RESIDUAL EFFECT OF GLYPHOSATE AS A RIPENER ON SUGARCANE

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Abstract

The effect of a low dosage of glyphosate in raising the juice purity and sucrose content of unstressed sugarcane stalks is well documented. The residual effect of the ripener on the succeeding crop of cane grown under favourable conditions has been shown to be short-lived, seldom influencing yields. The low residual activity of glyphosate was confirmed in several trials grown under optimum moisture conditions. In one large trial in which three successive crops were sprayed no evidence of a residual effect on yield was found. Yields were, however, increased considerably by the ripening effect of glyphosate. In three rainfed trials affected by drought, yields were reduced by 11 to 17% due to the application of glyphosate on the preceding crop. The decrease in yield in some varieties was much greater than in others. Varietal differences could be attributed to the different sensitivities of varieties to drought rather than to glyphosate *per se*. It is recommended that glyphosate be used only where cane is not stressed or likely to be stressed between the time of spraying and harvesting.

Introduction

When glyphosate is applied to leaves of sugarcane to promote natural ripening, it sometimes affects the subsequent ratoon crop to some extent. This so called residual effect of glyphosate has been studied by Clowes[1], Tianco and Gonzales[7], and Mills[5].

These authors generally agreed that the residual effect of glyphosate was likely to increase tillering, retard stalk elongation slightly and cause a certain amount of leaf chlorosis in the young crop. These effects usually disappeared in about six months and there was usually no measurable effect on cane or sucrose yields at the time of harvesting. This was true even when the amount of glyphosate applied was considerably higher than the amount recommended.

However Clowes and Inman-Bamber[3] indicated that some varieties appeared to be more susceptible than others to the post-harvest effect of glyphosate. N52/219 and N8 were noted as susceptible varieties. For this reason there is a need to study the residual effects of glyphosate on different varieties, particularly because glyphosate is known to kill sugarcane when sprayed at 10 times the ripening dosage.

This paper is a review of the data obtained from ratoon crops of trials that were conducted to assess the effects of glyphosate as a ripener (Clowes & Inman-Bamber[3]). The results of a large experiment at Pongola, where three successive crops were ripened, are also reported.

Both commercial sources of glyphosate, MON 8000 (now Polado) and Roundup, were used.

Method

Details of the small plot experiments under review are given in Table 1. Trials 1, 2 and 4 were irrigated and trial 3 was rainfed but received adequate water during the ratoon following ripener application. The variety in trials 1 to 4 was NCo 376. Trials 5 to 8 were rainfed and the sprayed crop as well as the subsequent ratoon crops were stressed at various stages. These four crops received respectively 78%, 91%, 95% and 73% of the longterm mean rainfall for the sites on which they were carried out.

The height of the topmost dewlap of any 20 stalks in each plot as well as the number of stalks in one row per plot, were recorded monthly in all trials except trial 4. A sprayed net plot consisted of two 8 m rows while the un-

TABLE 1
Details of small plot trials with glyphosate as a ripener to assess the residual effect

Tr.	Sprayed crop	Site	Soil series	Clay %	Degrees of water stress		Age of crop at spraying (months)	Date of spraying	Rate of chemical kg ae/ha	Interval between spray & harvest	Juice purity % at spraying	Suc. % cane response to ripener in prev. crop	Age of crop at harvest (months)
					At spraying	Following ratoon							
1	R3	Shakas-kraal (I)	Waldene	>30	Nil	Nil	8,0	28 Apr	0,6	19 weeks	70	1,6†	9,6
2	R4	Shakas-kraal (I)	Waldene	>30	Nil	Nil	11,0	30 Jun	0,6	9 weeks	84	1,1*	9,6
3	P	Umfolozi (R)	Dundee	10	Nil	Nil	10,2	25 Sep	0,3	6 weeks	84	1,3	10,6
4	P	Pongola (I)	Shorrocks	23	Nil	Nil	12,0	25 Mar	0,3	6 weeks	66	0,9	12,5
5	P	Mtunzini (R)	Shortlands	58	severe	severe	11,0	9 Sep	0,4	8 weeks	90	1,2†	17,6
6	P	Umdloti (R)	Joubertina	4	moderate	severe	12,0	16 Oct	0,4	5 weeks	92	1,4†	18,3
7	P	Paddock (R)	Longlands	12	moderate	moderate	11,0	9 Oct	0,4	5 weeks	91	1,8*	18,1
8	P	Nyalazi (R)	Dundee	16	moderate	moderate	12,0	25 Sept	0,3	6 weeks	90	1,8*	11,8

I = irrigated
R = dryland
* (P = 0,05)
† (P = 0,01)

sprayed control net plots were two rows wide in trials 1 and 2, and four rows wide in trials 3 to 8. The yields of the net plots were determined at the time of harvesting. Twelve stalks were taken from each plot to determine the contents of dry matter, brix and sucrose.

Details of the large trial with NCo 376 at Pongola on a deep clay soil of the Shorrocks series are given in Table 2. Each of 16 plots in this trial consisted of an irrigation block 220 m long and 12 rows wide. In the plant and subsequent two ratoon crops eight plots were sprayed with glyphosate at the rates given in Table 2. A total of 70*l* of spray solution per hectare was appied through two TK 1,0 floodjets mounted, one above each of two adjacent rows, on a hand-held boom which was connected to a knapsack sprayer operated at a pressure of 200 kPa. The mass and quality of the cane from each block was determined at the mill. Brix and sucrose contents of the cane were also determined in samples of 16 stalks taken from each block.

TABLE 2

Details of the large plot trial at Pongola where glyphosate was sprayed on three successive crops of NCo 376

Crop	Age at time of spraying (months)	Kg a.e. of chemical used per ha	Interval between spraying & harvesting (weeks)	Age at harvest (months)
P	10	0,38	12	13
1R	10	0,25	9	12
2R	10	0,35	8	12

Results

Well-watered trials with variety NCo 376 (Trials 1 to 4)

The visible effects of glyphosate on stalk height in two of the well-watered trials (2 and 3) had disappeared after two months of growth (Table 3). In trial 1 at Shakaskraal the residual effect was still evident in the height of the stalks at the time of harvesting and the cane yield from treated rows was significantly lower (P = 0,05) than that from untreated rows but the residual effect on sucrose yield was not statistically significant. The decrease in cane and sucrose yields due to the application of ripener on the previous crop in trial 4 was small and not statistically significant.

Rainfed, stressed trials with eight varieties (Trials 5 to 8)

Good responses to ripener were achieved in these trials despite the dry conditions at some sites during the ripening period. The subsequent ratoon crops were stressed to varying degrees.

Stalks in rows that had received ripener were usually shorter than stalks in untreated rows throughout the duration of succeeding ratoon crops although the differences narrowed as the crops aged (Figure 1). Cane and sucrose yields in three of the trials (5, 7 and 8) were significantly lower in treated rows than in control rows (Table 4). The loss in yield of cane and sucrose due to the application of ripener varied from 11 to 17%. A small yield loss of about 5% was observed in the rainfed trial at Umhloti (trial 6) but this effect was not statistically significant.

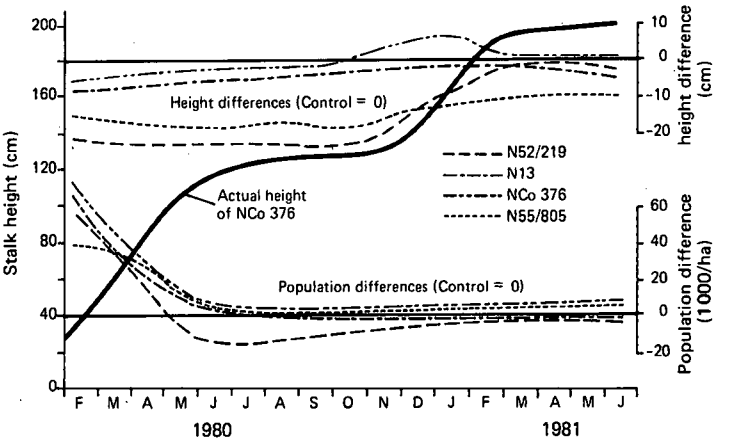

FIGURE 1 Average differences of stalk heights and populations between control cane rows and cane rows sprayed with glyphosate in the preceding crop for four varieties in trial 7.

In the trails where the residual effects were greatest (trials 5 and 8), the interactions between residual effects and varieties were statistically significant. The residual effect in trial 5 at Mtunzini was particularly severe on the cane and sucrose yield of NCo 376 and the sucrose yield of N12. NCo 376 was also more severely affected than the other varieties in trial 8 at Nyalazi. N55/805 appeared to be affected more than the other varieties at Umhloti and Paddock (trials 6 and 7).

Although the greatest decreases in yield observed at the time of harvesting were sometimes associated with the most severe stunting in the young crop, the coefficients of correlation between yield decrease and height decrease recorded at various ages were not high. The best indication of the extent to which yield was affected by residual activity of glyphosate, was the reduction in height recorded when the crops were six to seven months old. The residual effects of glyphosate on the stalk heights of younger cane and on stalk populations up to seven months were not significantly related to the residual effects on cane or sucrose yield. The probability of a decrease in yield at the time of harvest of cane that is still shorter than untreated cane six months after harvesting the sprayed crop is therefore high. The effect of shading on the treated rows by the taller untreated rows is not known but it is not considered great

TABLE 3

The percentage reductions in stalk heights, stalk populations, cane yields and sucrose yields due to the residual effects of glyphosate, and the mean yields of cane and sucrose from the treated plots of NCo 376 in trials 1-4

Trial	Stalk height %		Population %		Cane yield		Sucrose yield	
	2 months	6 months	2 months	6 months	Mean t/ha	% control	Mean t/ha	% control
1	−12	−7	−2	−3	106	−12*	13,7	−4
2	−1	0	+4	+6	103	−4	12,8	−7
3	+9	+3	−1	+3	120	−3	13,4	0
4	—	—	—	—	162	−2	16,8	−5

* (P = 0,05)

TABLE 4

The percentage reductions in cane and sucrose yields of eight varieties due to the residual effects of glyphosate, and the mean yields from treated plots in trials 5-8

Trial No.	Yields	NCo 376	N55/805	N52/219	J59/3	N8	N11	N12	N13	Mean	Mean yield t/ha
5	Cane	−27*		−14*	− 9		− 9	− 9*	−12*	−15**	72
	Sucrose	−35*		− 9	−13		− 3	−30*	− 5	−16**	5,1
6	Cane	− 9	−12			− 9	+ 4	+ 4	−16	− 6	106
	Sucrose	− 3	−14			− 5	− 1	− 1	− 7	− 5	12,9
7	Cane	− 6	−21*	−15*			− 2	−12*	−12*	−12**	122
	Sucrose	− 9	−21*	− 8			− 2	−14*	−14*	−11**	15,7
8	Cane	−29*	−12			−19*			−14*	−17**	93
	Sucrose	−29*	−15			−19*			−12	−17**	10,1

* (P = 0,05)
** (P = 0,01)

TABLE 5

Effect of glyphosate appled to ripen three successive crops of NCo 376 at Pongola

Crop	Juice purity %		Sucrose content %		Cane yield t/ha		Sucrose yield t/ha		Total increase in yield t suc/ha
	Control	Treated	Control	Treated	Control	Treated	Control	Treated	
P	78,7	82,4	11,9	13,4	157	155	18,7	20,8	2,1
1R	80,6	84,6	11,9	14,6	155	156	18,4	22,9	4,5
2R	79,8	83,7	11,0	13,2	148	144	16,1	19,0	2,9
Mean..	79,7	83,5	11,6	13,7	153	152	17,7	20,9	3,2

because height differences were usually less than 2 00 mm, and the row spacing was greater than 1,0 m.

The results of the large trial at Pongola are shown in Table 5. The combined effects of three annual applications of glyphosate on the cane yield of the second ratoon was very small. There was a marked increase in sucrose content and hence in sucrose yield due to treatment with the ripener on the second ratoon crop. The three applications of ripener resulted in a total additional 9,5 tons of sucrose per hectare.

Discussion

The results confirm previous observations (Clowes[1], Mills[5], Tianco and Gonzales[7]) that glyphosate sprayed on well grown cane at the recommended time and rate has little effect on the subsequent ratoon. The small residual effects that have sometimes occurred during these conditions have been offset by a considerable increase in sucrose yield due to the ripening effect of glyphosate. The results of the large trial at Pongola illustrate this.

The use of glyphosate on cane that is stressed in some way has not been recommended in the past because responses to treatment with ripener in such conditions have been erratic. It is now clear that even if responses are obtained, the detrimental effect on the subsequent ratoon may be important. Only the effects of stress due to a water deficiency have been considered here but the conclusions should be applicable to other types of stress as well.

The particularly severe residual effects of glyphosate on NCo 376 in two of the trials may be associated with the high sensitivity of this variety to drought.

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