

TWO NEW PRE-EMERGENCE GRASS KILLERS FOR THE SOUTH AFRICAN SUGAR INDUSTRY

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Abstract

Two new products, Butisan S (metazachlor) and Harness EC (acetochlor), have been developed recently for use in sugarcane in South Africa. The results of the efficacy and phytotoxicity experiments designed to evaluate these products are given in this paper. Both products belong to the acetanilide group of chemicals of which two, Lasso EC (alachlor) and Dual (metolachlor), are already registered. These products control annual and some perennial grass species when applied to the soil before weed germination. They provide control of *Cyperus esculentus* (yellow nutgrass) under favourable conditions, and limited control of broadleaf weeds. Alachlor and metolachlor have shown no phytotoxic effects on sugarcane. The two new products appear to have a similar control action on weeds but Butisan S is slightly more active on *C. esculentus* than the other products, and both Butisan S and Harness EC have a wider spectrum of broadleaf control. These products should however be used with an additional chemical to provide effective broadleaf weed control. Both new products, and particularly Butisan S, have shown phytotoxic effects on cane grown in pots, but field experiments suggest that no yield reductions are likely to occur from correct applications.

Introduction

A number of herbicides are registered for use in the South African sugar industry which include two acetanilides, Lasso (alachlor) and Dual (metolachlor). Both products are active mainly on grasses and must be applied to the soil before weed germination. They are usually used in combination with other chemicals to provide better control of broadleaf weeds. They are also applied with chemicals which have sufficient action on emerged weeds to give residual control of future germinating grasses. Both products provide a measure of control of *C. esculentus* (yellow nutgrass) under conditions which favour its pre-emergent control such as sufficient moisture to take the chemical into the soil before germination of the dormant tubers occurs. Lasso and Dual are therefore useful for weed control in sugarcane.

The two new acetanilides, Butisan S (metazachlor) and Harness EC (acetochlor) were developed during the past three years and the results of trials by the South African Sugar Association Experiment Station are reported in this paper. Improved performance in comparison with Lasso and Dual would concern better and more reliable control of *C. esculentus*, a broader spectrum of broadleaf weed control, and improved persistence of grass control. Thus, in evaluating the new products, their abilities in these spheres were considered.

A standard procedure is followed at the Experiment Station for the evaluation of new products, and it is conducted in close co-operation with the chemical companies who are developing the relevant herbicides. As these companies conduct a large number of trials on their products for weed control efficacy on a range of soil types and in a range of bioclimatic regions, the Experiment Station conducts only a few confirmatory weed control trials. Greater emphasis is

placed on phytotoxicity trials to evaluate the possible effects of these products on sugarcane growth. Experiments are conducted in pots and at two sites in the field. NCo376, which is still the most widely grown variety of sugarcane in South Africa, is used for these trials. The effects on sugarcane are assessed by comparing unsprayed control plots with plots treated with the new products or mixtures. Test chemicals are used at the expected level for recommendation and sometimes twice this level. Registered chemicals are also sometimes included at standard and twice standard rates for comparative purposes.

Methods

Weed control experiments

Five experiments were conducted, three in plant cane, one in ratoon cane, and one on fallow land. In two experiments, treatments were applied before emergence of weeds and in the remaining experiments weeds were present at the time of herbicide application:

A randomised block design with four replications was used in each experiment. Plots consisted of four rows each 4 m long in the three experiments conducted in sugarcane, while plots 8 m long and 2,5 m wide were used in the one experiment conducted on fallow land. A strip 1,5 m wide was left untreated at the end of each plot as a control.

Chemicals were applied using a gas-operated knapsack sprayer fitted with an Albuz APM Green floodjet. The pressure was 1,5 bars and the output ranged between 262 and 325 l ha⁻¹.

Visual ratings of weed control efficacy were made at various intervals after application. These ratings were percent weed control in the treated plots compared with weed occurrence in the adjacent control strips.

Pot phytotoxicity experiments

A randomised block design, consisting of six replications and two soil types, was used in each pot experiment. One post-emergence and two pre-emergence experiments were carried out on plant sugarcane, to test their effects.

Single-budded setts of sugarcane variety NCo376 were chopped, dipped in a solution of Benlate fungicide at 0,75 g l⁻¹ of water, and planted at a depth of 50 mm in light and heavy soils. Aldicarb nematicide was applied to the pots filled with sandy soil, while fertilizer was applied as granules (5.1.5(42)) to all the pots prior to planting and then as a nutrient solution containing N, P, K, Ca, Mg and S as well as the trace elements Cu, B, Mn, Zn and Mo.

All pots were irrigated with a dripper system and herbicides were applied by a gas-operated knapsack sprayer fitted with a Spraying Systems 8003-E even spray fanjet. The pressure that was used was 1,75 to 2 bars and the output was between 750 and 800 l ha⁻¹. Two passes were made over each pot.

Visual assessments of leaf scorch were made after spraying, stalk length measurements from the soil level to the top

visible dewlap of the main shoots were recorded, and tiller and shoot counts were made at regular intervals. All biomass above the ground was harvested two months after spraying pre-emergence treatments and one month after spraying post-emergence treatments.

Field phytotoxicity experiments

Six replications of a randomised block design were used for all the field phytotoxicity experiments. Plot size was five or six rows, each 8 m long and the two outer rows as well as 1 m at each end of the net rows were discarded at harvest.

Chemicals were applied with a lever-operated knapsack sprayer fitted with an Albus APM Green floodjet. The volume of applied chemical ranged from 248 to 310 l ha⁻¹ and the nozzle was held either directly over the cane rows or directly over the middle of the interrow to direct the spray away from the cane foliage. Untreated plots were weeded regularly.

Visual assessments of scorch on the cane foliage were made soon after herbicide application using a percentage scale. Stalk length measurements, taken from ground level to the top visible dewlap of 20 stalks per plot, were recorded at regular intervals. Stalk populations were assessed by counting all stalks in one net row per plot except at the time of harvest when the stalks in the three or four net rows were counted.

Overhead irrigation which applied 61 mm of water on a minimum cycle of 25 days was used in the experiments conducted at Pongola, while 25 mm was applied occasionally at Shakaskraal to supplement rainfall.

Crops were burnt prior to harvesting and the cane in the net rows was weighed using a tractor-mounted boom, grab and scale. Twelve stalks per plot were selected at random for cane quality determinations.

Details of each experiment and the weather and crop conditions during and after spraying are shown in Tables 1 and 2.

TABLE 1
Experiment details

Experiment no	Site	Description	Plant or ratoon cane	Pre- or Post-emergence	Soil % clay	Application dates	Application method	Cane growth stage at spray	
								Approx. leaf height (mm)	No of leaves per shoot
I	Umdlali	Weed control	Plant	Pre-	4	19.01.83	Over the row	0	0
II	Umdlali	Weed control	Plant	Pre-	25	23.09.83	Over the row	0	0
III	La Mercy	Weed control	Fallow land	Pre-	>30	12.10.84	Soil surface	No cane	No cane
IV	Umdlali	Weed control	Plant	Post-	4	21.02.82	Directed interrow	30	2
V	Umdlali	Weed control	Ratoon	Post-	>30	26.10.83	Directed interrow	20	1 to 2
VI	Mt Edgecombe	Phytotoxicity: pots	Plant	Pre-	5 & 43	22.09.83	Over the row	0	0
VII	Mt Edgecombe	Phytotoxicity: pots	Plant	Pre-	4 & 55	14.03.85	Over the row	0	0
VIII	Mt Edgecombe	Phytotoxicity: pots	Plant	Post-	3 & 33	06.02.84	Over the row	380 and 500	
IX	Pongola	Phytotoxicity: field	Plant	Pre/Post	>30	13.11.84 & 03.12.84	Over the row	0 and spike	0 and spike to 3
X	Shakaskraal	Phytotoxicity: field	Plant	Pre/Post	14	10.12.84 & 08.01.85	Over the row	0 and 390	0 and 3 to 4
XI	Pongola	Phytotoxicity: field	Ratoon	Post-	>30	22.10.84	Over the row	400	4
XII	Pongola	Phytotoxicity: field	Ratoon	Post-	>30	18.12.84	Over the row	550	4 to 5
XIII	Shakaskraal	Phytotoxicity: field	Ratoon	Post-	<30	28.09.84	Directed interrow	420	6

TABLE 2
Weather conditions during and after the spraying of each experiment

Experiment no	Date	Temperature at 2 pm (°C)	Relative humidity % at 2 pm	Sunshine (h)	Rainfall (mm)	Days to first rainfall	Amount of first rain (mm)	Rain in two weeks (mm)
I	19.01.83	28,8	63	11,9	0	12	13,0	13,0
II	23.09.83	18,5	70	1,2	1,6	0	1,6	28,8
III	12.10.84	22,2	77	9,7	0	2	0,6	62,4
IV	21.02.82	26,6	72	8,7	0	2	6	61,0
V	26.10.83	22,7	54	10,8	0	5	2,6	46,8
VI	22.09.83	21,0	80	1,4	9,5	0	9,5	21,8
VII	14.03.85	27,4	65	7,1	0	2	0,9	1,9
VIII	06.02.84	27,0	72	12,0	0	7	1,0	158,8
IX	13.11.84	20,4	56	1,5	0	2	4,0	22,4
	03.12.84	22,6	72	2,1	0	6	1,2	32,4
X	10.12.84	25,5	55	1,0	0	7	3,8	47,9
	08.01.85	24,0	69	0,0	0	4	0,5	126,9
XI	22.10.84	24,6	64	3,8	0	2	1,7	41,2
XII	18.12.84	32,2	53	6,8	0,2	0	0,2	15,2
XIII	28.09.84	26,5	62	7,9	0	2	1,3	21,6

Results

Weed control

Experiment I: two days after planting treatments were applied to the Fernwood series soil which had a fine even tilth. The week before spraying, 44 mm of rain fell while only 13 mm of rain fell in the two weeks after spraying. Visual ratings of the percent weed control of *C. esculentus* and grass weeds taken seven and nine weeks after spraying are shown in Table 3.

TABLE 3
Visual ratings of percent weed control in Experiment I

Treatment	Rate (kg or l product ha ⁻¹)	Weed control (%)			
		<i>Cyperus esculentus</i>		<i>Panicum maximum</i>	<i>Digitaria sanguinalis</i>
		7 weeks after spraying	9 weeks after spraying	9 weeks after spraying	9 weeks after spraying
Lasso + atrazine	5 + 2	53	15	25	37
Lasso + ametryne	5 + 3	66	27	33	-
Butisan S	1,5	63	22	-	25
Butisan S	2,5	82	87	67	88
Butisan S + ametryne	1,5 + 3	68	57	50	94
Butisan S + atrazine	1,5 + 3	59	42	15	-
Diuron + Sencor	2 + 2	82	74	35	89
Dual + ametryne	2,75 + 3	88	54	67	90

The standard Lasso + atrazine treatment provided approximately six weeks of acceptable control of annual grasses but *C. esculentus*, *Panicum maximum* and *Commelina benghalensis* were not well controlled. A higher rate of Lasso (6 l ha⁻¹) would normally be recommended for *P. maximum* and *C. esculentus*. The test chemical Butisan S was effective at the higher rate against *C. esculentus*, annual grasses and *P. maximum*, but it was weak on *C. benghalensis*. The lower rate was not effective but in mixtures with ametryne or atrazine it was superior to the standard Lasso + atrazine for control of *C. esculentus* and annual grasses.

Experiment II: moist soil was treated one day after the cane was planted and during the spraying 1,6 mm of rain fell. In the following two weeks, 28,8 mm of rainfall occurred. Visual ratings of percent weed control taken nine weeks after treatment are shown in Table 4.

A sparse population of grass weeds grew in the trial area which became dominated by *C. esculentus*. *Portulaca oleracea* and *C. benghalensis* also germinated successfully.

TABLE 4

Visual ratings of percent weed control in Experiment II

Treatment	Rate (kg or l product ha ⁻¹)	Weed control (%) 9 wks after spraying		
		<i>Cyperus esculentus</i>	<i>Portulaca oleracea</i>	<i>Commelina benghalensis</i>
Lasso + atrazine	6 + 2	7	80	50
Lasso + diuron	6 + 3	0	34	30
Butisan S + diuron	2 + 3	77	77	30
Harness EC + ametryne	3 + 3	35	82	41
Harness EC + diuron	3 + 3	30	70	49
Diuron + Sencor	2 + 2	44	83	79

Despite good moisture conditions, the standard treatments Lasso + atrazine, and diuron + Sencor, exhibited poor control of *C. esculentus*. *P. oleracea* was reasonably well controlled by both treatments but only diuron + Sencor provided good control of *C. benghalensis*.

Harness EC combinations were slightly better than Lasso + atrazine for *C. esculentus* control but they were similar for broadleaf control. Butisan S + diuron, at the rate used, was the most effective treatment on *C. esculentus*.

Experiment III: treatments were applied to a dry soil surface in fallow land which had been disc-cultivated to remove all existing weeds. Weeds in the unsprayed control areas were mainly *Sorghum bicolor* subsp. *verticilliflorum*, *Bidens pilosa*, *Siegesbeckia orientalis*, *Paspalum scrobiculatum* and *Digitaria sanguinalis*.

Equal concentrations of Lasso, Dual, Butisan S and Harness EC were used to compare their activity when used on their own. Visual ratings of percent weed control taken seven and 10 weeks after spraying are shown in Table 5.

Lasso gave poor control of *S. bicolor*, fair control of the other grasses, and very poor control of broadleaf weeds. The addition of atrazine slightly improved grass control but considerably improved broadleaf control. Butisan S, and to a lesser extent Harness EC, gave fair control of all the weed species including some control of *S. orientalis*. Both products were still inferior to the standard Lasso + atrazine combination for broadleaf control.

Experiment IV: treatments were applied to *C. esculentus*, *P. maximum*, *D. sanguinalis* and *Panicum subalbidum*. At the time of spraying, the grasses were at the pre-tillering to tillering stage while *C. esculentus* was flowering. Visual ratings of percent weed control taken 10 weeks after application are shown in Table 6.

TABLE 5
Visual ratings of percent weed control in Experiment III

Treatment	Rate (kg or l product ha ⁻¹)	Weed control (%)					
		<i>Sorghum bicolor</i>		Grass	<i>Bidens pilosa</i>		<i>Siegesbeckia orientalis</i>
		7 weeks after spraying	10 weeks after spraying	10 weeks after spraying	7 weeks after spraying	10 weeks after spraying	10 weeks after spraying
Lasso + atrazine	6 + 2	85	55	78	93	86	75
Lasso	3,9	60	68	72	30	13	15
Dual	2,1	67	55	75	7	5	3
Butisan S	3	93	65	88	90	78	67
Harness EC	1,57	87	66	77	73	53	57

TABLE 6

Visual ratings of percent weed control in Experiment IV

Treatment	Rate (kg or l product ha ⁻¹)	Weed control (%) 10 wks after spraying		
		<i>Cyperus esculentus</i>	<i>Digitaria sanguinalis</i>	<i>Commelina benghalensis</i>
Diuron + (ioxynil + 2,4-D)	2,5 + 1,25	83	96	87
Diuron + Sencor	2 + 2	87	88	96
Lasso + ametryne	5 + 6	87	93	95
Butisan S + ametryne	1,5 + 6	91	91	92
Lasso + ametryne + paraquat	5 + 3 + 1	97	96	97
Butisan S + ametryne + paraquat	1,5 + 3 + 1	91	98	95

All herbicide treatments gave good control of all weeds for approximately eight weeks. Butisan S was slightly less effective than Lasso on grass weeds but it was more effective on *C. esculentus*. The addition of paraquat to both Lasso and Butisan S mixtures improved the control of grasses and broadleaf weeds.

Experiment V: treatments were applied to *C. esculentus*, *P. maximum* and *D. sanguinalis* in a field of burnt ratoon cane. Ground cover of each species was estimated at 24,10 and 4% respectively. Visual ratings of percent weed control taken six weeks after spraying are shown in Table 7.

TABLE 7

Visual ratings of percent weed control in Experiment V

Treatment	Rate (kg or l product ha ⁻¹)	Weed control (%) 6 weeks after spraying	
		<i>Cyperus esculentus</i>	<i>Panicum maximum</i>
Diuron + (ioxynil + 2,4-D)	2,5 + 1,25	74	68
Butisan S + diuron + paraquat	1,5 + 3 + 1,5	97	97
Butisan S + (ioxynil + 2,4-D)	1,5 + 1	77	78
Harness EC	3	50	45
Harness EC + ametryne + paraquat	3 + 3 + 1,5	97	96
Harness EC + diuron + (ioxynil + 2,4-D)	3 + 3 + 1,25	97	87
Harness EC + ametryne	3 + 6	88	92
Diuron + Sencor	2 + 2	93	86

The commonly used short term post-emergence treatment, diuron + ioxynil + 2,4-D, was unable to control the weeds probably because of the range in their sizes at spraying. Diuron + Sencor was effective but control of *P. maximum* decreased six weeks after treatment. Butisan S with ioxynil + 2,4-D was ineffective and so was Harness EC, but when these products were applied in mixtures with adequate post-emergence activity, control was improved. Treatments which included paraquat generally provided the best weed control but stunting of the crop occurred with these mixtures.

Phytotoxicity experiments in the field and in pots

Results of herbicide treatments applied to the soil before the cane emerged and to young plant cane growing in pots are shown in Tables 8, 9 and 10.

Experiment VI: Lasso + atrazine had no effect on the cane foliage mass when used at twice the normal recommended rate. Butisan S treatments however, caused a slight reduction in stalk elongation and foliage mass was also reduced but

TABLE 8

Mass of above-ground cane parts in Experiment VI expressed as a percent of that in unsprayed pots

Treatment	Rate (kg or l product ha ⁻¹)	Cane mass (% of control)	
		Light soil	Heavy soil
Lasso + atrazine	12 + 6	96	100
Lasso + diuron	12 + 6	72	99
Butisan S	3	94	79*
Butisan S	6	104	68**
Butisan S + diuron	4 + 6	89	77*
Butisan S + atrazine	2 + 3	94	90
Butisan S + atrazine	4 + 6	79	74**
Butisan S + ametryne	4 + 6	88	80*
Harness EC	3	99	88
Harness EC	6	96	87
Harness EC + diuron	6 + 6	83	86

* statistically significant at the 5% level

** statistically significant at the 1% level

this was more pronounced in the heavier soils than in the lighter soils. The lower rate of Butisan S + atrazine was less phytotoxic than the higher rate but it was more phytotoxic than Lasso + atrazine in heavy soil. Harness EC alone appeared to reduce foliage mass in heavier soils and the combination treatment caused the same effect in both soil types.

TABLE 9

Mass of above-ground cane parts in Experiment VII expressed as a percent of that in unsprayed pots

Treatment	Rate (kg or l product ha ⁻¹)	Cane mass (% of control)	
		Light soil	Heavy soil
Lasso + atrazine	12 + 6	90	100
Butisan S	1,7	102	95
Butisan S	8	88	86
Lasso	10,4	114	101
Dual	5,6	110	109
Harness EC	3	114	87
Harness EC	4,7	112	86

Experiment VII: in this experiment, both Butisan S and Harness EC were used at a high rate and affected cane growth in heavy soils while only Butisan S showed an effect in light soils.

TABLE 10

Mass of above-ground cane parts in Experiment VIII expressed as a percent of that in unsprayed pots

Treatment	Rate (kg or l product ha ⁻¹)	Cane mass (% of control)	
		Light soil	Heavy soil
Diuron + Sencor	2 + 2	97	101
Butisan S	6	97	88
Butisan S + ametryne	4 + 6	82	97
Butisan S + ametryne + paraquat	4 + 6 + 2	50**	67**
Harness EC	3	108	110
Harness EC	6	95	104
Harness EC + ametryne	6 + 12	71*	90
Harness EC + ametryne + paraquat	3 + 3 + 1,5	65**	86*
Lasso + diuron	12 + 6	75**	101

* statistically significant at the 5% level

** statistically significant at the 1% level

TABLE 11
Crop characteristics and yield data in Experiment IX

Treatment	Pre- or Post-emergence	Rate (kg or l product ha ⁻¹)	Crop measurements			Yield		
			Stalk length 3 mths after spraying (m)	Stalk population 3 mths after spraying (1000 ha ⁻¹)	Stalk length at harvest (m)	Cane (t ha ⁻¹)	Sucrose % cane	Sucrose (t ha ⁻¹)
Control (unsprayed)		0	1,37	126	2,61	121	13,3	16,1
Lasso + atrazine	Pre-	6 + 3	1,41	139	2,59	122	12,8	15,6
Butisan S + ametryne	Pre-	2 + 4	1,42	137	2,69	125	13,4	16,6
Harness EC + ametryne	Pre-	3 + 4	1,38	138	2,66	128	13,2	16,8
Lasso + ametryne	Post-	6 + 4	1,37	133	2,65	120	13,2	15,8
Lasso + ametryne + paraquat	Post-	6 + 3 + 1,5	1,42	139	2,61	123	13,3	16,3
Butisan S + ametryne + paraquat	Post-	2 + 3 + 1,5	1,38	140	2,59	122	13,1	15,9
Harness EC + ametryne + paraquat	Post-	3 + 3 + 1,5	1,38	132	2,67	127	13,0	16,5
CV %						5,5	4,8	6,0
SE of treatment means						3,95	0,36	0,56
LSD (0,05)						8,0	0,7	1,1

Experiment VIII: where treatments were applied over the cane foliage, Harness EC showed no effect on cane grown in either soil type while Butisan S showed only a slight effect on cane in heavy soils. Combinations of these chemicals with other post-emergence chemicals showed severe effects on both light and heavy soils. Lasso + diuron affected the growth of cane in light soils.

Experiment IX: four days after the cane was planted the pre-emergence treatments were applied. Post-emergence treatments were applied after cane had reached the spike to 3-leaf stage of growth, which was after 24 days.

After two weeks there was some weed growth in the untreated plots and in those plots treated with Lasso + ametryne. No effects were visible from any treatment not containing paraquat on the young plant cane.

Crop characteristics three months after treatment, at harvest and the yield at harvest are shown in Table 11.

In the heavy soil there were no adverse effects from any treatment and both test chemicals were similar to the standard Lasso + atrazine.

Experiment X: both pre-emergence and post-emergence treatments were applied to plant cane at Shakaskraal on a light soil (14 % clay). Pre-emergence treatments were applied immediately after planting and post-emergence treatments were applied when the cane was approximately 390 mm tall and shoots had an average of three to four unfurled leaves. Crop measurements were made at three and six months of age (Table 12).

Weed control from most treatments was good, but more weeds grew in the control plots. Slightly better growth occurred in the pre-emergence treated plots except for those treated with Butisan S + diuron, which were similar to the control plots. Post-emergence treatments, including paraquat, caused some stunting with Butisan S + diuron being worse than the mixtures with Lasso + diuron or Harness EC + diuron.

Experiment XI: the treatments were all applied over ratoon cane when it was about 345 mm in height. Cane foliage was scorched by all treatments, but the scorching by the Butisan S combinations was slightly less than that caused by the Lasso or Harness EC treatments. This scorching was only temporary. Crop characteristics at two months after treatment, at the time of harvest and the yield results at harvest are shown in Table 13.

TABLE 12

Crop measurements taken at 3 and 6 months of age in Experiment X

Treatment	Rate (kg or l product ha ⁻¹)	Crop measurements			
		3 months		6 months	
		Stalk length (m)	Stalk population (1000 ha ⁻¹)	Stalk length (m)	Stalk population (1000 ha ⁻¹)
Control (unsprayed)	-	0,71	182	0,95	115
Lasso + atrazine	6 + 3	0,75	194	1,03	125
Lasso + diuron	6 + 3	0,79	192	1,04	132
Lasso + diuron + paraquat	6 + 3 + 1,5	0,65	193	0,96	118
Harness EC + diuron	3 + 3	0,74	186	1,02	124
Harness EC + diuron + paraquat	3 + 3 + 1,5	0,66	207	0,98	129
Butisan S + diuron	2 + 3	0,70	192	0,98	118
Butisan S + diuron + paraquat	2 + 3 + 1,5	0,61	194	0,89	124

The cane was stunted to varying degrees by all the treatments. Yield reductions were similar to those caused by Lasso + diuron, and Butisan S + ametryne showed the lowest yields. There was evidence of an interaction between products such that Lasso in combination with diuron and Butisan S in combination with ametryne caused the most severe effects on sugarcane.

Experiment XII: treatments were applied onto the cane row of a ratoon crop at Pongola when the cane was 550 mm high with four to five unfurled leaves per shoot.

Crop characteristics two months after spraying, at the time of harvest and the yield results at harvest are shown in Table 14.

All treatments applied at the standard rates, stunted the cane slightly and small stalk length differences were apparent at the time of harvest. Yields tended to be lower for all treated plots but the effects were not statistically significant. Diuron + ioxynil + 2,4-D with each acetanilide reduced yields more than with diuron alone. The differences between Lasso, Butisan S and Harness EC were small and not consistent.

TABLE 13
Crop characteristics and yield data in Experiment XI

Treatment	Rate (kg or l product ha ⁻¹)	Crop measurements				Yield		
		Stalk length 2 mths after spraying (m)	Stalk population 2 mths after spraying (1000 ha ⁻¹)	Stalk length at harvest (m)	Stalk population at harvest (1000 ha ⁻¹)	Cane (t ha ⁻¹)	Sucrose % cane	Sucrose (t ha ⁻¹)
Control (unsprayed)	0	0,66	245	2,84	154	141	13,6	19,0
Lasso + ametryne + S	6 + 6	0,60	283	2,83	158	139	13,6	18,8
Lasso + ametryne + S	12 + 12	0,58	254	2,81	160	139	13,4	18,6
Butisan S + ametryne + S	5 + 12	0,58	269	2,80	162	133	13,5	17,9
Harness EC + ametryne + S	6 + 12	0,55	238	2,81	154	137	13,6	18,6
Lasso + diuron + S	12 + 6	0,57	260	2,83	165	132	13,2	17,5
Butisan S + diuron + S	5 + 6	0,59	267	2,81	162	143	13,7	19,5
Harness EC + diuron + S	6 + 6	0,59	251	2,80	165	144	13,2	18,9
CV %						5,0	4,0	6,0
SE of treatment means						4,0	0,31	0,64
LSD (0,05)						8,2	0,6	1,3

TABLE 14
Crop characteristics and yield data in Experiment XII

Treatment	Rate (kg or l product ha ⁻¹)	Crop measurements				Yield		
		Stalk length 2 mths after spraying (m)	Stalk population 2 mths after spraying (1000 ha ⁻¹)	Stalk length at harvest (m)	Stalk population at harvest (1000 ha ⁻¹)	Cane (t ha ⁻¹)	Sucrose % cane	Sucrose (t ha ⁻¹)
Control (unsprayed)	0	1,29	165	2,34	154	99	14,4	14,0
Diuron + ioxynil + 2,4-D	2,5 + 1,25	1,18	183	2,24	169	94	14,0	13,2
Lasso + diuron + ioxynil + 2,4-D	6 + 2,5 + 1,25	1,14	168	2,28	173	92	14,2	13,1
Butisan S + diuron + ioxynil + 2,4-D	2,2 + 2,5 + 1,25	1,19	176	2,25	172	91	14,0	12,8
Harness EC + diuron + ioxynil + 2,4-D	3 + 2,5 + 1,25	1,14	171	2,27	152	94	14,2	13,4
Lasso + diuron + S	6 + 3	1,20	186	2,30	157	98	14,4	13,9
Butisan S + diuron + S	2,2 + 3	1,17	169	2,27	153	97	14,2	13,7
Harness EC + diuron + S	3 + 3	1,24	181	2,27	163	96	14,1	13,6
CV %						6,2	2,8	8,2
SE of treatment means						4,66	0,23	0,64
LSD (0,05)						9,5	0,5	1,3

TABLE 15
Crop characteristics and yield data in Experiment XIII

Treatment	Rate (kg or l product ha ⁻¹)	Crop measurements				Yield		
		Stalk length 3 mths after spraying (m)	Stalk population 3 mths after spraying (1000 ha ⁻¹)	Stalk length at harvest (m)	Stalk population at harvest (1000 ha ⁻¹)	Cane (t ha ⁻¹)	Sucrose % cane	Sucrose (t ha ⁻¹)
Control (unsprayed)	0	0,85	194	1,81	132	67	14,7	9,8
Lasso + ametryne	6 + 6	0,79	195	1,72	147	63	14,6	9,1
Butisan S + ametryne	1,7 + 6	0,82	189	1,79	148	66	14,6	10,1
Harness EC + ametryne	3 + 6	0,82	217	1,77	148	68	14,6	9,9
Lasso + ametryne + ioxynil + 2,4-D	6 + 4 + 1,25	0,79	198	1,78	145	63	14,4	9,1
Butisan S + ametryne + ioxynil + 2,4-D	1,7 + 4 + 1,25	0,82	213	1,80	142	66	14,1	9,3
Harness EC + ametryne + ioxynil + 2,4-D	3 + 4 + 1,25	0,80	210	1,75	147	66	14,4	9,5
CV %						7,8	2,6	7,2
SE of treatments means						2,94	0,22	0,39
LSD (0,05)						5,9	0,4	0,8

Experiment XIII: standard rates of the mixtures were applied across the interrow of the sugarcane lines, away from the cane foliage. Some contact was made however with the lower cane leaves and so all treatments caused some necrosis and chlorosis of leaves which was worse where ioxynil + 2,4-D was included with the ametryne.

Crop characteristics three months after spraying, at the time of harvest and yield results at harvest are shown in Table 15.

All treatments affected stalk length but the differences between treatments were small. No statistically significant yield reductions occurred from any treatment at harvest although Lasso combinations gave the most severe effects.

Discussion

Weed control

These trial results indicate that Butisan S is active on *C. esculentus*, grasses and some broadleaf weed species when applied to the soil before weed emergence. Good control of emerged weeds also occurs when Butisan S is mixed with other chemicals with adequate post-emergence activity. Weed control improved when the rate at which the chemical was applied increased on both heavy and light soils. When the effectiveness of this product was compared with that of Lasso used at the same rate of active ingredient per ha, it appeared to be more active on all three weed groups, but at the rate of Butisan S likely to be used for registration, the differences were not as marked. Effectiveness was not sufficient to eliminate the need for an additional chemical to control broadleaf weeds. Richardson and West¹ and Richardson and Parker² report that Butisan S is superior to Lasso and Dual for weed control and persistence when compared at the same rates of active ingredient per ha, and these results confirm their findings.

Harness EC provided control of grasses and some broadleaf weeds but it was less active than Butisan S on *C. esculentus* and superior to Lasso in pre-emergence experiments. For adequate post-emergence activity the addition of other chemicals was essential and the pre-emergence broadleaf control was not sufficient to eliminate the need for an additional broadleaf weed control chemical.

Phytotoxicity

Pot experiments have show that both Butisan S and Harness EC affect young plant cane growth if applied before the cane emerges. By comparison, Lasso does not cause damage even when applied at twice the recommended rates. This effect on growth occurred mainly on heavy soils but mixtures with atrazine, ametryne or diuron had some effect on light soils.

When the chemicals were applied alone over the cane foliage the damage was limited in comparison with the effects where they were mixed with other chemicals. When

diuron was added to Lasso some severe effects were caused with both pre- and post-emergence applications in light soils only. Leaching of Butisan S and Harness EC could explain their limited phytotoxicity in the light soils (3 to 5% clay content).

Field experiments on medium and heavy soils indicated that neither Butisan S nor Harness EC, in the various combinations used, were more damaging to cane than Lasso in combination with other chemicals. Both pre- and post-emergence applications were used in ratoon cane and no statistically significant yield reductions were recorded despite early stunting effects.

Conclusions

The results of 14 experiments to test the weed control efficacy and phytotoxicity of the two new acetanilides have shown that both Butisan S and Harness EC are as effective as Lasso for *C. esculentus*, grass and broadleaf weed control. At the rates intended for registration, Butisan S appears to be the most effective on *C. esculentus* and broadleaf weeds while Harness EC is more effective than Lasso but less effective than Butisan S. Butisan S is most phytotoxic to plant cane grown in pots while Harness EC is less damaging than Butisan S but more damaging than Lasso. Field experiments showed no evidence of cane damage from any of these chemicals used alone. However, if used in mixtures with post-emergence chemicals, the damage associated with such chemicals can be expected.

Acknowledgements

Appreciation is expressed to the chemical companies which supplied sample material and to Mr R. Adendorff and farm managers of SASA Experiment Station farms for their co-operation when conducting these experiments.

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APPENDIX I

Chemicals and formulations used in the experiments

Product	Formulation	Chemical
Lasso EC	384 g l ⁻¹	alachlor
atrazine	500 g l ⁻¹	atrazine
diuron	800 g kg ⁻¹	diuron
Actril DS	70%	ioxynil + 2,4-D
Certrol DS	70%	ioxynil + 2,4-D
Sencor	700 g kg ⁻¹	metribuzin
Dual	720 g l ⁻¹	metolachlor
Gramoxone	200 g l ⁻¹	paraquat
Butisan S	500 g l ⁻¹	metazachlor
Harness EC	960 g l ⁻¹	acetochlor
ametryne	500 g l ⁻¹	ametryne