11,5	12	43	13,1	12	85	10,4	19	83	11,8	14	—	—	135	11,3	12	—	—
October	53	11,2	12	95	10,9	14	305	13,1	14	71	12,0	14	137	10,4	11	11,1	11	62	11,3	13	12,3	13
November	171	10,5	15	80	11,5	16	48	10,4	13	90	12,1	12	99	—	—	12,3	11	68	—	—	12,8	12
December	138	9,6	13	168	11,4	16	123	11,3	13	28	13,9	12	14	—	—	13,1	12	—	—	—	—	—
January	—	—	—	302	8,1	14	—	—	—	30	9,6	13	—	—	—	—	—	—	—	—	—	—
Mean	667	11,5	13,9	939	11,2	14,1	762	11,4	14,0	408	11,0	14,0	584	10,6	11,5	11,2	11,0	446	10,7	14,0	11,7	12,2

TABLE 3

Results from Treated and Untreated Fields in 1979, including Standard Deviations (s.d.)

	TREATED FIELDS									UNTREATED FIELDS							
Month of Harvest	Field no.	Variety	Sucrose % cane	Juice purity %	Fibre % cane	Tons cane/ha	Tons cane/ha month	Age (month)	Interval between spraying and harvesting (weeks)	Field no.	Variety	Sucrose % cane	Juice purity %	Fibre % cane	Tons cane/ha	Tons cane/ha/ month	Age months
May	8	NCo 376	10,7	80,7	15,0	125	11,4	11	10	29	NCo 376	10,0	77,7	16,4	167	9,8	17
	9	NCo 376	10,4	79,4	14,0	121	11,0	11	8	—	—	—	—	—	—	—	—
June	132	NCo 376	11,5	82,0	14,3	142	10,9	13	8	10	NCo 310	10,2	79,8	15,6	161	10,1	16
July	7	NCo 376	11,5	85,6	15,1	109	8,4	13	9	15	NCo 376	10,1	78,4	16,0	127	9,1	14
	251	NCo 376	10,6	79,3	13,8	130	10,8	12	4	18	NCo 376	9,5	75,3	16,4	150	13,6	11
	252	NCo 376	10,9	79,3	14,5	149	12,4	12	4	—	—	—	—	—	—	—	—
August	131	NCo 310	12,4	85,6	16,7	114	9,5	12	9	17	NCo 376	11,0	81,6	15,7	81	6,8	12
	1a	NCo 376	11,9	82,7	15,6	136	10,5	13	5	—	—	—	—	—	—	—	—
	253	NCo 376	11,1	81,3	15,0	80	6,2	13	5	—	—	—	—	—	—	—	—
	282	NCo 376	11,4	81,7	14,5	145	11,2	13	5	—	—	—	—	—	—	—	—
September	—	—	—	—	—	—	—	—	—	142	NCo 310	11,3	81,7	15,6	93	9,3	10
	—	—	—	—	—	—	—	—	—	221	NCo 376	11,6	86,8	19,2	90	6,9	13
	—	—	—	—	—	—	—	—	—	32	NCo 376	11,0	81,9	18,6	117	9,8	12
October	12	NCo 376	12,5	86,2	16,6	123	9,5	13	3	6	NCo 376	11,3	83,1	17,0	81	6,2	13
	141	NCo 376	12,0	84,7	17,7	117	8,4	14	3	—	—	—	—	—	—	—	—
	281	NCo 376	12,4	83,0	17,5	109	9,1	12	4	—	—	—	—	—	—	—	—
November	1b	NCo 376	12,2	83,3	19,2	74	6,7	11	6	—	—	—	—	—	—	—	—
	51	NCo 376	13,2	85,2	17,6	89	7,4	12	4	—	—	—	—	—	—	—	—
	52	NCo 376	13,1	84,1	17,5	81	6,8	12	5	—	—	—	—	—	—	—	—
		Mean	11,7	82,7	15,9	115,2	9,38	12,3	5,8	—	—	10,7	80,7	16,7	118,6	9,07	13,1
		s.d.	0,85	2,35	1,57	23,75	1,90	0,87	2,29	—	—	0,74	3,35	1,32	34,46	2,26	2,26

TABLE 1

Results from using glyphosate in trials sprayed during the early, middle or late part of the milling season

Treatment	Sucrose % cane				Juice purity			
	weeks after spraying				weeks after spraying			
	0	4	6	8	0	4	6	8
Early Season								
Control	4,6	6,3	7,9	8,7	56,7	66,0	73,2	75,5
Glyphosate	5,1	8,8*	11,5*	12,2*	59,8	74,6*	83,8*	85,2*
Mid Season†								
Control	10,1	11,4	11,7	11,9	80,0	84,1	88,3	86,9
Glyphosate	10,1	12,1	13,4	12,7	80,0	85,4	89,3	88,8
Late Season								
Control	14,6	14,9	14,7	14,4	94,2	92,6	93,7	93,0
Glyphosate	14,6	15,4	17,0*	16,6*	94,4	92,8	95,6	94,3*

* significantly different from control (P = 0,05)

† no statistical analyses possible

1978 and continued throughout the 1979 season. The age of the cane treated varied between 8 and 13 months and yields of about 115 tons per hectare were obtained. The interval between spraying and harvesting varied between three and ten weeks depending on the time of year.

Most of the cane was sprayed by air with a Pawnee Brave fitted with 40 to 45 D12 nozzles delivering droplets with a Volumetric Median Diameter (VMD) of 450 microns. The swath width was 16 m and 50 litres of spray solution were applied per hectare. Application was made early in the morning (06h00 to 09h00) or occasionally late in the afternoon (16h00 to 17h30) when weather conditions were suitable for spraying. There were few obstructions in the normal flight path and consequently it was easy to mark these fields. Marking was not always done using the row layout. The standard procedure used was to use small pegs to mark out 16 m swaths at each end of the field. This was done prior to spraying. The markers comprised four metre tall bamboo poles with a square metre of white material attached to the top of each pole. These markers were held in position at each end of the first swath which had been previously marked with pegs. Each time the plane flew over the marker, the man holding the marker advanced to the next peg.

Ground application equipment was used on 15 hectares in March 1979 and on one small plot trial in June 1978. Spraying Systems TK 1,0 floodjets were used which delivered about 70 litres per hectare at 200 kPa. One nozzle sprayed two rows at a time. Spray operators walked down every fourth or fifth interrow which was opened up prior to spraying to ensure that a constant walking speed could be achieved.

The rate of 0,4 kg a.i. per hectare of glyphosate was applied except in trials where different rates were compared. This standard rate was equivalent to about 0,67 kg Mon 8000 or 1,0 litre of Roundup. Nalcotrol, an anti-drift additive was used in one of the trials where ground application was used. One millilitre of Nalcotrol was added to each litre of spray solution.

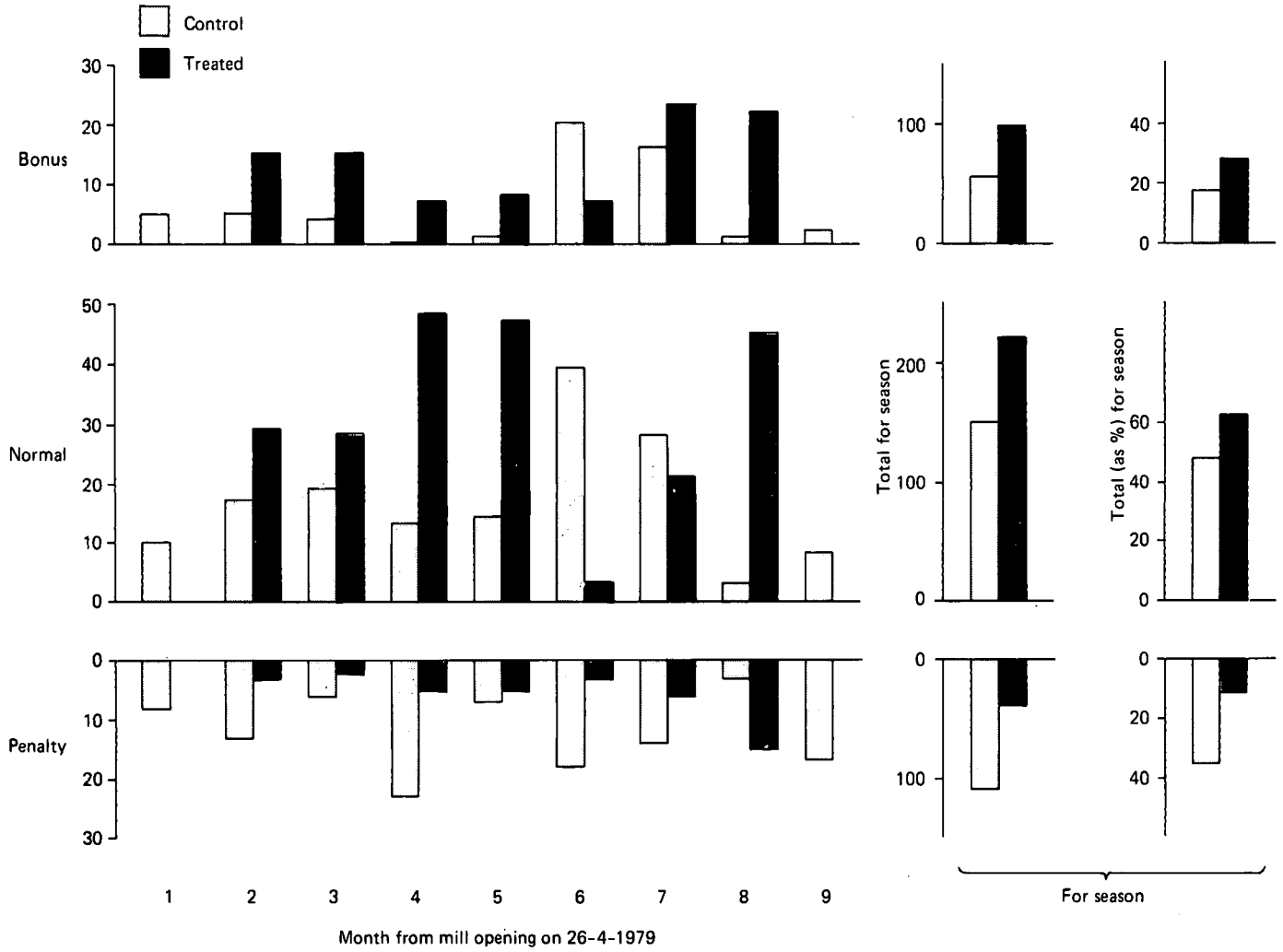

FIGURE 2 Number of consignments receiving bonus, normal or penalty ratings for quality each month and means for the season.

Results

Results from the three trials (Table 1) show that large ripening responses were obtained from cane treated early and late in the milling season, with smaller responses which would nevertheless have been economic in mid-season. Table 2 shows mean monthly rainfall, sucrose % cane and age of cane at harvest for each month of the milling season from 1974 onwards. During the last two seasons when glyphosate was applied, results for both treated and untreated cane indicate that cane treated with glyphosate harvested at 12 months of age was equal in quality to 14 month old untreated cane harvested during previous seasons (ie 1974-1977) while untreated cane during the last two seasons was lower in quality than in previous seasons. More detailed results from individual fields are given in Table 3, which shows a slight advantage in terms of mean cane yield per hectare per month for treated compared with untreated fields. Juice purity and sucrose content of cane from treated fields tended to be higher than those of cane from untreated fields.

Ratings of cane quality

Figure 2 shows the number of consignments receiving bonus, normal or penalty ratings for each month and means for the 1979 season. Consignments of treated cane consistently received better quality ratings than untreated cane, confirming the ripening effects on treated cane. Table 4 provides a comparison of the effects of these ratings during the last two seasons on financial return per ton of cane. The penalty was reduced and bonus increased per ton of cane in 1979 compared with the previous season when less cane was treated (Figure 1).

TABLE 4

Returns for the 1978 and 1979 season including effects of bonus and penalty ratings

Season	Tons cane	Area cut (ha)	Tons Cane/ ha	Sucrose % cane	Fibre % cane	Juice Purity %	Cents per ton	
							Penalty	Bonus
1978	33 462	287	116,6	11,40	16,62	82,51	0,21	5,42
1979	31 588	270	117,0	11,39	16,47	82,19	0,13	7,23

Note: The area of cane treated in 1979 was twice that treated in 1978 (see Fig 2)

TABLE 5

Cutter performance on ripened and unripened cane. Tons cane cut per man in one 8 hour day

Treatment	Cutter (1 to 11)											Mean
	1	2	3	4	5	6	7	8	9	10	11	
Unripened	9	8	9	10	8	9	11	7	11	8	10	9,1
Ripened	13	11	11	13	11	12	14	11	13	10	13	12,0
											CV %	4,7
											LSD (P = 0,05)	0,47

TABLE 6

Comparing the mass of cane per truck when cane was either treated with ripener or remained untreated

TONS CANE

Treatment	Truck (1 to 12)												Mean
	1	2	3	4	5	6	7	8	9	10	11	12	
Untreated	3,5	3,1	3,6	2,7	2,9	3,4	3,1	2,7	3,4	3,5	2,9	3,2	3,17
Treated	3,8	3,3	4,1	4,1	3,1	4,2	4,1	2,9	3,8	3,8	3,3	3,3	3,65
												CV %	8,1
												LSD (P = 0,05)	0,25

Management implications

Cutter performance was determined in one trial harvested in October, 1978. The results in Table 5 show that cutter performance was increased by 32 per cent on ripened cane compared with untreated cane harvested in the same block and the difference was statistically significant. It was observed that treated cane burnt better and more evenly than untreated cane which resulted in easier and more efficient topping.

In a different trial, the mass of treated and untreated cane which could be loaded normally into trucks (narrow gauge railway) was compared. Trucks containing treated cane carried 15 per cent more cane than trucks carrying untreated cane (Table 6).

The effects of treated and untreated cane on tops and trash delivered to the mill over two weeks in 1979 are shown in

TABLE 7

Data on tops and trash delivered to the mill from treated and untreated parts of the same field

Date 22.10.79 to 28.10.79	Trash %	Tops %	Total %
Mill average	2,9	2,2	5,1
Grower average — Treated cane	2,4	1,2	3,6
Difference from mill average	−0,5	−1,0	−1,5

Date 29.10.79 to 3.11.79	Trash %	Tops %	Total %
Mill average	3,1	2,4	5,6
Grower average — Untreated cane	4,1	2,8	6,8
Difference from mill average	+1,0	+0,4	+1,2

Table 7. The results suggest that treatment with glyphosate is likely to have been responsible for reducing the percentage of tops and trash.

Visual symptoms

The onset and intensity of the symptoms differed and depended on the amount of chemical applied, condition of the growing crop and in particular on the weather conditions at the time of spraying and afterwards. The following symptoms were usually apparent about three weeks after application : leaves became paler, apical growth was inhibited, the stalk below the apex hardened and matured and sideshoots developed on nodes at the top of the stalk. These sideshoots developed more quickly at the end of the season than during the early or middle part of the milling season. Flower emergence was also inhibited when glyphosate was applied during the early part of the season.

Regrowth

Glyphosates sometimes produced leaf chlorosis and temporary stunting of growth in the following untreated ratoon crop. These effects were most noticeable in trials when higher rates were used and were more pronounced in mid winter when ripening responses were small. These effects diminished with time but were noticeable up to a few months after harvest. Heights and counts taken after seven months in one trial showed no apparent differences between treatments. On two occasions an original swath received a second application so that effects on regrowth could be observed. Marked stunting and chlorosis were observed in contrast to the remainder of the field which was treated normally, where only negligible effects on regrowth were observed. At one time consideration was being given to replanting these two swaths. However, as time passed the effects lessened and by harvest, these areas could not be distinguished from cane in the remainder of the field.

Mill queries

In nearly all cases the mill returns agreed with what could be expected for the consignment (ie whether it was treated or untreated cane). However, there were two occasions where figures for fibre % cane were queried on consignments of treated cane. On both occasions the mill adjusted these values.

Discussion

Results from the three trials showed the considerable potential of glyphosate in improving cane quality and sugar yields on this estate. These results (Table 1) and the permit for restricted use of glyphosate resulted in large scale commercial testing of glyphosate, the main objective being to determine the effects on regrowth and to provide information on management implications. The main problem with commercial testing on a field scale is that the results for treated and untreated fields are not generally susceptible to statistical analysis, and the data collected have therefore to be evaluated subjectively and with caution.

The commercial application of glyphosate on this estate has noticeably improved cane quality, particularly at the beginning and end of the milling season when conditions favour growth rather than ripening (Tables 1, 2 and 3). Glyphosate had a large effect during both seasons on the cane quality rating. Consignments of ripened cane received fewer penalty ratings and more bonus ratings than unripened consignments (Figure 2). There was no evidence to suggest that glyphosate reduced cane yield of the treated crop because cane yields during 1978 and 1979 were similar (Table 4) as were mean yields of treated and untreated cane during 1979 (Table 3).

In addition to improving cane quality, the use of glyphosate also has other management implications. A better burn is usually achieved and this may account for the small reduction in fibre % cane (Table 3) which could result from less tops and trash (Table 7) in treated consignments. Topping treated cane was more precise because it was topped at the apical growing point which was easily determined after burning. The topping of untreated cane was not normally as precise because it is not as easy to determine the optimum topping height when the intensity of burn varies within a field.

Easier topping resulted in cutter performance being increased by approximately 3 tons per man per day (Table 5). This is equivalent to a 30 per cent increase in productivity. When cutting treated (not lodged) fields commercially, 16 cutters are needed to fill 60 trucks (capacity approximately 3 tons each) whereas on untreated cane, 20 cutters are required. This represents a 20% increase in cutter performance on treated cane. Truck weights were also improved (Table 6), probably because treated stalks carried less leaf and trash at the top of the stalk and were less prone to lodging than untreated stalks. The marking procedure and application of glyphosates has to be carefully controlled to ensure that over-application is avoided. This is necessary to reduce the likelihood of a possible reduction in the yield of the following ratoon crop. Efficient application requires close co-operation between the grower and the pilot, which can only be completely effective if procedures are first discussed in detail. It is also strongly advisable to have radio communication between the ground staff and pilot during the spraying operation. It is worth mentioning that with ground application, it is difficult to control the forward speed of the operator. It also appears that rates used for ground application can possibly be reduced by about 20 per cent because recovery of the chemical is improved, when compared with aerial application. The cost of aerial application is likely to vary between about R6 and R15 per hectare, depending on the proximity to the airstrip and the area to be sprayed.

During the early and middle part of the season, the interval between spraying and harvesting was between six and ten weeks, whereas at the end of the season this period was reduced to between three and six weeks after spraying. These intervals tended to coincide with the rate of sideshoot emergence and development which appears to be related to the amount of growth taking place. Only slight chlorosis on regrowth was observed when glyphosate was applied at the normal rates and the cane outgrew these effects within a few weeks. However, results showed that over-application must be avoided. There was no evidence to indicate that spraying in the early morning or late afternoon or delaying harvesting from six to ten weeks in the early and middle parts of the season or from three to six weeks late in the season had any effect on regrowth of the following ratoon crop.

For an investment of R30 per hectare, which includes both chemical (using the cost of Roundup as R20 per hectare) and application (R10 per hectare), there was a probable net return of about R134 as a result of the estimated 1,3 tons sucrose per hectare increase in yield (assuming 1 ton sucrose is worth R103). It is evident that mill returns are showing

the expected response to glyphosate, despite the large variability which exists within a field.

The commercial evaluation of ripeners on this estate was made easier due to the uniform conditions of soil and topography which exist, conditions which are not the normal in the rainfed regions of the industry.

Conclusion

Glyphosates are playing a major role in increasing profitability and assisting management. An aspect which is being carefully monitored is the possibility of an effect on the following untreated ratoon crop.

Acknowledgements

The author would like to thank Mr. E. W. Millard of Monsanto for supplying the glyphosate and conducting the field trials; the staff of the South African Sugar Association Experiment Station for assistance and analyses; and Messrs. C. Rautenbach (Rautenbach and Sons) and P. C. Wise (Technical Spraying Services) for applying the chemical.