PROMISING NEW HERBICIDES TO REPLACE HORMONE HERBICIDES IN SUGARCANE FIELDS

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Abstract

The demand for products to replace hormone herbicides has resulted in the development and registration of three new herbicides for use in sugarcane fields. Impi (sulcotrione + diuron), Galleon (sulcotrione + atrazine) and Spotaxe (dicamba + 2,4-D) were all tested and found to be only mildly phytotoxic to sugarcane, and for weed control efficacy generally compared favourably with some standard treatments.

Introduction

The choice of herbicides in the South African sugar industry was reduced due to a voluntary ban on the use of hormonal products in 1987, following reported damage to vegetable crops. The ban incorporated all phenoxy herbicides, including the iso-octyl ester and amine salt formulations of 2,4-D (2,4-dichlorophenoxy acetic acid) as well as MCPA (2-methyl-4-chlorophenoxy acetic acid). As a result, herbicide companies have increased their efforts to find suitable replacements for these products which were used extensively in the South African sugar industry. A few have proved successful and compare favourably with the more commonly used herbicides such as Actril DS (ioxynil + 2,4-D).

The first of these products (a formulation of 150 g/l sulcotrione and 300 g/l diuron) was developed by ICI Agrochemicals and is distributed under the trade name of Impi. A second ICI formulation (125 g/l sulcotrione + 300 g/l atrazine) is to be sold as Galleon. The formulated rates for Impi are 3,33 l product/ha and that for Galleon is from 1,6 l to 3,6 l product/ha. Both are registered for use as single products in sugarcane fields. Sulcotrione is one of the new triketone class of herbicide, being selective on sugarcane and effective in controlling a wide range of broadleaf weeds and some grasses. The chemical is both foliar and root absorbed. Some sprayed weeds display a characteristic whitening of the leaves. The product is only mildly toxic, with an oral LD50 of more than 5000 mg/kg and has a low level of persistence in the soil. Residue studies showed that sulcotrione was below the limit of detection even after double rates were applied post-emergence onto sugarcane (Purnell, 1991).

The third chemical is sold as Spotaxe and was developed by Sandoz Ltd., Basel, Switzerland. The chemical formulation of Spotaxe is 80 g/l dicamba (benzoic compound) + 240 g/l 2,4-D (phenoxy compound), both of which are formulated as the N-amino-propylmorpholine (APM) salts of these compounds. Studies have shown that the volatility of the APM formulation is about 98% lower than other more volatile formulations of 2,4-D, and that the hazard associated with secondary drift is minimal (personal communication). Spotaxe alone at 2,5 l/ha or 2 l/ha with 2,5 l/ha diuron is registered for early post-emergence application mainly for broadleaf weed control. All Spotaxe treatments are registered with Armoblen 650, an adjuvant with wetting, penetrating and buffering properties.

Methods

Treatments are sprayed by knapsack using a floodjet nozzle to deliver about 300 l/ha at a pressure of 150 kPa. Cane from the field phytotoxicity trials is cut by hand, weighed and sampled. Weed efficacy trials are rated by visually assessing the percentage control for each weed species present, and comparing with an untreated strip around each plot.

Impi was included in five field and two tray site phytotoxicity trials as well as in six weed efficacy trials. Rates used in the field and tray phytotoxicity trials ranged from 2,92 l to 6,67 l product/ha (500-1 000 g ai/ha sulcotrione and 1 000-2 000 g ai/ha diuron). One additional trial included sulcotrione at an excessive level of 3 600 g ai/ha in a tank mix with diuron at 4 000 g ai/ha. The tray site trials were conducted using variety NCo376 grown in drip irrigated trays (270 x 330 mm) containing both sandy and clay soils. Four of the field trials were established in ratoon cane of the varieties NCo376 or N17 and in one trial plant cane of variety N14 was used. In each instance the treatments were applied when the bend of the uppermost leaf was approximately 500 mm high. Product rates in the weed efficacy trials ranged from 2,92 to 3,33 l/ha and the weed growth stage was late post-emergence in all but one trial.

Galleon was tested in two field and two tray phytotoxicity trials, where the lowest rate used was greater than the highest recommended rate (3,6 l/ha). This product was sprayed at 4 and 8 l/ha in one pre to early post-emergence weed control trial.

Spotaxe was used in three field trials and one tray site phytotoxicity trial. Rates varied between 2 and 6,26 l/ha in the phytotoxicity trials and 3,13 l/ha with 2,5 l/ha of diuron, or on its own at 3,75 l/ha in the weed control trials. The rates used in the efficacy trials were slightly higher than the registered rates to balance the 2,4-D content to that of a standard rate of Actril DS. Armoblen 650 was not added to the Spotaxe treatments in any of the trials.

Results

Phytotoxicity

Impi

Results are presented of one post-emergence tray trial. Because of the limited rooting depth in the trays, the tray trials are regarded as a severe test of the product's effect on sugarcane. The data in Table 1 show the effects of treatments on shoot length and fresh mass yield compared with the unsprayed control and a Sencor + diuron (3 + 2 l/ha) standard treatment, approximately five weeks after spraying.

The results reflect the severity of the test as both Impi treatments proved to be phytotoxic to cane grown in trays. Apart from Sencor + diuron on the clay soil, reductions in fresh mass yield reached levels of statistical significance (P=0,05) for both the standard and Impi treatments.

Table 1

Shoot lengths and fresh mass of treated cane expressed as a percentage of that of unsprayed cane

Treatments	Rate (l product/ha)	Shoot lengths		Fresh mass	
		sand	clay	sand	clay
Control	–	100	100	100	100
Sencor + diuron	3 + 2	90	90	81	88
Impi	2,92	82	86	67	84
Impi	5,84	82	84	65	74
Galleon	8	91	94	88	85
Spotaxe	2	115	102	127	96
Spotaxe	4	103	94	94	82
Spotaxe + diuron	2 + 2,5	98	99	104	97
Spotaxe + diuron	4 + 5	101	95	110	90
S.E. of difference		7	5	7*	8
LSD (0,05)		14	10	14*	16

(* for treatments with Spotaxe S.E. of difference = 15, LSD = 30)

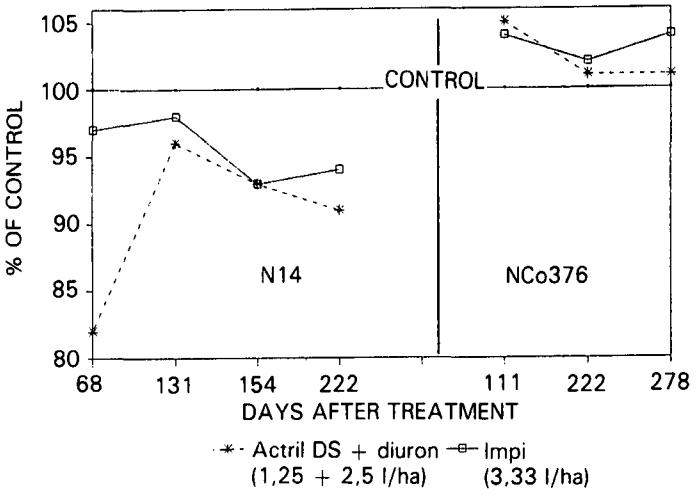

FIGURE 1 Treatment effects on stalk heights as a percentage of the unsprayed control

The product proved to be far less damaging to field grown cane. Figure 1 illustrates the effects of Impi applied at 3,33 l/ha and the Actril DS + diuron standard at 1,25 + 2,5 l/ha on stalk heights in one trial on variety N14 and one trial on variety NCo376. As with some other herbicides, results imply that variety N14 is slightly more sensitive to Impi than is variety NCo376. However growth suppression on N14 with over the row application of Impi was not severe enough to result in significant yield losses at harvest (Table 2, Trial 5).

Harvested field trial results confirm that phytotoxic effects of sulcotrione + diuron on varieties NCo376 and N17 do not reach a level of statistical significance, even at rates of active ingredient far exceeding those of the formulated product. Results of these trials appear in Table 2.

Galleon

Up to 8 l/ha of Galleon (1 000 g ai sulcotrione + 2400 g ai/ha atrazine) proved to be safe on cane in trays even when

Table 2

Treatment effects on cane yield, sucrose % cane and sucrose yield expressed as a percentage of the unsprayed control

Treatment	Rate (l/ha)	Rate (g a.i./ha)	Cane yield (tons/ha)	Sucrose %cane	Sucrose yield (tons/ha)
Trial 1					
riety N17 (ratoon)					
Actril DS + diuron	2,5+5	–	93	99	92
sulcotrione/diuron	10+5	3600 / 4000	98	96	98
S.E. of difference			± 2,8	± 4,0	± 5,1
Trial 2					
Variety NCo376 (ratoon)					
Sencor + diuron	3+2	–	105	99	103
sulcotrione / diuron	2,92	500 / 1000*	100	98	99
sulcotrione / diuron	3,55	500 / 1500	111	99	110
S.E. of difference			± 5,2	± 1,7	± 5,0
Trial 3					
Variety NCo376 (ratoon)					
Sencor + diuron	3+2	–	102	96	98
sulcotrione / diuron	2,92	500 / 1000*	99	99	98
sulcotrione / diuron	5,84	1000 / 2000	101	93	94
S.E of difference			± 3,8	± 3,9	± 5,7
Trial 4					
Variety NCo376 (ratoon)					
Actril DS	1,25	–	102	98	100
sulcotrione / diuron	3,33	500 / 1000*	99	102	101
sulcotrione / diuron	6,67	1000 / 2000	105	100	104
S.E. of difference			± 6,2	± 1,7	± 6,3
Trial 5					
Variety N14 (plant)					
Actril DS + diuron	1,25+25	–	93	95	87
sulcotrione / diuron	3,33	500 / 1000*	99	99	97
sulcotrione / diuron	6,67	1000 / 2000	97	89	85
S.E. of difference			± 2,8	± 4,4	± 4,8

* (Formulation strength of Impi)

applied over the foliage in sandy soils. Although rates were more than twice the highest rate recommended for Galleon (450 g ai sulcotrione + 1080 g ai/ha atrazine), reductions in yield were not statistically significant (Table 1). High rates were also applied in the field phytotoxicity trials on variety NCo376, where cane yields were from 99% to 103% of those from the unsprayed control plots.

Spotaxe

Spotaxe alone or in combination with diuron resulted in minimal growth disturbance and effect on fresh mass yield in the tray site trials (Table 1). Although statistically non-significant, phytotoxic effects appeared to be greater on the clay soil, possibly due to slower leaching of the product from the confined root zone.

The low levels of phytotoxicity evident in the tray trials are supported by growth measurements from a trial where Spotaxe + diuron, at rates in excess of the registered rates, appeared to cause less growth suppression of plant cane of the sensitive variety N14, than did the standard treatment of Actril DS + diuron (Figure 2). These results are reassuring as Turner *et al.* (1990) showed that the average reduction due to treatment with Actril DS + diuron, recorded from 29 phytotoxicity trials, was only 7%. Harvested trial data for Spotaxe treatments on variety NCo376 in three trials prove the product to be safe even where rates were more than double that of the highest recommended level (Table 3, Trial 3). In each case, cane yield for the high rate of Spotaxe treatments was either equal to, or greater than that for the Actril DS or Actril DS + diuron standard.

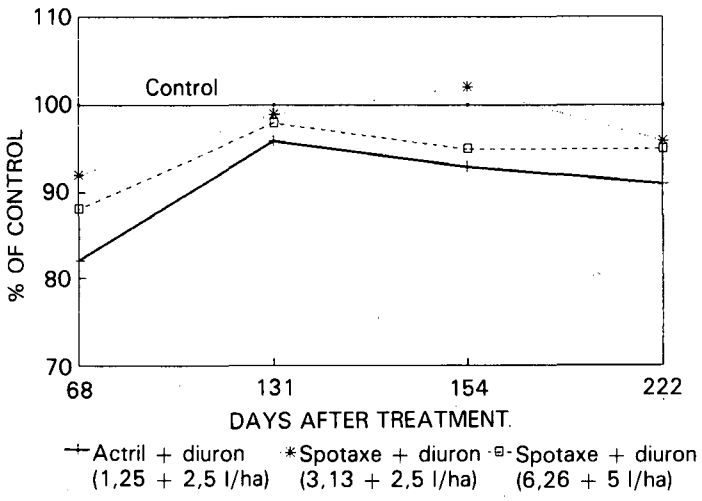

FIGURE 2 Treatment effects on stalk heights as a percentage of the unsprayed control

Weed control efficacy

Impi

Results are reported from a trial where Impi was sprayed onto weeds in the late post-emergence stage. This is regarded as a severe test of the product's performance as many of the weed species present had flowered. Efficacy levels on broadleaf and grass weeds are illustrated in Figure 3.
At 3,33 l/ha the product has control limitations on certain broadleaf weeds (Blesovsky and Johnson, 1991). Control of *Portulaca oleracae* was found to be unacceptable at the late post-emergence stage (Figure 3) as was that for *Commelina benghalensis* in another trial (unpublished data). However, in the latter trial general weed control was good considering

Table 3

Treatment effects on cane yield, sucrose % cane and sucrose yield expressed as a percentage of the unsprayed control

Treatment	Rate (l/ha)	Cane Yield (tons/ha)	Sucrose % cane	Sucrose yield (tons/ha)
Trial 1				
Variety NCo376 (ratoon)				
Actril DS + diuron	1,25+2,5	103	102	106
Spotaxe	2	102	106	107
Spotaxe	4	104	102	105
S.E. of difference		± 2,9	± 3,2	± 4,2
Trial 2				
Variety NCo376 (ratoon)				
Actril DS	1,25	103	97	100
Spotaxe	2	108	98	105
Spotaxe	4	103	96	99
S.E. of difference		± 6,2	± 1,7	± 6,3
Trial 3				
Variety NCo376 (ratoon)				
Actril DS + diuron	1,25+2,5	93	95	87
Spotaxe + diuron	3,13+2,5	99	96	95
Spotaxe + diuron	6,26+5	99	95	93
S.E. of difference		± 2,8	± 4,4	± 4,8

the late stage of spraying. Late post-emergence control of the grass species *Eleusine indica* and *Digitaria sanguinalis* was particularly effective and compared favourably with that achieved by 2 l/ha Velpar + 2 l/ha diuron (Figure 3). The good late post-emergence control of grasses led to Impi being tested with MSMA on *Cynodon dactylon*, a species regarded as being resistant to most chemicals. Results showed that even at double rates of Impi + MSMA (6,66 + 8 l/ha), only 2% control was achieved compared with 96% control with Roundup (glyphosate) at 6 l/ha (unpublished data). Weed efficacy results from applying Impi in one pre to early post-emergence trial are compared with those of a long term standard treatment in Figure 4 to illustrate the short period of control that can be expected from this product.

Galleon

Galleon was tested in one pre to early post-emergence trial on a sandy soil containing 9% clay. Excellent broadleaf weed control was achieved with 4 l/ha of Galleon with the effect persisting for up to 16 weeks. This rate also provided acceptable short term control of *Digitaria sanguinalis* and *Cyperus esculentus*.

Spotaxe

The effects of Spotaxe treatments were compared with other similar herbicides for broadleaf weed control under rainfed and irrigated conditions and results are illustrated in Figure 5. Weed growth was at an advanced stage of development at both sites. Although Spotaxe rates were higher than those recommended, Armoblen 650 was excluded and broadleaf efficacy of the product alone at 3,75 l/ha in the rainfed trial was generally below that of the standard Actril DS treatment at 1,5 l/ha (Figure 5). The addition of 2,5 l/ha of diuron to 3,13 l/ha of Spotaxe markedly increased broadleaf weed control to levels similar to that of Actril DS + diuron at 1,25 + 2,5 l/ha and Oxytril (ioxynil + bromoxynil) + diuron at 1,25 + 2,5 l/ha. Grass species were not controlled by either Spotaxe or Actril DS when applied alone, but control was obtained when 2,5 l/ha of diuron was added. Late post-emergence broadleaf weed control with Spotaxe + diuron at 3,13 + 2,5 l/ha in the irrigated trial equalled that of Actril DS + diuron at 1,25 + 2,5 l/ha (Figure 5) where both treatments provided control for more than 10 weeks.

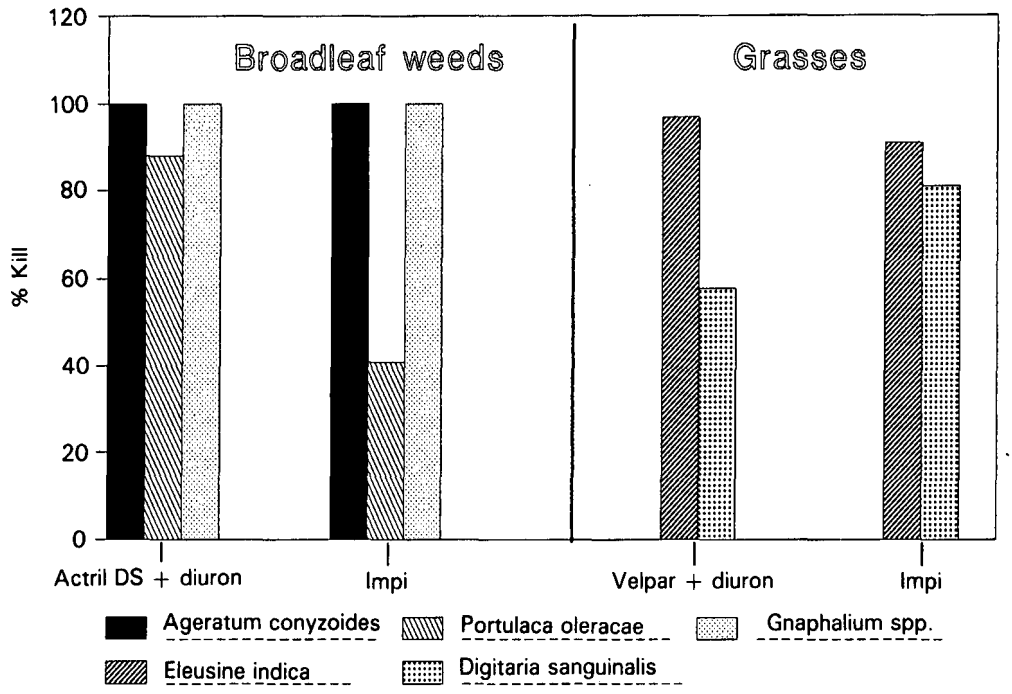

FIGURE 3 Percentage weed control with Impi compared to standards

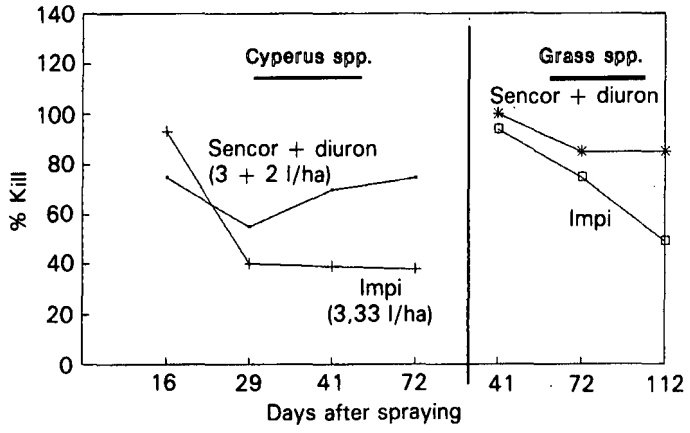

FIGURE 4 Weed control with time

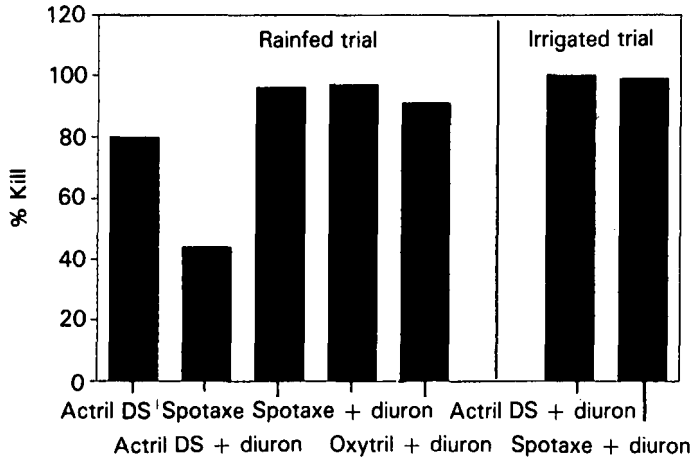

FIGURE 5 Percentage broadleaf weed control

Discussion and conclusions

Phytotoxicity:

Treatment effects on yield in the field trials were minimal for each of these new products and their mixtures. Results showed that without exception, yield differences compared with the control were negligible and in no case did they approach statistical significance, despite the products being applied at excessive rates over the cane foliage at a susceptible growth stage. On average, yields for cane treated with the tested products indicated similar phytotoxicity as the Sencor + diuron standard, but appeared to be less phytotoxic to cane than the Actril DS + diuron standard.

Yield reductions from Impi in the tray trials may be attributed to diuron phytotoxicity, as higher rates of sulcotrione were applied in the form of Galleon with far less effect. Phytotoxic effects on sugarcane from applications of these products are unlikely to occur where sprays are directed onto the interrows and away from the cane foliage.

Weed control efficacy:

Impi, Galleon and Spotaxe + diuron all provided acceptable weed control, although rates and timing of application in the trials did not always comply with manufacturers recommendations. The exclusion of Armoblen 650 from the Spotaxe treatments is likely to have had a detrimental effect on the weed efficacy of this product. The fact that these products generally provided similar or superior weed control to the commonly used herbicides is of primary importance.

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