RECENT RESEARCH FINDINGS FOR IMPROVED CONTROL OF SOME CREEPING GRASS SPECIES IN SUGARCANE FIELDS IN SOUTH AFRICA

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Abstract

Perennial creeping grasses such as *Cynodon dactylon* are of major concern in the South African sugarcane industry, and investigations to establish optimum control measures for these species have been given high priority. Research results showed that herbicides with a base of glyphosate (isopropylamine salt of glyphosate) or sulfosate (trimesium salt of glyphosate) produced consistent acceptable kill ratings for *Cynodon* spp., and products such as MSMA (720 g/ℓ monosodium methane arsenate) and TCA (960 g/kg sodium trichloroacetate) in combination controlled *Digitaria abyssinica.* The *Cynodon* species investigated included *C. dactylon* and *C. plectostachyus*, the former being both stoloniferous and rhizomatous and the latter stoloniferous only. *D. abyssinica* is a rhizomatous species (Gibbs Russell *et al.*, 1991) Different application techniques such as controlled droplet applicators were compared with the conventional manually operated knapsack sprayers. In addition, certain physical operations intended to enhance product efficacy were tested. These included rotavating or slashing, with herbicide application commencing after sufficient regrowth had occurred. Tests extended from early to late summer to determine seasonal influence on control measures. Trials were conducted in a semi-controlled environment as well as under fallow conditions, and in plant and ratoon cane fields. Results indicated that creeping grass control in sugarcane can be improved by making specific changes to current recommendations. Observations in heavily infested fields indicated that good grass control and minimal cane damage can be achieved by slashing cane and spraying the grass after a suitable period.

Introduction

It is generally agreed that rhizomatous and/or stoloniferous grasses are becoming more prevalent in the SA sugar industry. This may have been exacerbated by reduced competition from other herbicide sensitive weeds, and by drought conditions that favour more hardy species. Evidence from trials indicates that *Cynodon dactylon* thrives and becomes dominant in situations where competition is eliminated (Richard, 1992). This is also illustrated in Figure 1, which shows the invasive potential and domination of *C. dactylon* following good pre-emergence control of other competitors. In addition, the loss of cane canopy in dry conditions sanctions the survival of shade susceptible species such as *Cynodon dactylon.* It is of concern that the area infested with *C. dactylon* appears to be increasing at an alarming rate, particularly on sandy coastal soils. Correspondingly, the infestation of *Digitaria abyssinica* appears to be expanding on the heavier soils in the Natal midlands. Although it is difficult to estimate the total extent of the area infested and the influence this has on sugar production, it is accepted that these and other species are becoming a limiting factor to cane production in certain areas.

Due to the herbicide tolerance of these problem weeds, current recommendations are generally based on systemic non-selective products highly phytotoxic to sugarcane. Being non-selective, the use of these products is restricted to fallow fields or as spot spray treatments to eradicate localised grasses in cane. Where these grasses are rampant in emerged sugarcane, growers either hand weed or apply knockdown remedies such as Gramoxone (paraquat 200 g a.i./ℓ) plus diuron (diuron 800 g a.i./ℓ). Although these treatments are less damaging to the crop, control is only temporary.

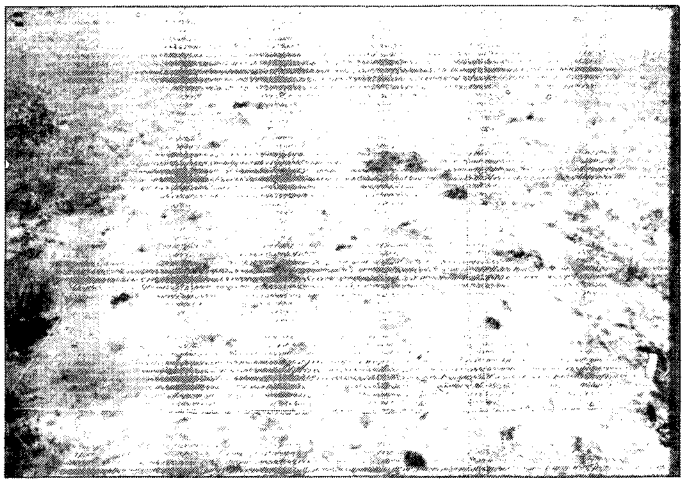

FIGURE 1 *Cynodon dactylon* colonisation after pre-emergence weed control of other weed competitors.

It is for this reason that research has been focused on alternative products and application techniques in the hope of reducing cane phytotoxicity from non-selective herbicides. Physical operations involving cutting back or chopping up and incorporating the biomass to eliminate apical dominance and stimulate bud germination, were investigated to determine whether weed control efficacy from systemic products could be improved. These operations would also reduce the translocation distance of chemicals in the plant. Field observations in cane smothered by creeping grass indicate that pre-slashing the crop and spraying the grass after a suitable period can be highly advantageous. This was also reported on by Landrey (1993).

Methods

Between 1990 and 1994, fourteen field trials were established on fallow as well as in ratoon and plant cane fields. *C. dactylon* trials were generally sited on sandy soils with clay contents ranging from 6-10%. The majority of trials established on *C. plectostachyus and D. abyssinica* were on soils with clay contents ranging from 30-59%. Except for a few *C. dactylon* trials sprayed during autumn, the majority were sprayed during the summer months from October to January.

In certain experiments, an attempt was made to improve chemical efficacy by manually cutting back the grass and treating fresh regrowth. Other treatments included digging-in by hoe or mechanically rotavating or discing to segment and bury rhizomes and stolons. Spraying in all cases commenced when sufficient regrowth had occurred. In one trial, mechanical rotavation was used to incorporate Eptam Super [720 g/ℓ EPTC (thiocarbamate)] as a pre-emergence treatment.

Spray equipment used included a hydraulic knapsack sprayer fitted with either a TK 1.5 or Albuz (green) floodjet nozzle, operating at 1,0 and 1,5 kPa and delivering 100 and 290 ℓ/ha respectively. Other equipment tested included the Herbi 4 and the Nomix Precision Pro battery driven, spinning disc, controlled droplet applicators (CDA). Shields were used in some trials, and spray nozzles were unprotected in others. Shields tested included the 'Beloot' drag type shield (Figure 2a), the 'Brazilian' lance mounted shield (Figure 2b) and a prototype designed for crop protection from herbicide applied with a CDA (Figure 2c).

Trials were conducted in both fallow and sugarcane fields. Plot sizes were 2,5 m × 8 m (20 m²) and on average four replications were included. In each case only sites with heavy and uniform grass cover were selected. Further investigations were carried out under semi-controlled conditions, where grass was grown in 0,90 m × 18,0 m strips of soil between permanent concrete pathways. In the strip trials, physical treatments were carried out along the length of each strip and chemical treatments were sprayed across the strips.

FIGURE 2a 'Beloot' drag type shield.

FIGURE 2b 'Brazilian' lance mounted shield.

FIGURE 2c SASEX prototype CDA shield.

Some small scale field observations were also conducted to corroborate trial results and to investigate certain treatments that were not included in the trials. These included a study into the cutting back to ground level of cane heavily infested with *C. plectostachyus*, and then spraying the grass 24 hours later.

Results

Cynodon dactylon

Weed control efficacy of different non-glyphosate herbicides on Cynodon dactylon

Eleven herbicides were tested individually or in mixtures on *C. dactylon* and the results compared with a standard glyphosate treatment (Table 1).

Table 1

Weed control efficacy on *Cynodon dactylon* expressed as a percentage of kill achieved with 6 ℓ/ha of Roundup ±6-7 weeks after spraying (five weeks after Gramoxone application in split treatment)

Treatment	Rate ℓ/ha or kg/ha	Percentage kill compared with Roundup
Gramoxone + diuron	2,5 + 2	29
Velpar + diuron	2,5 + 2	5
TCA	20	47
Dalapon + Rev 10	10 + 1	65
Dalapon + Gramoxone	12 + 2,5	11
Dalapon + Gramoxone (split)	12 / 2,5	93
Combine + MSMA + Armoblen 650	2 + 3 + 0,45	9
Eptam Super *	10	53
MSMA + TCA	4 + 15	5
Impi + MSMA	3,33 + 4	2
ICIA 0179 + MSMA	1 + 4	3
ICIA 0179 + MSMA + TCA	1 + 4 + 15	7
Agil + Citrex	4 + 1	91

* applied pre-emergence

None of the products provided permanent long term control of *C. dactylon*, and the majority resulted only in mild phytotoxic symptoms 6-7 weeks after spraying (Table 1). Landrey (1993) also recorded poor control of this species with Velpar, diuron, Gramoxone and MSMA. Particularly poor responses resulted from TCA applied alone, Velpar (240 g/ℓ hexazinone) + diuron and Combine (500 g/ℓ tebuthiuron) + MSMA + Armoblen 650 (adjuvant). Early efficacy symptoms were good from ICIA 0179 (coded product) + MSMA + TCA, Agil (240 g/ℓ propaquizafop) + Citrex (adjuvant), and the split Dalapon (850 g/kg proprop)/ Gramoxone treatments, but thereafter effects decreased rapidly. Although the average control recorded for incorporated EPTC was only moderate, variability in efficacy ranged from 20% to 98% and was related to the efficiency of the mechanical operation.

Weed control efficacy of different glyphosate herbicides on Cynodon dactylon

The new glyphosate based herbicides Stirrup (144 g/ℓ isopropylamine salt of glyphosate), Tumbleweed (360 g/ℓ isopropylamine salt of glyphosate) and Touchdown (720 g/ℓ trimesium salt of glyphosate) + Add-2 (adjuvant) were tested and compared with Roundup at 6 ℓ/ha. Split applications of half the recommended rates were compared with single sprays for both Roundup and Touchdown. Roundup was also tested with Sting (180 g/ℓ isopropylamine salt of glyphosate) at rates adjusted to supply the same level of active ingredient as that obtained from 6 ℓ/ha of Roundup. In addition, Roundup was included at the standard rate, applied as a low volume spray of 100 ℓ/ha. Table 2 shows the effects of these treatments on vigorously growing *C. dactylon* during summer.

There appears to be a slight advantage in using the recommended rates of Roundup applied in low water volumes and when applied in conjunction with Sting. However, there did not appear to be any merit in adding Armoblen 650 to Roundup. Excellent kill was recorded with Touchdown + Add-2, and in particular with Stirrup and Tumbleweed. However, no treatment gave permanent long term control. Split applications generally only improved length of control.

Table 2

Weed control efficacy of different glyphosate based products on *Cynodon dactylon*, expressed as percentage kill seven and 16 weeks after initial spraying

Treatment	Rate ℓ/ha or kg/ha	Percentage kill	
		7 wks	16 wks
Roundup	6	93	*
Roundup (low volume)	6	97	*
Roundup + Armoblem 650	6 + 0,3	91	*
Roundup (split)	(3) × 2	17	97
Roundup + Sting	4 + 4	97	*
Touchdown + Add-2	4 + 0,3	90	*
Touchdown + Add-2 (split)	(2 + 0,3) × 2	85	100
Tumbleweed	7,5	100	*
Stirrup (Nomix system)	10	100	*

* = control non-significant at this stage.

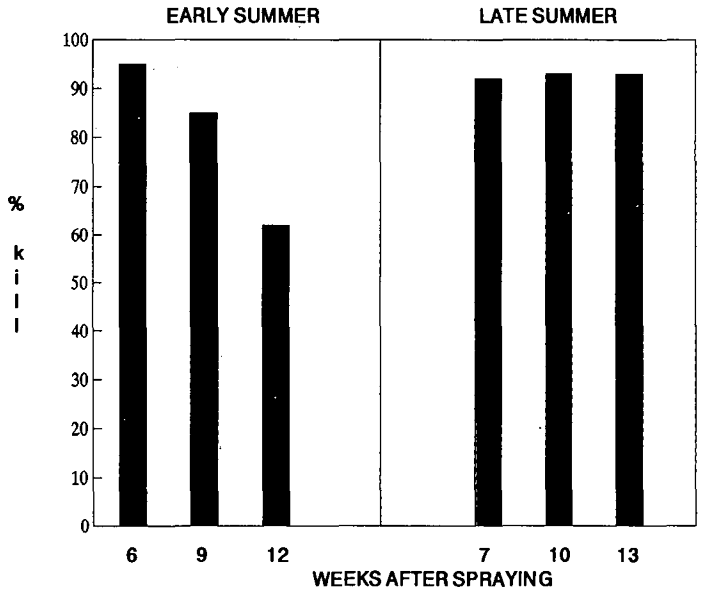

FIGURE 3 Efficacy of 6 ℓ/ha of Roundup when applied to *Cynodon dactylon* in early and late summer.

Differences in weed control efficacy of Roundup on Cynodon dactylon *when applied in early and late summer*

Two trials compared the influence of season on efficacy of 6 ℓ/ha of Roundup on *C. dactylon*. The trials were intended to verify claims made by other researchers that non-selective systemic products, such as glyphosate, provide greater efficacy when applied in late summer or autumn (Butler, 1992). One trial was sprayed in mid-December and the other was treated in mid-February. Figure 3 illustrates the weed control efficacy levels for 6 ℓ/ha of Roundup on *C. dactylon* in the two trials.

The trial sprayed in late summer resulted in permanent control of this species, and regrowth that occurred was insignificant. Rapid regrowth occurred seven weeks after spraying the earlier trial.

Effects of certain physical operations on the weed control efficacy of Roundup on Cynodon dactylon

Digging this grass in to reduce stolon and rhizome length resulted in variable but generally good improvements in efficacy. This occurred only in fallow situations, or when the cane had been completely overrun and the operation was conducted over the whole area. Improvements in kill ranged from 8-39%, with best results being obtained from Roundup + Sting. Where digging-in was confined to the interrow only, grass re-established from the cane lines. Approximately 14 man-days were required to manually dig-in one hectare.

Hand slashing or mechanical mowing also resulted in variable effects on efficacy of glyphosate products. It appears that an increase in kill of up to 20% can be obtained when the condition of the grass after cutting is vigorous and thus more susceptible to glyphosate, than when grass is left undisturbed to become moribund.

The use of shields to protect sugarcane when applying glyphosate products in the interrows

Shields to protect cane from glyphosate damage were tested on a limited scale in certain trials. Both the drag and lance attached shields (Figures 2a and 2b) provided adequate protection when used in plant cane. However, the extent of control was limited to interrows, and re-colonisation took place from the rows. Interesting results were achieved with the prototype shield designed for use with the Herbi 4 controlled droplet applicator (Figure 2c). Using this equipment in one observation, Buster (200 g/ℓ glufosinate-ammonium) was applied at a rate of 5 ℓ/ha of chemical in ±50 ℓ/ha water. Spraying was confined to the interrows of cane heavily infested with flowering *C. dactylon*. Although this rate caused severe scorch symptoms on the grass, the equipment provided adequate protection to the cane (Figure 4). Glyphosate was also applied with this equipment with minimal cane damage. This was due to the horizontal trajectory of the CDA spray pattern, which enables spraying to be conducted close to the ground. The design of the shield causes disturbance of the grass and improves coverage and efficacy (Anon, 1990). Similar observations have been made with the Nomix Precision Pro applicator ([1]English, personal communication).

[1] K English, Consultant, Nomix-Pajen

Cynodon plectostachyus

Trials were initially conducted in strips of soil planted to this grass and separated by concrete pathways. Physical operations such as digging-in or hoeing back were carried out on the entire strip length. Chemical treatments were then applied across the strips when sufficient regrowth had occurred.

Weed control efficacy of different non-glyphosate herbicides on Cynodon plectostachyus

Gallant (125 g/ℓ haloxyfop-ethoxyethyl), Dalapon, Gramoxone, Combine, Focus Ultra (100 g/ℓ cycloxydim) and MSMA proved to be ineffective on this grass species, as did different combinations of these products.

Weed control efficacy of different Roundup based treatments on Cynodon plectostachyus

In the soil/concrete panels, Roundup at 8 ℓ/ha was used as the standard and compared with a split Roundup application of 6 ℓ + 6 ℓ/ha, and a combination of 6 ℓ/ha Roundup and 3 ℓ/ha Armoblen 650. Regrowth at 21 weeks after application was unacceptable where Roundup at 8 ℓ/ha was applied to the undisturbed sections, and the addition of Armoblen 650 to Roundup did not improve efficacy sufficiently to compare with the standard. The split application of Roundup provided best control at ±3 weeks after the second spraying (Table 3). Similar trends were evident in the hoed-back sections and, although the Roundup + Armoblen 650

Table 3

The effects of different physical operations on percentage weed control efficacy of different Roundup based treatments on *Cynodon plectostachyus* 21 weeks after initial spraying

Treatment	Rate ℓ/ha	Percentage kill		
		Undisturbed	Hoed back	Dug in
Roundup	8	37	8	90
Roundup (split)	6 + 6	87	88	100
Roundup + Armoblen 650	6 + 0,3	25	40	90

treatment appeared to be superior to the standard, at no stage was it better than the initial 6 ℓ/ha of Roundup in the split treatment. Efficacy of all the Roundup treatments improved dramatically where the grass was previously dug-in to simulate discing or rotavating (Table 3). It appears that physically cutting up and burying stolons reduces apical dominance, promotes germination and decreases the distances required for chemical translocation.

Two field trials were established on ratoon cane heavily infested with *C. plectostachyus*. Sections were either dug in or left undisturbed and the hoed-back treatment was omitted. Roundup at 8 ℓ/ha applied in 290 ℓ/ha water was compared with Roundup + Sting at 6 ℓ + 4 ℓ/ha respectively, in 100 ℓ/ha water. Further treatments were applied using the Herbi 4 and Nomix controlled droplet applicators. These included Roundup + Sting applied in 20 ℓ/ha and 50 ℓ/ha water using the Herbi 4, and Stirrup applied with the Nomix applicator at 10 ℓ and 12 ℓ/ha. Digging-in before spraying was highly beneficial, particularly in one trial where increases in control ranged from 20 to 50%. Roundup at 8 ℓ/ha and, in particular, the Roundup + Sting combination, resulted in the best control up to 15 weeks after spraying. Inferior results were recorded from all CDA applications and appeared to be associated with reduced coverage, as the 50 ℓ/ha treatment significantly outperformed the 20 ℓ/ha treatment. Improved coverage would result from the use of shields or wire attachments designed to flatten the grass in front of the disc (1English, personal communication).

In one field observation, cane heavily infested with *C. plectostachyus* was cut back and the grass sprayed with a

FIGURE 4 Effects on *Cynodon dactylon* of 5 ℓ/ha of Buster applied through a Herbi 4 fitted with the SASEX prototype shield.

FIGURE 5 Effects of cutting-back ratoon cane and spraying *Cynodon plectostachyus* with glyphosate.

mixutre of 6 ℓ/ha Roundup + 4 ℓ/ha Sting. Spraying commenced 24 hours after the cutting-back operation. The results were promising, as the grass was well controlled and the cane did not appear to be adversely affected. Recovery of cane growth was exceptional and there was little evidence of herbicide phytotoxicity (Figure 5). Optimum time intervals between cutting back and spraying may vary with season and locality, and should be further investigated.

Digitaria abyssinica

Two trials were established on this species to test chemical weed control efficacy and the benefits of pre-discing. Gramoxone + Armoblen 650 at 3 ℓ and 0,6 ℓ/ha respectively, Focus Ultra at 3 ℓ/ha, Asulox (400 g/ℓ asulam) at 9 ℓ/ha and Fusilade Super (125 g/ℓ fluazifop-p-butyl) at 6 ℓ/ha all proved ineffective under both pre-disced and non-disced conditions.

Grass control was generally good from the remaining treatments that included Roundup with and without Armoblen 650 at 6 ℓ + 0,6 ℓ/ha respectively, TCA + MSMA at 15 kg + 4 ℓ/ha respectively, with and without Armoblen 650 or Nu-Film-17 (adjuvant), TCA + MSMA + diuron at 12,5 kg + 3 ℓ + 3 ℓ/ha respectively, and Dalapon + Armoblen 650 at 12 kg + 0,6 ℓ/ha respectively. One trial was done during early summer and the other included early and late summer treated sectors. In all cases spraying commenced at the early flowering stage.

Figure 6 illustrates the dramatic effect of discing on chemical efficacy in both trials when spraying was carried out in early summer (November). Improvements were significant for all treatments other than Roundup + Armoblen 650 in Trial 1. This may have been due to slower regrowth and the sparse distribution that occurred after discing, which was not conducive to Roundup efficacy. At four months, responses from the other treatments were very poor in the undisturbed sectors treated earlier in the season (see Trial 1 early summer in Figure 6). Initial control was good but regeneration was rapid and almost complete after four months.

The exceptional increases in efficacy of these treatments following discing may be partly explained by the pre-emergence activity of TCA, as the grass distribution was reduced

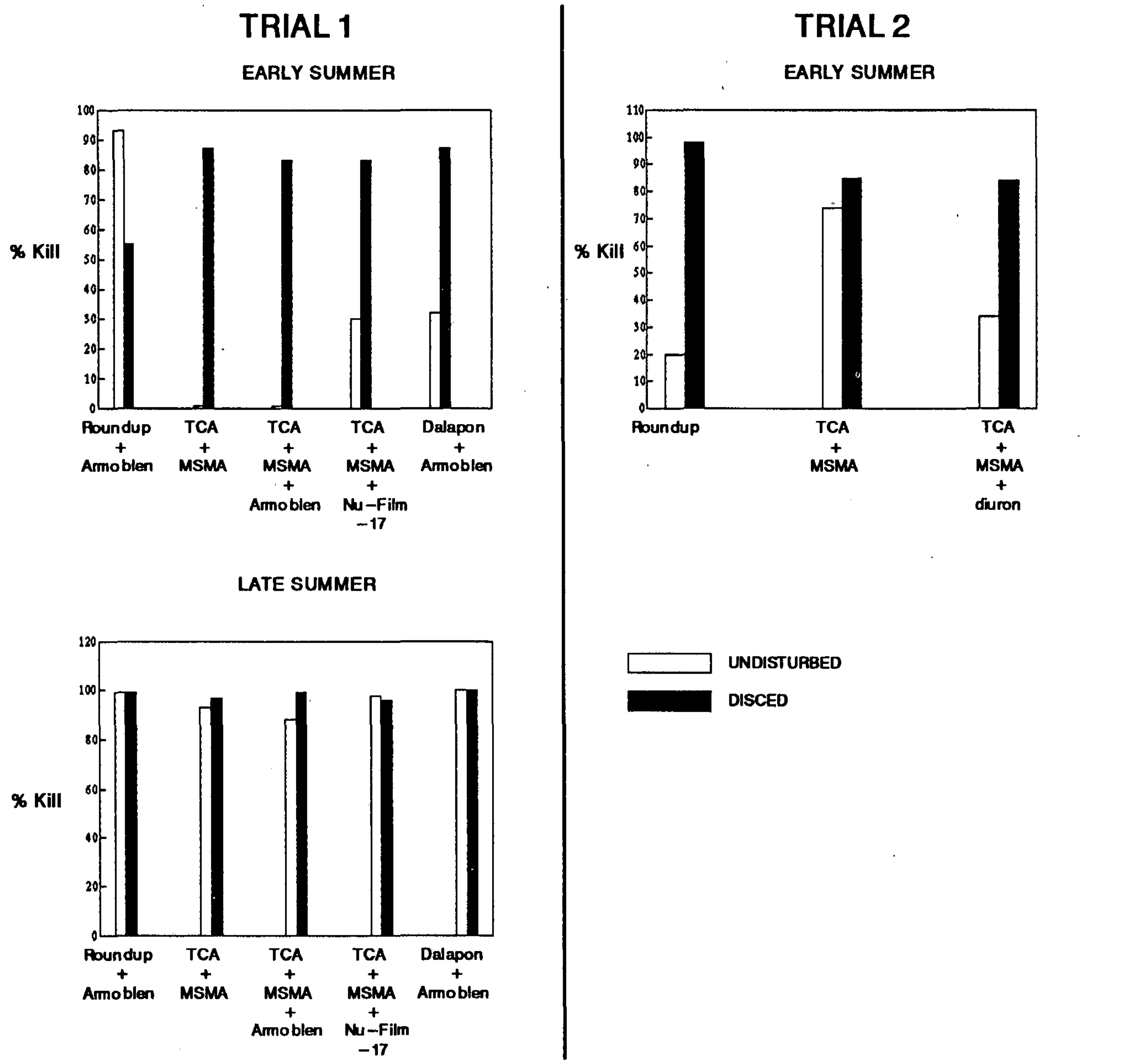

FIGURE 6 The influence of discing prior to spraying regrowth on the efficacy of a range of herbicides on *Digitaria abyssinica* expressed as percentage kill.

and significant amounts of herbicide were soil applied. Responses to discing in Trial 1 were significantly reduced for the late February spraying (see Trial 1 late summer in Figure 6). This was due to the improved long term efficacy of these products later in the year which nullified benefits from discing.

Discussion

The research has shown that, of the products tested for the control of *C. dactylon*, only glyphosate (isopropylamine or trimesium salt forms) produced meaningful results. However, the control achieved with Eptam Super showed promise, but success is dependent on efficient incorporation. Control from Touchdown + Add-2 at 4 ℓ + 0,3 ℓ/ha respectively, Tumbleweed at 7,5 ℓ/ha, and Stirrup at 10 ℓ/ha, were comparable with the 6 ℓ/ha Roundup standard. There appeared to be a slight added benefit to Roundup efficacy on this grass by reducing spray volumes to 100 ℓ/ha, and by using mixtures of Roundup and Sting at 4 ℓ + 4 ℓ/ha as opposed to Roundup alone. The results of seasonal effects on glyphosate efficacy were conclusive where sustained long term control was achieved during late summer only. Digging-in before spraying produced variable but on average better results than when left undisturbed. The success of the cutting-back operation depended on the condition of the regrowth at the time of spraying. Differences in chemical performance were significant only where the operation resulted in vigorous regrowth. The use of protective shields has shown much promise but requires further investigation, particularly with CDA equipment.

Of the products tested on *C. plectostachyus*, only glyphosate provided acceptable weed control efficacy. However, the current SA Sugar Association recommendation of 8 ℓ/ha of Roundup does not give permanent long term control when applied to non-disturbed stands of this weed. Increasing the Roundup rate to 12 ℓ/ha applied as a 6 ℓ + 6 ℓ/ha split, substantially increased the length of control. The results also indicate that the total spray volume needs to be high to optimise chemical efficacy by maximising coverage on this grass. This is shown by the poorer results obtained where reduced total application volumes were used. The importance of digging or rotavating/discing this species to improve chemical efficacy has been shown conclusively in the results. The high degree of success from pre-incorporation of this species may be attributed to the fact that it is stoloniferous only. It is assumed that this method would be less successful on species with rhizomes. There are practical problems in standing cane as incorporation can be done only in the interrows, which become reinfested from the rows.

Results for the *D. abyssinica* trials showed this species to be susceptible to products other than glyphosate. Efficacy from TCA + MSMA and Dalapon + Armoblen 560 were generally good, but sometimes tended to be short-lived when applied to this weed in the undisturbed (non-disced) state. The weed control efficacy of TCA + MSMA at 15 kg + 4 ℓ/ha respectively, was superior to TCA + MSMA + diuron at 12,5 kg + 3 ℓ + 3 ℓ/ha respectively. There is conclusive evidence from the trials showing improved chemical efficacy benefits from pre-discing, although this trend appeared to decline later in the season when treatments applied to undisturbed grass were also highly effective.

Conclusions

Cynodon dactylon

Products containing glyphosate were the most effective and will remain prominent in future recommendations. Reducing the rate of water to 100 ℓ/ha with glyphosate is beneficial to weed control efficacy on this species, and the practice should be adopted for both economical and practical reasons. The added surfactant component in the Roundup + Sting mixture at 4 ℓ + 4 ℓ/ha, resulted in sufficient improvement over single product performance to warrant slight cost increases. Advantages gained by reducing the water rate and using glyphosate mixtures can also be met with CDA equipment, and registration of this method should be encouraged. CDA shields will need to be developed to minimise cane damage. Digging this species in or cutting it back would not be recommended in standing cane as encroachment from the cane lines makes the practice uneconomical. However, where the grass is moribund, slashing to promote vigourous regrowth and to optimise chemical efficacy would be recommended, as would pre-discing of fallow land.

Cynodon plectostachyus

Glyphosate efficacy on regrowth following digging-in is normally highly beneficial. Current recommendations would be based on 8 ℓ/ha Roundup (or equivalent products) or the Roundup + Sting combination applied in conventional rates of water (240 ℓ to 300 ℓ/ha). Split glyphosate applications at rates equivalent to Roundup at 6 ℓ + 6 ℓ/ha would ensure length of control. Further work on CDA equipment is necessary before these systems can be recommended.

Digitaria abyssinica

To maximise control, this species requires manual or mechanical soil incorporation, with herbicides applied only after regrowth is complete. This technique has been very successful early in the season. TCA + MSMA at 15 kg and 4 ℓ/ha respectively, would be an acceptable herbicide treatment for use in standing cane, but spraying should be directed away from the crop foliage. Glyphosate based products equivalent to Roundup at 6 ℓ/ha or the TCA + MSMA mixture at 15 kg + 4 ℓ/ha respectively, would be suitable for fallow conditions.

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