DEVELOPMENTS FOR IMPROVED CHEMICAL CANE ERADICATION

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Abstract

Sugarcane killing practices often result in inadequate eradication of the old crop. Techniques aimed at improving the efficacy of chemicals are therefore being researched. Results from a series of trials have shown that mechanical or hand slashing of ratoon cane suppresses apical dominance and generally enhances chemical cane killing action on the regrowth. Slashing before spraying proved to be particularly effective on cane treated later with Fusilade Super. There were further dramatic improvements in efficacy when spraying was followed by shearing of the roots with a mechanical undercutter. This combination tillage technique has resulted in highly statistically significant improvements in cane mortality from half recommended rates of both Roundup (glyphosate 359 g/l) and Fusilade Super (fluazifop-p-butyl 125 g/l). Further research has shown that harvest to plant delays in minimum tillage may be reduced by using fully enclosed shields to direct chemicals on to old ratoon lines while providing protection to adjacent plant cane. Roundup in this instance was the more suitable product.

Introduction

Minimum tillage has become an accepted and important practice in crop re-establishment in the South African sugar industry. About 12% of the total 91 969 ha included in the South African Sugar Association Field Record System survey for 1992 was established with minimum tillage (*Viljoen, personal communication). This practice is reported to reduce soil erosion, cultivation costs and pressure from weeds substantially, and is recommended for use on erodible soils and on steep lands (Iggo and Moberly, 1976).

Disadvantages of the system may include insufficient chemical cane killing efficacy early in the season, particularly on heavy soils, which may lead to regrowth of volunteers and necessitate physical removal (Butler, 1992). In addition, chemical eradication of cane is limited to periods of active growth and is climate dependent (Anon, 1992). In the absence of a sufficiently long fallow period, transfer of ratoon stunting disease (RSD) from ratoon volunteers to the plant crop is a threat (Bailey and Tough, 1992). Beside agronomic difficulties associated with minimum tillage, high rates of expensive products are necessary which result in greater economic risk.

For these reasons and because minimum tillage has an important role to play in soil conservation, research was directed towards improving the system.

Methods

Between 1989 and 1991, four field trials were established on ratoon cane, one being at Pongola under irrigation and three on dryland fields at Mount Edgecombe. The trial at Pongola was on a Hutton form soil and those at Mount Edgecombe were on Rensburg, Longlands and Arcadia form soils. Harvest dates ranged from late winter through to midsummer.

In an attempt to improve chemical efficacy, mechanical or hand slashing preceded spraying in three trials and hand slashing alone in one trial. In all instances an attempt was made to cut back or slash cane foliage to ground level. The interval from harvest to slashing depended on the rate of growth. Cane cut in July required approximately four months to regenerate fully, while only three to four weeks were required for summer cut cane. The mechanical operation was carried out with a tractor-mounted rotary slasher or with an industrial lawnmower, and hand operations were done with long handled cane knives. In all instances the cane was considered to have tillered fully at the time of slashing.

Chemical treatments were applied with a knapsack sprayer fitted with a green Albuz floodjet nozzle, that delivered approximately 300 l/ha at a pressure of 150 kPa. In two trials certain treatments were sprayed with a 'Beloot' shield (Figure 1) which is mounted on skids and equipped with two offset Albuz (green) floodjet nozzles fully enclosed in a domed plastic cover. The implement was pulled by the knapsack operator and resulted in considerable disturbance of the cane during spraying. Consequently chemical coverage of the target was improved.

FIGURE 1 'Beloot' shield

*BK Viljoen, Head Field Record System, SASEX

In two trials, direct comparisons of cane killing efficacy were made between Roundup and Fusilade Super. Rates ranged from 4 to 8 l/ha for Roundup (1 436 to 2 872 g a.i. glyphosate/ha) and 3 to 6 l/ha for Fusilade Super (375 to 750 g a.i. fluazifop-p-butyl/ha). Current registered rates for cane eradication by chemical treatment only, are 8-10 l/ha for Roundup and 6 l/ha for Fusilade Super.

The effects of mechanically undercutting cane stools after spraying were investigated in one trial that included three harvest periods from August through to December. This operation was described by Butler (1992) who referred to it as 'combination tillage'. Intervals between spraying and undercutting ranged from two to seven days. The operation was conducted with a tractor-mounted Howard single blade shear, with a horizontal cut of one metre at an operational depth of 100-150 mm below the soil surface (Butler, 1992). The implement caused minimal disturbance of the above-ground portion of the stools. Interactions between time of year, stool shearing (undercutting), cutting back, products, product rates and the effects of an enclosed shield were catered for in this trial.

Assessments of cane eradication efficacy were made by counting regenerated tillers and stools or calculating numbers of hoe units required per hectare. A hoe unit is defined as being a 250 mm length of cane row that requires a single hoe action to remove the cane regrowth, regardless of numbers of tillers present (Richardson *et al.*, 1985).

Results

Effects on chemical efficacy of cutting back ratoons before spraying

It was noted in three trials that different cane growth patterns resulted from hand and mechanical slashing. Mechanical slashing shattered the above-ground section of the cane stool, whereas hand slashing tended to be less damaging as stalks were cleanly severed. Primary tillers developed normally after mechanical slashing but were mostly absent following hand slashing. The latter treatment appeared to cause a greater suppression of apical dominance. Tiller population counts in slashed plots just before spraying indicated a general decline in numbers compared with normally ratooned cane. This was about 14% fewer tillers in one trial. Stalk heights were also reduced in slashed plots. Slashing was carried out in November in the three trials with regrowth sprayed four to six weeks later. Roundup was applied in all trials and Fusilade Super was included in one trial only.

Both methods of slashing back generally resulted in marked improvements in cane mortality compared with the non-slashed treatments. However, improvements were variable, with increases in mortality ranging from 9% to 94% above non-slashed controls. Mechanical slashing appeared on average to enhance chemical efficacy slightly more than hand slashing, particularly with Roundup. In one trial the influence of hand slashing was assessed for both chemicals over three harvest dates. Figure 2 shows the slashing effect on product efficacy with reductions in hoe units plotted below, and increases above equivalent non-slashed treatments (plotted at zero). Efficacy of 4 l/ha of Roundup was not affected for the August and December harvested cane, but was significantly improved for cane cut in October and sprayed in December. This may have been associated with more favourable weather conditions for the December spraying. Table 1 shows the different weather conditions on the three spray dates. The December spraying was conducted in sunny warm conditions, whereas on the other two days the weather was overcast. In November and January, 7,5 mm of rain fell within one day of spraying, whereas only 0,1 mm was recorded three days after spraying in December.

Table 1

Weather conditions on three spray dates

Weather criteria	Spray date		
	18th November	17th December	30th January
General	Overcast	Sunny	Overcast
Sunshine hours	3,6	9,8	0,1
Rainfall on spray date	Nil	Nil	Nil
Number of days to first rain	1	3	1
Millimetres of rain at first rain	7,5	0,1	7,5

Results for cane treated with the standard 8 l/ha of Roundup, showed a trend for improved efficacy from slashing, from the cooler to the warmer months. Slashing greatly improved cane killing efficacy for both rates of Fusilade Super irrespective of season (Figure 2).

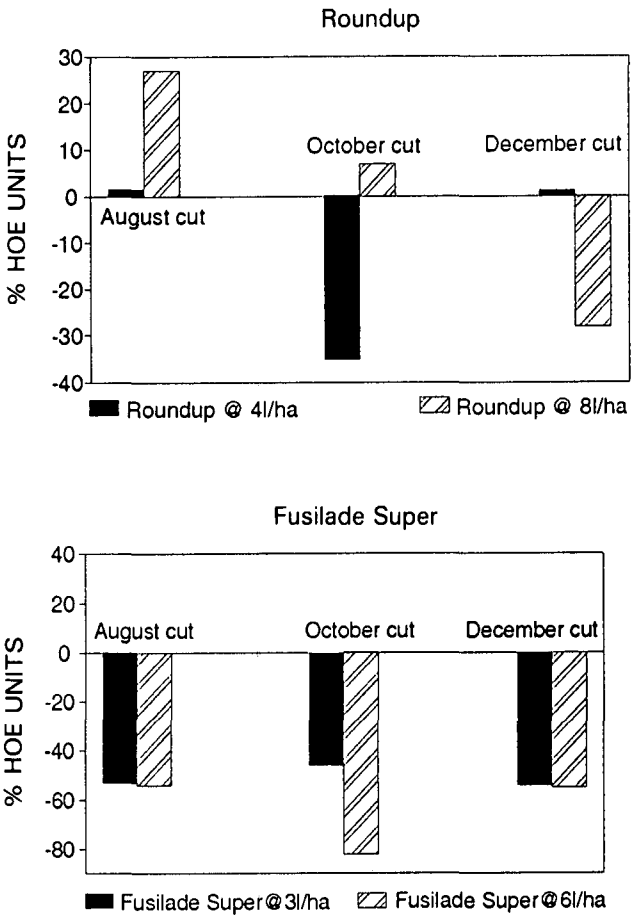

FIGURE 2 Effect of slashing on hoe units expressed as a percentage of equivalent non-slashed treatments.

Effects on chemical efficacy of the 'Beloot' drag shield

Both Roundup and Fusilade Super were included in the two trials where the Beloot shield was used. The design of the implement resulted in considerable disturbance of the cane foliage and chemical coverage of the leaves was improved.

Trial 1. This trial was designed to investigate reducing harvest to plant delays in minimum tillage systems. Cane was planted in the old ratoon interrows soon after harvesting and the two crops were allowed to germinate simultaneously. Treatments were applied with the Beloot shield to protect the plant crop. The benefits of both hand and mechanical slashing were also assessed. Spraying of the old ratoon started in late November, 10 weeks after planting when the height of the plant crop was approximately 25 cm to the top visible dewlap (TVD). The spraying was done in gusty conditions, but the chemical was confined in the shield and there was no evidence of primary drift. Early post-spray ratings showed extreme phytotoxicity to plant cane growing in plots where the ratoon crop was treated with 6 l/ha of Fusilade Super. These symptoms persisted and reductions in stalk heights, populations and yields of the plant crop were still present 12 months after spraying (Table 2). Cane and sucrose yield losses for Fusilade Super treatments were all significantly lower (P=0,05 and P=0,01) compared with equivalent Roundup treatments.

Statistically significant differences in cane yield were recorded between plant cane grown alongside normally ratooned cane which had been eradicated with Fusilade Super and plant cane grown alongside mechanically slashed Fusilade Super treated cane. It is probable that the normally ratooned cane presented a bigger leaf surface area, which afforded greater chemical volatilization. Visual phytotoxicity symptoms from Roundup were absent in both the plant cane in the experiment and in the adjacent commercial cane.

Trial 2. In this trial, direct comparisons were made between Roundup and Fusilade Super efficacy. Efficacy comparisons were also made for cane sprayed with a hand lance and that sprayed with the enclosed shield. Both standard and half rates of Roundup and Fusilade Super were applied to cane cut in August, October and December. The shield effect on Roundup efficacy was positive while decreases in efficacy were recorded for some Fusilade Super treatments (Table 3). There appeared to be a significant increase in efficacy from 6 l/ha of Fusilade Super applied with the Beloot for the late harvested cane only. At no stage was the efficacy of 4 l/ha of Roundup applied with the shield greater than that of the conventionally sprayed standard 8 l/ha Roundup treatment. Increases in efficacy from Roundup with this implement tended to decrease as spraying continued into the warmer months (Table 3).

Effects on chemical efficacy of combination tillage

The effects of undercutting cane roots after spraying was assessed in one trial that included cane harvested in August, October and December, and sprayed in November, December and January respectively. Undercutting started seven days after the November spraying, two days after the December spraying and six days after the January spraying.

In all instances the benefits from the operation were dramatic. Average effects on regrowth from undercutting for standard rates of Roundup and Fusilade Super, half rates of the two products, as well as the non-sprayed undercut control, are compared with equivalent non-undercut treatments

Table 2

Treatment effects on stalk heights (cm to TVD), populations (× 1 000/ha) and plant cane yield 12 months after spraying

Treatment	Rate l/ha	Stalk height	Stalk pops.	Cane yield (t/ha)	Sucrose % cane	Sucrose yield (t/ha)
Roundup	8	167	80	51	11,5	5,9
Hand slash + Roundup	8	172	87	58	11,9	7,0
Mechanical slash + Roundup	8	169	84	56	12,2	6,8
Fusilade Super	6	149	69	39	11,8	4,6
Hand slash + Fusilade Super	6	156	78	46	11,1	5,1
Mechanical slash + Fusilade Super	6	160	78	48	11,5	5,5
CV%				13,7	5,2	15,5
Standard error - Treatment means ±				2,8	0,2	0,4
LSD (0,05)				8,0	0,7	1,1
LSD (0,01)				11,0	1,0	1,4

Table 3

Effects on efficacy in hoe units (× 1 000/ha) from the 'Beloot' drag shield compared with cane sprayed conventionally (percentage differences shown in brackets)

Treatment	Rate (l/ha)	August (sprayed November)		October harvest (sprayed December)		December harvest (sprayed January)	
Roundup	4	24,0		15,6		22,1	
Roundup + shield	4	13,6	(+43%)	8,4	(+46%)	17,9	(+19%)
Roundup	8	8,4		5,8		9,1	
Roundup + shield	8	2,3	(+73%)	3,6	(+38%)	8,8	(+3%)
Fusilade Super	3	8,4		14,0		23,4	
Fusilade Super + shield	3	8,4	(0%)	16,6	(−19%)	24,0	(−3%)
Fusilade Super	6	4,2		10,7		17,9	
Fusilade Super + shield	6	8,8	(−110%)	9,7	(+9%)	9,7	(+46%)

in Table 4. The operation resulted in significant (P=0,01) reductions in hoe units in all cases.

Table 4

Overall effect of root undercutting on hoe units (× 1 000/ha) for cane cut in August, October and December

Treatment	August cut (sprayed/ undercut) November	October cut (sprayed/ undercut) December	December cut (sprayed/ undercut January
No undercutting	8,41	8,00	14,15
Root undercutting	1,64 (80)*	1,51 (81)*	1,60 (89)*
CV %	43,0	58,0	26,0
LSD (0.05)	1,4 (80)*	1,9 (81)*	2,3 (89)*
LSD (0.01)	1,9 (80)*	2,5 (81)*	3,1 (89)*

* = percentage improvement

Figure 3 shows the increases in cane mortality from root undercutting for each chemical compared with the standard non-undercut 8 l/ha Roundup treatment. Undercut treatments are represented by the dark shaded columns, nearly all of which show a significant reduction in required hoe units compared with the 8 l/ha Roundup standard (plotted at zero).

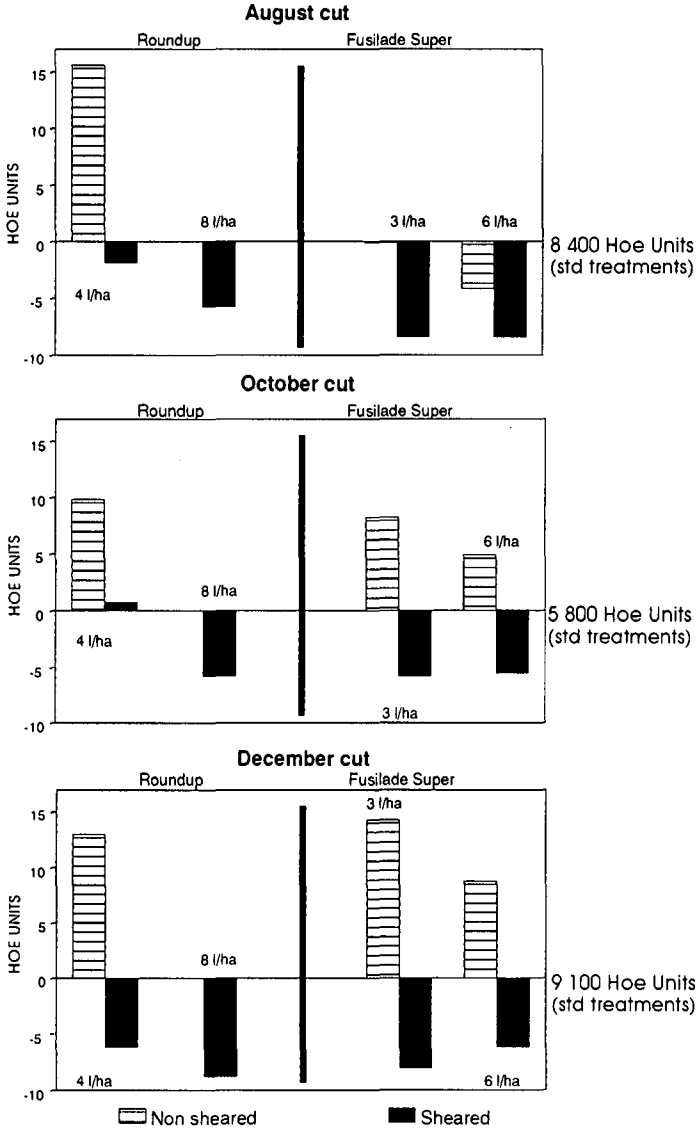

FIGURE 3 Effect of root undercutting on hoe units (× 1 000/ha) compared with the non-undercut 8ℓ/ha Roundup standard (plotted at zero).

Cane mortality from 4 l/ha of Roundup increased significantly with root undercutting to equal or excel that achieved by the standard treatment. Cane eradication from 8 l/ha of Roundup applied in combination with root undercutting was very much higher than that of the non-undercut standard. The effect of the operation on efficacy of 8 l/ha Roundup appeared to be greater for the December cut cane, which was sprayed in late January and undercut in early February. This was about 8 500 fewer hoe units than the standard (Figure 3). However, this trend did not apply to the October cut cane as the undercutting effect appeared to be less than that for the August cut crop. This may have been due to insufficient chemical translocation resulting from the shorter two day spray to undercut delay for the October harvested cane.

The non-undercut Fusilade Super treatments were very effective on August cut cane where both rates compared favourably with the standard (Figure 3). Thereafter both rates were inferior to the standard. Undercutting significantly improved the performance of both rates of this product at all three stages. It is important to note that 3 l/ha of Fusilade Super proved more effective than the standard at all stages, when used in conjunction with root undercutting.

Comparisons between Roundup and Fusilade Super for cane eradication

Direct comparisons for cane killing efficacy between Roundup and Fusilade Super were drawn from two trials. Results for both trials were compared for conventionally applied treatments to discount interactions from cutting back, root undercutting and the use of shields. Standard registered rates of 8 l/ha of Roundup and 6 l/ha of Fusilade Super were used in one trial while the standard and half the standard rates were included in the second trial. Where only the standard rates were used, 6 l/ha of Fusilade Super sprayed in November onto September harvested cane resulted in a 49% decrease in hoe units compared with 8 l/ha of Roundup.

Figure 4 shows results for the second trial that included both rates of the products applied over three cutting cycles. Negative results represent fewer hoe units and therefore improved cane killing efficacy compared with the 8 l/ha Roundup standard (plotted at zero). At no stage was half the standard rate of Roundup comparable to the standard

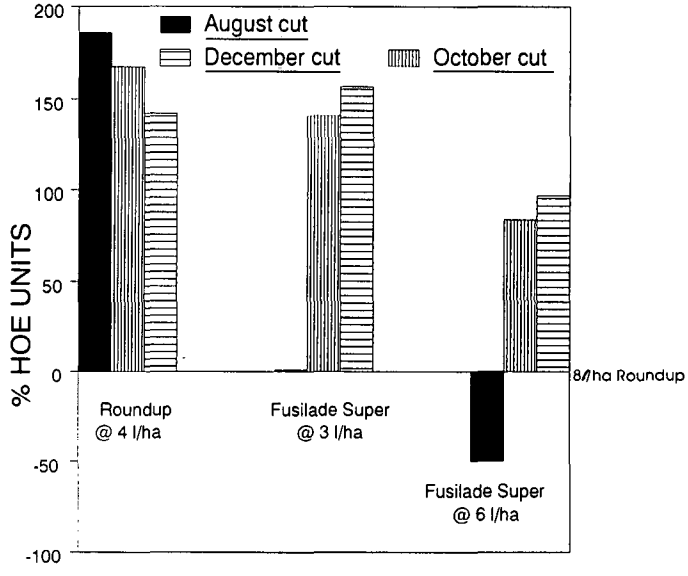

FIGURE 4 Effect on percentage hoe units compared with the standard.

8 l/ha treatment. Three l/ha of Fusilade Super provided similar levels of eradication to the standard for an August cut crop sprayed in mid November but, compared with the standard efficacy, declined thereafter. The recommended 6 l/ha rate of Fusilade Super was significantly superior to the Roundup standard for cane cut in August and sprayed in November, but was far less effective on the December and January sprayed cane (Figure 4).

Discussion

It is evident from the results that certain practices offer significant potential for improving chemical cane eradication.

Slashing back cane foliage before spraying generally enhanced chemical efficacy. Slashing back, particularly by mechanical methods, improved Roundup efficacy more in the hotter summer months. Improvements to Fusilade Super efficacy were significant at all stages and did not appear to be dependent on climate. It appears that slashing generally suppresses apical dominance, making the cane stool more susceptible to chemical damage.

Benefits to chemical cane killing from the use of the Beloot shield were variable for Fusilade Super, but were consistently better with Roundup. One possible explanation is that wider cane stools were trampled by the implement and inadequately covered with chemical, but that this may have been compensated for by better Roundup translocation compared with Fusilade Super. Disturbance of the cane foliage may have provided benefits similar to those achieved by split applications of Roundup reported by Chedzey and Findlay (1985). Increased glyphosate coverage and efficacy by physical disturbance of the plant was also reported from Australia (Anon. 1990).

The concept of minimising harvest to plant delays with the Beloot shield is feasible in minimum tillage. However, there is a danger of RSD transfer from the ratoon to the plant crop as the causal bacterium can survive for a number of months after harvesting (Bailey and Tough, 1992). It would be necessary therefore to ensure that the old ratoon is RSD free before applying this technique. This method of crop re-establishment would represent a significant saving in time, leading to increased profits compared with conventional methods (de Robillard, 1982). At present Roundup would be the only product to consider with this technique, because unacceptable damage to the plant crop resulted from Fusilade Super. Routes of chemical transfer were via the soil into the roots and from the sprayed rows to the plant cane leaves by volatilization. Volatility of Fusilade Super is a serious limiting factor, as damage occurred in adjacent tall cane growing about 8 m from the treated plots.

There is strong evidence that registered and half registered rates of Fusilade Super, applied conventionally onto normally ratooning cane, are capable of improved eradication compared with 8 l/ha Roundup. Improvements however appear to be restricted to cane sprayed before the onset of hot summer conditions.

Root undercutting resulted in highly significant increases in the efficacy of chemical cane killing, and results corroborate closely with those reported by Butler (1992). In all cases improvements from root undercutting overshadowed gains from other operations. Acceptable kill was achieved with half rates of Roundup and Fusilade Super, while root undercutting would greatly lessen the risk of regrowth when standard rates are applied. Table 5 shows the economic possibilities of eradicating cane with half recommended rates of chemicals in combination tillage. (Roundup at 4 l/ha is now registered for cane eradication with combination tillage). The full economic advantages of combination tillage with half chemical rates are not shown, but would include further savings on labour or chemicals due to lower volunteer pressure (see also Figure 3).

Table 5

Approximate cost (Rands) of registered rates of Roundup and Fusilade Super compared with half rates in combination with root undercutting

	Roundup		Fusilade Super	
	4 l/ha	8 l/ha	3 l/ha	6 l/ha
Chemical cost/ha	172	344	215	430
Undercutting cost/ha	106	-	106	-
Total	R278	R344	R321	R430

Note: Chemical application costs not included.
Chemical costs based on October 1992 list price.
Undercutting cost included that of implement (R4 500) based on undercutting ± 20 ha/annum (*E, Meyer, personal communication).

Conclusions

The practice of undercutting chemically treated cane roots is highly recommended and should be considered before other techniques. In the absence of root undercutting, slashing back the cane should precede spraying, particularly with Fusilade Super. The Beloot shield maximises chemical coverage of the foliage and increases efficacy, particularly with Roundup. Combinations of the best treatments for each situation would provide optimum kill. The Beloot was also found to be suitable for use in reducing harvest to plant delays, where the ratoon to be eradicated grows alongside germinated plant cane. The choice of chemical should in this case be Roundup, and the ratoon classified RSD free. Where conventional spraying is conducted on to normally ratooning cane, 6 l/ha of Fusilade Super is the better choice for spring eradication but 8 l/ha of Roundup appears to be the better treatment thereafter.

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