THREE NEW HERBICIDES FOR SUGARCANE FIELDS IN SOUTH AFRICA

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

KEY WORDS: Herbicides, phytotoxicity, weed efficacy trials.

INTRODUCTION

The choice of herbicides in the South African sugar industry has recently been reduced due to a voluntary ban on the use of hormonal products following apparent drift and 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 sugarcane industry. A few have proved successful and compare favorably 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. Both products have been recommended alone for early post-emergence weed control. Recommended rates for Impi are 3.33 l product/ha while that for Galleon is from 1.6 l to 3.6 l product/ha. Both are currently 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 following treatment. The product is only mildly toxic with an oral LD50 of more than 5,000 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). 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 (Pretorius). 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 0.3 l/ha of Armoblen 650, an adjuvant with wetting, penetrating and buffering properties.

METHODS

Guidelines for registration of new products for use in sugarcane fields in south Africa indicate a need for a minimum of one tray site and two fields phytotoxicity trials, as well as four weed efficacy trials. The South African Sugar Association (SASA) Experiment Station conducts the required phytotoxicity trials and attempts to include each new product in at least one efficacy trial. Chemical companies are responsible for conducting the remainder of the required efficacy trials.

Treatments are sprayed by knapsack using a floodjet nozzle to deliver approximately 300 l/ha at a pressure of 150 kPa. Cane from the field phytotoxicity trials is cut by hand, weighed and sampled for full cane analysis and results are subjected to statistical analysis by the SASA Experiment Station Biometry Department. Weed efficacy trials are rated by assessing the percentage control for each weed species present.

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 mm x 330 mm) containing both sandy and clay soils. Four of the field trials were established in fields of ratoon cane of the varieties NCo376 or N14 and in another 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
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 to the unsprayed control and a Sencor + diuron (3 l/ha) standard treatment, approximately five weeks after spraying.

**Table 1. Shoot lengths and fresh mass of treated cane expressed as a percentage of that of unsprayed cane.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (1 product/ha)</th>
<th>Shoot length (%)</th>
<th>Fresh mass (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>sand</td>
<td>clay</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Sencor + diuron</td>
<td>3 + 2</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Impi</td>
<td>2.92</td>
<td>82</td>
<td>86</td>
</tr>
<tr>
<td>Impi</td>
<td>5.84</td>
<td>82</td>
<td>84</td>
</tr>
</tbody>
</table>

The results reflect the severity of the test as all treatments proved to be phytotoxic to cane grown in trays. Apart from Sencor + diuron on the clay soil, reductions in fresh mass yield all reached levels of statistical significance (P = 0.05).
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 2.25 l + 2.5 l/ha on stalk heights in one trial on variety N14 (yet to be harvested) and one trial on variety NCo376 (harvested). As with some other herbicides, results imply that variety N14 is slightly more sensitive to Impi than is variety NCo376.

![Figure 1](image.png)

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

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 + 2,400 g ai/ha atrazine) proved to be safe on cane in trays even when applied over the foliage in sandy soils. Although rates were more than twice the highest rate recommended for Galleon (450 g ai sulcotrione + 1,080 g ai/ha atrazine), reductions in yield were not statistically significant. 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.
Table 2. Treatment effects on cane yield, sucrose % cane and sucrose yield expressed as a percentage of the unsprayed control.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (l/ha)</th>
<th>Rate (g ai/ha)</th>
<th>Cane yield (tons/ha)</th>
<th>Sucrose % cane</th>
<th>Sucrose yield (tons/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variety N17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actril DS + diuron</td>
<td>2.5+5</td>
<td>3600/4000</td>
<td>93</td>
<td>93</td>
<td>93</td>
</tr>
<tr>
<td>Sulcotrione/diuron</td>
<td>10+5</td>
<td></td>
<td>98</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Trial 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variety NCo376</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sencor + diuron</td>
<td>3+2</td>
<td>-</td>
<td>105</td>
<td>105</td>
<td>105</td>
</tr>
<tr>
<td>Sulcotriolone/diuron</td>
<td>2.92</td>
<td>500 / 1000</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Trial 3</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Variety NCo376</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Sencor + diuron</td>
<td>3+2</td>
<td>-</td>
<td>102</td>
<td>102</td>
<td>102</td>
</tr>
<tr>
<td>Sulcotriolone/diuron</td>
<td>2.92</td>
<td>500 / 1000</td>
<td>99</td>
<td>99</td>
<td>99</td>
</tr>
<tr>
<td>Trial 4</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Variety NCo376</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actril DS</td>
<td>1.25</td>
<td>-</td>
<td>102</td>
<td>102</td>
<td>102</td>
</tr>
<tr>
<td>Sulcotriolone/diuron</td>
<td>3.33</td>
<td>500 / 1000</td>
<td>99</td>
<td>99</td>
<td>99</td>
</tr>
</tbody>
</table>

*Formulation strength of Imi

Harvest results from one post-emergence phytotoxicity trial indicated that Spotaxe is non-mutant phytotoxic to cane than is Actril DS. These findings are supported by growth measurements from a trial where Spotaxe + diuron at rates in excess of the recommended rates, appeared to cause less growth suppression of plant cane of variety A414 than did the standard treatment of Actril/DS + diuron (Figure 2). These results are reassuring as Turner (et al) showed that the average reduction due to treatment with Actril DS + diuron, recorded from 29 phytotoxicity trials, was only 7%.
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 (Biesovsky and Johnson). Control of *Portulaca oleracea* was found to be unacceptable at the late post-emergence stage (Figure 3) as was that for *Commelina benghalensis* in another trial (Leibbrandt). However, in the latter trial general weed control was good considering the late stage of spraying. Late post-emergence control of the grass species *Eleusine indica* and *Digitaria sanguinalis* was particularly effective and compared favorably 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 l + 8 l/ha), only 2% control was achieved compared to 96% control with Roundup (glyphosate) at 6 l/ha (Leibbrandt).

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.
Garlic

Garlic was tested in a pre- to early post-emergence trial on a sandy soil containing 9% clay. Excellent broadleaf weed control was achieved with 4 l/ha of Garlic 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 are illustrated in Figures 5. Weed growth was at an advanced stage of development at both sites. Although Spotaxe rates were higher than those recommended, Atrazine 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 treatment Actril DS 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 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 1 + 2.5 l/ha in the irrigated trial equaled that of Actril DS + diuron at 1.25 1 + 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.
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 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. Yield reductions from Impi in the tray trials may be attributed more 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 is unlikely to occur where sprays are directed on to 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.
REFERENCES

TROIS NOUVEAUX HERBICIDES POUR LA CANNE À SUCRE AU SUD AFRIQUE

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RESUME
Suite à la demande de produits pour le remplacement des herbicides à base d'hormone, trois nouveaux herbicides ont été développés et enregistrés pour utilisation dans les champs de canne à sucre au Sud Afrique. Les essais avec le Impi (sulcotrione + diuron), le Galleon (sulcotrione + atrazine) et le Spotaxe (dicamba + 2,4-D) ont démontré une légère phytotoxicité sur la canne avec un contrôle efficace des herbes en comparaison avec des traitements standards.

Mots clefs: Herbicides, phytotoxicité, contrôle efficace d'herbe.

TRES NUEVOS HERBICIDAS EN CAÑALES DE AFRICA DEL SUR

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RESUMEN
La demanda de productos que reemplacen a los herbicidas hormonales ha dado como resultado el desarrollo y la aprobación para el uso de 3 nuevos herbicidas en campos de caña de azúcar en Africa del Sur. Impi (sulcotrione + diuron) Galleon (sulcotrione + atrazine) y Spotaxe (dicamba + 2,4-D). Se probaron y resultaron muy ligeramente fitotóxicos a la caña de azúcar y eficaces en el control de malezas comparados a los que normalmente se usan en este País.

Palabras claves: Herbicidas, fitotoxicidad, valor maleza.