THE SENSITIVITY OF SOME SOUTH AFRICAN SUGARCANE VARIETIES TO HERBICIDES

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Abstract

Results of five experiments conducted to assess the sensitivity of some South African sugarcane varieties to herbicides are reported. Most of the herbicides and varieties used commonly were tested in the experiments, which form part of a continuing programme of evaluation of new herbicides and varieties. NCo 376 was included in all experiments for the purpose of comparison. Herbicides were applied either at the standard rate or twice the standard rate to sugarcane foliage. Marked differences in variety sensitivity were apparent, stalk heights, stalk populations and yields being reduced due to treatment with herbicides. Reductions of yield were severe in pot experiments but were considerably less in field experiments. In general, if herbicides are applied at the correct rates and in the correct manner, no commercially important yield reductions should occur.

Introduction

One variety, NCo 376, has been most widely grown in the South African (SA) sugar industry for a number of years. For this reason registration trials to assess the phytotoxicity of new herbicides to sugarcane have been concentrated on this variety. Fortunately sugarcane is relatively insensitive to the effects of herbicides and this factor is therefore not taken into account in the variety breeding programme of the SA Sugar Association Experiment Station. However it is well known that sugarcane varieties can differ in their sensitivity to herbicides (Richardson[1]) and new varieties are tested for sensitivity to herbicides just prior to or soon after being released for commercial cultivation.

Three new varieties have been released in the past few years. These are N12, N13 and N14. The commonly grown varieties now include: J59/3, N52/219, N55/805, NCo 293, NCo 310, NCo 376, NCo 382, N8, N11, N12, N13 and N14. Ten of these varieties were included in one or more of five experiments reported here. Both field and pot experiments were included in the programme.

Materials and Methods

Field experiments

A randomised block design with split plots and five or six replications was used in all trials except Experiment III. Plot size was six rows each eight metres long, with the two outer rows and one metre at each end of the net rows being discarded at the time of harvest.

Chemicals were applied by means of a lever-operated knapsack sprayer fitted with a Spraying Systems TK5 floodjet. The volume applied ranged from 270 to 310 ℓ/ha for the various experiments. The nozzle was held directly over the cane rows. Untreated plots were maintained weed-free by means of hand or mechanical cultivation.

Visual assessments of leaf scorch, taken at intervals soon after application, were based on a scale of 1 to 9, where 1 = no effect and 9 = dead.

Crop growth measurements were made prior to spraying and at intervals until the time of harvest. These consisted of stalk height measurements from ground level to the top visible dewlap on 20 stalks per plot. Stalk populations were calculated by counting all stalks in one net row per plot (except at the time of harvest, when the stalks in four net rows were counted).

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

Experiment details and conditions at the time of spraying of each experiment are presented in Table 1.

Pot experiments

A split plot design with four replications was used for the pot experiments (IV and V).

Eight or ten single-eyed setts of each variety were dipped in a solution of Benlate fungicide (0,75 g/ℓ) and either placed in vermiculite beds in a glasshouse (Experiment IV) or planted directly into pots (300 mm × 300 mm × 100 mm). Setts planted in vermiculite were transplanted into pots after two weeks. The pots contained either a sand or a clay loam soil. Setts were planted at a depth of 50 mm and fertilizer was applied to the soil just prior to planting and subsequently in the form of a nutrient solution containing KNO_3, $Ca(NO_3)_2$, $MgSO_4$, N and P as well as the trace elements Cu, B, Mn, Zn, Mo.

Herbicides were applied by means of a gas-operated knapsack sprayer fitted with a Spraying Systems 8004-E fanjet or a yellow polijet. The nozzle was held directly over the cane. The volumes applied were 700 ℓ/ha (Experiment IV) and 370 ℓ/ha (Experiment V).

Visual assessments of leaf scorch were made at intervals after spraying. Stalk height measurements from soil level to the top visible dewlap of the main shoots were recorded, and tiller and shoot counts were made at regular intervals. All above-ground biomass was harvested and weighed one month (Experiment IV) and 1,5 months (Experiment V) after spraying.

Experiment I

This experiment was conducted at Pongola in the northern irrigated area of the sugar industry on a Shorrocks series soil. Six sugarcane varieties were planted in November 1977. The cane was irrigated with 60 mm of effective water from overhead sprinklers every 25 days, or as soon thereafter as the soil moisture deficit reached 60 mm. The plant crop and three subsequent ratoons were treated with various combinations of herbicides. The six varieties were NCo 376, NCo 293, N52/219, N8, N55/805 and N11.

Treatments used and the rates at which the chemicals were applied were:

Crop	Treatment	Rate in kg or ℓ ai or ae/ha
Plant	1 Control (unsprayed)	—
	2 Alachlor+atrazine+paraquat	3,84 + 2,0 + 0,4
	3 Diuron + 2,4-D amine (+ surfactant)	4,0 + 2,88
	4 Ametryne + 2,4-D amine (+ surfactant)	3,0 + 2,88
Ratoon 1	1 Control	—
	2 Diuron + 2,4-D amine (+ surfactant)	2,0 + 1,44
	3 Diuron + metribuzin	1,6 + 1,4
	4 Diuron + hexazinone	1,0 + 0,675

Crop	Treatment	Rate in kg or ℓ ai or ae/ha
Ratoon 2	1 Control	—
	2 Diuron + metribuzin	1,6 + 1,4
	3 Bladex Plus (cyanazine + atrazine) (+ surfactant)	4,5
	4 Bimate (tebuthiuron + diuron) (+ surfactant)	3,75
Ratoon 3	1 Control	—
	2 Diuron + paraquat	3,2 + 1,0
	3 Diuron + MSMA	4,8 + 4,32
	4 Diuron + 2,4-D amine (+ surfactant)	4,0 + 2,88

The treatments applied to the plant and third ratoon crops were double the amounts recommended for commercial practice, but the first and second ratoon crops received only the recommended amounts.

Experiment II

This experiment was also conducted at Pongola. The varieties used were J59/3 and N14, both released for use mainly in the northern irrigated areas, together with NCo 376 as a standard. The trial was planted in September 1980. Treatments were applied over the crop after emergence of the cane and comprised:

Treatment	Rate in kg or ℓ ai or ae/ha	
1 Control (unsprayed)	—	
2 Diuron + ioxynil + 2,4-D	4,0 + 1,75	
3 Metolachlor + ametryne (+ surfactant)	4,0 + 6,0	J59/3 & N14 only
4 Diuron + paraquat	1,5 + 0,5	J59/3 & N14 only

Treatments 2 and 3 were applied at double the commercially recommended rates, but treatment 4 was applied only at the recommended rate.

Experiment III

In this experiment two varieties, N8 and N13, both suited to the weak sand areas were planted on a Fernwood series soil at Felixton. Treatments which were applied at various growth stages of the cane included:

Treatment	Variety	Rate in kg or ℓ ai or ae/ha	Stage of growth of crop
1 Control	N8	—	—
2 Metolachlor+atrazine	N8	4,0+2,0	pre-emergence
3 Metribuzin	N8	4,2	post-emergence
4 Diuron+ioxynil+2,4-D	N8	4,0 + 1,75	post-emergence
5 Bladex Plus + S	N8	9,0	post-emergence
6 Control	N13	—	—
7 Diuron + ioxynil + 2,4-D	N13	4,0 + 1,75	post-emergence

This experiment was established in September 1981; only visual assessments of herbicide effects have so far been recorded. The treatments represent double the commercially recommended rates of application.

Experiment IV

This experiment was established in pots and included six sugarcane varieties. These were NCo 376, J59/3, N11 N12, N13 and N14. Treatments were applied onto the cane foliage.

Treatment	Rate in kg or ℓ ai or ae/ha
1 Control (unsprayed)	—
2 Diuron	8,0
3 Ioxynil + 2,4-D	3,5
4 Paraquat	0,8

These rates were four times the recommended rates for commercial use.

Experiment V

This experiment was also conducted in pots. Varieties used were the same as those used in Experiment IV and treatments were:

Treatment	Rate in kg or ℓ ai or ae/ha
1 Control (unsprayed)	—
2 Metribuzin	4,2
3 Hexazinone	1,35
4 Ametryne + S	8,0

The rates in this experiment were double those recommended for commercial application. Hexazinone is recommended for use in ratoon cane only and the rate used here is double that used commercially.

Details of the chemicals which were used in the experiments are given in the appendix.

Results and Discussion

Experiment I

Plant crop

At the time of spraying the cane was 0,55-0,6 m high with six to eight leaves unfurled per shoot. Only small differences existed between varieties.

Crop measurements made one month after spraying and at the time of harvesting, and yield results are presented in Table 2.

Stunting due to all treatments was marked at an early stage of growth on all varieties with the exception of N55/805 after treatment with diuron + 2,4-D + surfactant. The effects persisted to some extent until the time of harvest.

In general stalk populations were not affected by herbicide treatments. However, N52/219 had more stalks in treated plots and N8 fewer stalks in all treated plots. Differences between treatments were small.

Yields of NCo 376, N55/805 and N8 were adversely affected by all treatments. Diuron + 2,4-D + surfactant was safer on N55/805 than were the treatments which included paraquat or ametryne. The order of increasing sensitivity of these varieties was NCo 376, N55/805 and N8.

Flowering occurred in all untreated plots of varieties N11, NCo 293 and N52/219, and was inhibited to some extent in all treated plots. Yields were correspondingly greater from treated (and non-flowered) plots than from unsprayed control plots. Any effects of herbicides on the yield of these varieties would therefore have been masked. Since reductions in stalk height were apparent in these varieties at an early stage, it could be expected that yields would have been affected to some extent. The sensitivities of these three varieties to herbicides in terms of stalk height at an early stage appeared to be that all treatments affected N52/219 to the same extent, whereas NCo 293 and N11 were affected more by paraquat than by the other treatments.

Ratoon 1

The stalk heights were 140-150 mm high at the time of spraying and only small differences existed between varieties.

Crop measurements made two months after spraying and at the time of harvesting and yield results are presented in Table 3.

Stunting of the cane due to treatment with standard rates of all herbicides was apparent on most varieties after two months. The effects of diuron + 2,4-D + surfactant on NCo 376, N52/219 and N11, and of diuron + hexazinone on N55/805 and N11 persisted until the time of harvest.

Yield reductions were small and not statistically significant (ns) on most varieties, although all treatments affected yields of NCo 376. Diuron + metribuzin was the most damaging treatment despite the fact that it caused the least reduction in stalk height. Low stalk populations were responsible for the low yield when this treatment was used.

Some varieties gave lower yields (ns) after treatment with certain combinations. These were:

N55/805 — after treatment with diuron + metribuzin and diuron + hexazinone

NCo 293 and N8 — after treatment with diuron + 2,4-D + surfactant

N11 — after treatment with diuron + hexazinone

Ratoon 2

The stalk heights were 190-220 mm when the herbicides were applied, N11 being somewhat shorter than other varieties.

Crop measurements made three months after spraying and at the time of harvesting and yield data are presented in Table 4.

Standard rates of chemicals stunted the growth of all varieties except NCo 293 to some extent at an early stage. Only the effects of Bimate on N52/219 and N8 persisted till harvest, the yields in some instances being decreased to a statistically significant extent. Diuron + metribuzin caused reductions in sucrose yields of NCo 293, N8 and N11 and a slightly lower pol percent cane and mass per stalk.

TABLE 1

Experiment details and conditions at spraying

Expt. No.	Plant or ratoon cane	Soil Clay %	Application date	Temperature on day of spray 8 am (°C)	Rainfall on day of spray (mm)	Rainfall within one week of spray	Age at harvest (months)
I (*a*)	Plant	23	17.01.78	22,8	0	110,4	11,8
(*b*)	Ratoon	23	9.01.79	21,7	0	14,8	12,0
(*c*)	Ratoon	23	8.01.80	19,3	0,3	50,3	11,2
(*d*)	Ratoon	23	23.12.80	28,3	0	14,1	12,2
II	Plant	24	22.12.80	23,4	0	12,7	12,6
III	Plant	5	26.10.81	17,6	3,6	3,6	—
IV	Plant	2 & 50	13.05.80	17,8	0	0,4	2,8
V	Plant	4 & 30	19.10.81	17,1	0	4,4	3,5

TABLE 2

Actual stalk height measurements and harvested crop characteristics for the unsprayed control plots of the plant crop in Experiment 1, and the data for other treatments expressed as a percentage of the results for unsprayed control plots

Variety	Treatment	Stalk height (m) IMAS†	Stalk height (m) At harvest	Stalk popln (1 000/ha) at harvest	Yield t cane/ ha
NCo 376	Control (unsprayed)	0,635	2,40	137	139
	Alachlor + atrazine + paraquat	65	96	95	94
	Diuron + 2,4-D amine + S	70	93	99	95
	Ametryne + 2,4-D amine + S	69	94	93	96
N52/219	Control (unsprayed)	0,583	2,42	77	115
	Alachlor + atrazine + paraquat	75	98	112	102
	Diuron + 2,4-D amine + S	74	98	117	102
	Ametryne + 2,4-D amine + S	75	98	119	103
N8	Control (unsprayed)	0,635	2,55	120	112
	Alachlor + atrazine + paraquat	64	89	85	89*
	Diuron + 2,4-D amine + S	54	92	82	89*
	Ametryne + 2,4-D amine + S	54	94	79	88‡
N55/805	Control (unsprayed)	0,49	2,23	99	113
	Alachlor + atrazine + paraquat	68	92	98	89*
	Diuron + 2,4-D amine + S	97	96	102	96
	Ametryne + 2,4-D amine + S	74	92	98	92
NCo 293	Control (unsprayed)	0,628	2,25	98	112
	Alachlor + atrazine + paraquat	62	96	100	101
	Diuron + 2,4-D amine + S	82	104	100	105
	Ametryne + 2,4-D amine + S	64	100	108	105
N11	Control (unsprayed)	0,52	2,42	105	98
	Alachlor + atrazine + paraquat	59	93	97	108
	Diuron + 2,4-D amine + S	80	98	90	111*
	Ametryne + 2,4-D amine + S	79	97	86	105

* Statistically significant at the 5% level † IMAS = one month after spraying ‡ Statistically significant at the 1% level

TABLE 3

Actual stalk height measurements and harvested crop characteristics for the unsprayed control plots of the first ratoon crop in Experiment I, and the data for other treatments expressed as a percentage of the results for unsprayed control plots

Variety	Treatment	Stalk height (m)		Stalk popln (1 000/ha) at harvest	Yield	
		2 MAS†	At harv.		t cane /ha	t suc. /ha
NCo 376	Control (unsprayed)	1,42	2,47	166	136	17,4
	Diuron + 2,4-D amine + S	87	90‡	105	90*	94
	Diuron + metribuzin	98	101	93	89‡	98
	Diuron + hexazinone	96	97	98	92*	88*
N52/219	Control (unsprayed)	1,42	2,56	98	99	13,6
	Diuron + 2,4-D amine + S	87	95	101	104	102
	Diuron + metribuzin	92	99	102	102	104
	Diuron + hexazinone	99	98	97	99	103
N8	Control (unsprayed)	1,7	2,58	147	106	12,7
	Diuron + 2,4-D amine + S	82	102	98	95	91
	Diuron + metribuzin	87	102	98	98	98
	Diuron + hexazinone	90	103	99	98	92
N55/805	Control (unsprayed)	1,37	2,54	125	117	17,1
	Diuron + 2,4-D amine + S	96	98	100	101	94
	Diuron + metribuzin	97	96	96	92	88
	Diuron + hexazinone	94	94*	97	94	87*
NCo 293	Control (unsprayed)	1,45	2,49	111	113	14,6
	Diuron + 2,4-D amine + S	89	97	105	95	97
	Diuron + metribuzin	98	98	109	101	103
	Diuron + hexazinone	94	97	105	103	101
N11	Control (unsprayed)	1,45	2,62	119	105	12,6
	Diuron + 2,4-D amine + S	88	95*	98	97	106
	Diuron + metribuzin	92	97	105	104	110
	Diuron + hexazinone	88	95*	103	95	107

* Statistically significant at the 5% level † 2MAS = Two months after spraying ‡ Statistically significant at the 1% level

TABLE 4

Actual stalk height measurements and harvested crop characteristics for cane in the unsprayed control plots of the second ratoon crop in Experiment I, and the data for other treatments expressed as a percentage of the results for cane in the unsprayed control plots

Variety	Treatment	Stalk height (m)		Stalk popln (1 000/ha) at harvest	Yield	
		3 MAS†	At harv.		t cane /ha	t suc. /ha
NCo 376	Control (unsprayed)	2,03	2,5	153	134	19,5
	Diuron + metribuzin	92	101	93	100	97
	Bladex Plus + S	95	101	99	103	99
	Bimate + S	95	100	103	95	93
N52/219	Control (unsprayed)	1,99	2,49	103	118	19,0
	Diuron + metribuzin	97	101	102	97	96
	Bladex Plus + S	99	99	103	96	95
	Bimate + S	90	95	108	90*	90*
N8	Control (unsprayed)	2,27	2,82	145	109	14,3
	Diuron + metribuzin	89	99	103	95	88*
	Bladex Plus + S	96	98	98	96	94
	Bimate + S	86	92‡	99	94	90*
N55/805	Control (unsprayed)	1,74	2,31	109	112	17,0
	Diuron + metribuzin	95	101	112	98	99
	Bladex Plus + S	98	100	104	102	102
	Bimate + S	97	98	99	100	101
NCo 293	Control (unsprayed)	1,97	2,56	122	119	17,4
	Diuron + metribuzin	101	99	103	95	91*
	Bladex Plus + S	104	102	100	97	93
	Bimate + S	99	100	108	103	98
N11	Control (unsprayed)	1,96	2,46	126	105	15,9
	Diuron + metribuzin	97	100	99	95	91*
	Bladex Plus + S	97	98	92	98	94
	Bimate + S	96	101	100	101	97

* Statistically significant at the 5% level † 3MAS = Three months after spraying ‡ Statistically significant at the 1% level

TABLE 5

Actual stalk height measurements and harvested crop characteristics for the unsprayed control plots of the third ratoon crop in Experiment I, and the data for other treatments expressed as a percentage of the results for unsprayed control plots

Variety	Treatment	Stalk height (m)		Stalk popln (1 000/ha) at harvest	Yield	
		2 MAS†	At harv.		t cane /ha	t suc. /ha
NCo 376	Control (unsprayed)	1,49	2,57	173	132	18,1
	Diuron + paraquat	72	86‡	94	93	90‡
	Diuron + MSMA	89	95	101	99	101
	Diuron + 2,4-D amine + S	59	79‡	101	83‡	82‡
N52/219	Control (unsprayed)	1,48	2,48	120	116	17,5
	Diuron + paraquat	80	94	111	95	94
	Diuron + MSMA	85	94	92	94	91*
	Diuron + 2,4-d amine + S	69	89‡	111	91*	89‡
N8	Control (unsprayed)	1,77	2,77	167	107	14,0
	Diuron + paraquat	69	84‡	97	89‡	81‡
	Diuron + MSMA	72	90†	98	92*	85‡
	Diuron + 2,4-D amine + S	59	82‡	87	74‡	68‡
N55/805	Control (unsprayed)	1,4	2,33	138	114	16,9
	Diuron + paraquat	71	94	107	89‡	89‡
	Diuron + MSMA	89	100	103	98	99
	Diuron + 2,4-D amine + S	87	99	95	98	98
NCo 293	Control (unsprayed)	1,47	2,54	138	125	16,5
	Diuron + paraquat	75	89‡	98	84‡	87‡
	Diuron + MSMA	90	98	95	90‡	92
	Diuron + 2,4-D amine + S	73	93*	99	87‡	91
N11	Control (unsprayed)	1,4	2,48	140	112	15,0
	Diuron + paraquat	70	94*	106	88‡	83‡
	Diuron + MSMA	86	92*	110	95	95
	Diuron + 2,4-D amine + S	74	97	108	94	93

* Statistically significant at the 5% level † 2MAS = Two months after spray ‡ Statistically significant at the 1% level

TABLE 6

Actual stalk height measurements and harvested crop characteristics for the unsprayed control plots in Experiment II, and the data for other treatments expressed as a percentage of the results for unsprayed control plots

Variety	Treatment	Stalk height (m)		Stalk popln (1 000/ha) at harvest	Yield	
		1 MAS†	At harv.		t cane /ha	t suc. /ha
NCo 376	Control (unsprayed)	1,04	2,59	144	129	17,0
	Diuron + ioxynil + 2,4-D	67	97	110	93	85‡
N14	Control	0,97	2,84	121	142	18,4
	Diuron + ioxynil + 2,4-D	64	85‡	88	84‡	80‡
	Metolachlor + ametryne	64	90*	100	82‡	76‡
	Diuron + paraquat	65	88*	96	87‡	80‡
J59/3	Control	0,92	2,52	108	120	17,9
	Diuron + ioxynil + 2,4-D	72	92	94	89*	85‡
	Metolachlor + ametryne	63	90*	97	88*	85‡
	Diuron + paraquat	63	88*	96	88*	85‡

* Statistically significant at the 5% level † 1MAS = One month after spraying ‡ Statistically significant at the 1% level

Ratoon 3

The height of the cane at the time of spraying was on average:

NCo 376 : 550-650 mm, six to eight leaves unfurled
NCo 293 650 mm, six to eight leaves unfurled
N11 : 450 mm, five to seven leaves unfurled
N8 : 370-450 mm, five to seven leaves unfurled
N52/219 : 550 mm, six to seven leaves unfurled
N55/805 : 750 mm, six to seven leaves unfurled

Crop measurements made two months after spraying and at the time of harvesting, and yield data are presented in Table 5.

Herbicides were applied at double the recommended rates and very marked stunting of the crop occurred due to all treatments on all varieties. Least severe was diuron + MSMA on all varieties (except N52/219) and diuron + 2,4-D on N55/805 only. In most cases differences persisted until the time of harvesting and were associated with corresponding reductions in yield. Diuron + 2,4-D + surfactant was particularly damaging on N8, where yield was reduced by 28 tons of cane per hectare. This was associated with shorter stalks and a lower population of stalks.

EXPERIMENT II

The height of the crops at the time of spraying was:

J59/3 : 600 mm
N14 : 750-800 mm
NCo 376 650-700 mm

The weather was overcast but hot on the day of spraying. Stalk height measurements made one month after spraying and at the time of harvesting, and yield data are presented in Table 6.

In this experiment the herbicides in the first two treatments were applied at double the recommended rate and in the third treatment the rate was the one normally recommended.

Leaf scorch symptoms were exceptionally marked on varieties J59/3 and N14 due to all treatments. Diuron + ioxynil + 2,4-D affected these varieties more than NCo 376. Stunting of the cane in all treated plots was obvious after treatment, and the effects persisted until the time of harvesting when very marked yield reductions were apparent due to all treatments. Differences between treatments were small. Sensitivity of N14 and J59/3 was greater than that shown by NCo 376. The actual yields of N14 after treatment with the various chemicals were similar to the yield of NCo 376 after treatment with diuron + ioxynil + 2,4-D.

Experiment III

In this experiment post-emergence treatments were applied at an early stage of cane growth. At the time of treatment N8 was about 200 mm high with about 65 mm of stalk, whilst N13 was 260 mm high with 90 mm of stalk.

Visual assessments of leaf chlorosis were made three and 11 days after treatment, based on a 1-9 scale where 1 = no effect and 9 = dead. The results are presented in Table 7.

TABLE 7

Visual assessments of leaf chlorosis made three and 11 days after application of post-emergence herbicide treatments

Treatment	Variety / days after spray			
	N8		N13	
	3	11	3	11
Control (unsprayed)	1,4	1	2,2	1,6
Metolachlor + atrazine	1,5	1	—	—
Metribuzin	3,7	4,2	—	—
Diuron + ioxynil + 2,4-D	2,9	4,2	4,3	4,8
Bladex Plus + S	3,0	3,8	—	—

1 = no effect 5 = just unacceptable
4 = just acceptable 9 = dead

N8 and N13 are varieties suited to weak sands. The site of the experiment was chosen because of the particularly weak sandy soil and it is evident that under these conditions all the post-emergence treatments have caused some leaf chlorosis. The pre-emergence treatment of metolachlor + atrazine has had no apparent effect on N8 even though the rates applied were double those recommended.

Experiment IV

At the time of spraying the stalk heights were:

NCo 376	: 155 mm	J59/3	: 155 mm
N11	: 165 mm	N13	: 145 mm
N12	: 105 mm	N14	: 130 mm

The results are presented in Table 8.

Large reductions in the mass of material harvested were caused by very high rates of the herbicides used. Marked varietal differences were also apparent. For all varieties except N14 and J59/3. ioxynil + 2,4-D caused small reductions of yield; the effect of diuron was more severe and that of paraquat was most severe. N14 and J59/3 were most severly affected by diuron but paraquat was also very damaging. In contrast ioxynil + 2,4-D had virtually no effect on these two varieties.

TABLE 8

Actual mass of above-ground material harvested from unsprayed control plots in Experiment IV, and the amounts harvested after spraying six sugarcane varieties with three herbicides, expressed as a percentage of the unsprayed control yields

Variety	Treatment	Foliage mass (g)	
		Light soil	Heavy soil
NCo 376	Control (unsprayed)	211	240
	Diuron	76*	63†
	Ioxynil + 2,4-D	94	88
	Paraquat	54†	48†
N11	Control (unsprayed)	210	323
	Diuron	83	81†
	Ioxynil + 2,4-D	111	103
	Paraquat	54†	54†
N12	Control (unsprayed)	126	174
	Diuron	83	70†
	Ioxynil + 2,4-D	98	93
	Paraquat	51†	35†
J59/3	Control (unsprayed)	203	256
	Diuron	26†	23†
	Ioxynil + 2,4-D	94	95
	Paraquat	39†	46†
N13	Control (unsprayed)	150	205
	Diuron	80	58†
	Ioxynil + 2,4-D	89	87
	Paraquat	61†	44†
N14	Control (unsprayed)	143	162
	Diuron	28†	28†
	Ioxynil + 2,4-D	113	82
	Paraquat	43†	41†

* Statistically significant at the 5% level
† Statistically significant at the 1% level

TABLE 9

Actual mass of above-ground material harvested from unsprayed control plots in Experiment V, and the amount harvested after spraying six sugarcane varieties with three herbicides, expressed as a percentage of the unsprayed control yields

Variety	Treatment	Foliage mass (g)	
		Light soil	Heavy soil
NCo 376	Control (unsprayed)	180	194
	Metribuzin	86	113
	Hexazinone	53†	30†
	Ametryne	87	109
N11	Control (unsprayed)	112	161
	Metribuzin	90	88
	Hexazinone	40†	27†
	Ametryne	87	76†
N12	Control (unsprayed)	107	142
	Metribuzin	71†	77†
	Hexazinone	41†	34†
	Ametryne	87	68†
J59/3	Control (unsprayed)	105	156
	Metribuzin	34†	34†
	Hexazinone	25†	13†
	Ametryne	39†	57†
N13	Control (unsprayed)	120	156
	Metribuzin	69*	95
	Hexazinone	40†	32†
	Ametryne	67*	91
N14	Control (unsprayed)	128	176
	Metribuzin	16†	20†
	Hexazinone	48†	14†
	Ametryne	60†	65†

* Statistically significant at the 5% level
† Statistically significant at the 1% level

Some treatments reduced the number of live shoots and this occurred more often in light soil than heavy soil, in particular due to paraquat on NCo 376, and diuron on N14 and J59/3.

Cane growing in pots of the size used and in soils of the types used in this experiment can be considered to be growing under severe conditions despite the attention given to the supply of moisture and nutrients. Nevertheless, most varieties were able to withstand excessive doses of the chemicals used, but the results indicate the need for extreme care in the choice and application ot these herbicides under harsh conditions in the field.

EXPERIMENT V

The varieties differed little in height, although at the time of spraying N14 and NCo 376 were the best grown.

Mass of above-ground material at the time of harvesting (2,8 months) are presented in Table 9.

All treatments affected all varieties to some extent. Hexazinone had the worst effect generally but N14 and J59/3 were also sensitive to metribuzin and ametryne. The results confirm the greater apparent sensitivity of these two varieties to a number of herbicides in comparison with NCo 376. Generally the effects of treatments were severe in both soil types, but N13 and NCo 376 were less affected by metribuzin and ametryne in heavy soils than in light soil. Hexazinone appeared to be more damaging in heavy soils.

General discussion

The yield of sugarcane from treated plots, expressed as a percentage of that from untreated control plots for each variety in each experiment is indicated in Table 10.

The effects of herbicide treatments on yields of varieties N52/219, NCo 293 and N11 in the plant crop of Experiment I are masked as flowering occurred in unsprayed control plots of these varieties and sprayed cane outyielded unsprayed cane.

These results indicate that:

1. N55/805, NCo 293, N11 and N52/219 are less sensitive to diuron + 2,4-D amine + surfactant than is NCo 376.
2. N55/805, NCo 293 and N11 are less sensitive to Bimate + surfactant than are NCo 376, N8 and N52/219.
3. NCo 376 and N55/805 are less sensitive than are other varieties to Bladex Plus + surfactant.
4. Diuron + paraquat is more phytotoxic than diuron + MSMA on varieties N55/805, NCo 293, N11 and NCo 376 while varieties N8 and N52/219 are affected to a similar extent by both combinations.
5. J59/3 and N14 are more sensitive than NCo 376 to diuron + ioxynil + 2,4-D, diuron, paraquat, metribuzin, hexazinone and ametryne but less sensitive to ioxynil + 2,4-D applied on its own.
6. N11, N12 and N13 are more sensitive to metribuzin, hexazinone and ametryne than NCo 376 but with the exception of N13 are less sensitive to diuron, ioxynil + 2,4-D and paraquat.

Conclusions

The ten varieties used in these experiments showed differences in their sensitivity to herbicides and herbicide combinations.

Particularly sensitive varieties were:

N8 : very sensitive to diuron or ametryne in combination with 2,4-D amine but affected by most herbicide combinations.

N14 and J59/3 : particularly sensitive to diuron, hexazinone, metribuzin, ametryne and paraquat.

TABLE 10

Yield of cane from treated plots expressed as a percentage of yields from untreated control plots for each variety in each experiment

	Rate *1	Plant or ratoon	Varieties									
			NCo 376	N52/ 219	N8	N55/ 805	NCo 293	N11	J59 /3	N14	N12	N13
Al + atr + par	×2	P	94	102	89	89	101	108				
Diu + 2,4-D + S	×2	P	95	102	89	96	105	111				
Amet + 2,4-D + S	×2	P	96	103	88	92	105	105				
Diu + 2,4-D + S	×1	R1	90	104	95	101	95	97				
Diu + metrib	×1	R1	89	102	98	92	101	104				
Diu + hexaz	×1	R1	92	99	98	94	103	95				
Diu + metrib	×1	R2	100	97	95	98	95	95				
Bladex Plus + S	×1	R2	103	96	96	102	98	98				
Bimate + S	×1	R2	95	90	94	100	103	101				
Diu + par	×2	R3	93	95	89	89	84	88				
Diu + MSMA	×2	R3	99	92	94	98	90	95				
Diu + 2,4-D + S	×2	R3	83	91	74	98	87	94				
Diu + ioxy + 2,4-D	×2	P	93						89	84		
Metol + amet	×2	P							88	82		
Diu + par	×1	P							88	87		
Diu	×4	P	70					82	25	28	77	69
Ioxy + 2,4-D	×4	P	91					107	95	98	96	88
Par	×4	P	51					54	43	42	43	53
Metrib	×2	P	100					89	34	18	74	82
Hexaz	×2	P	42					34	19	31	38	36
Amet	×2	P	98					82	48	63	78	79

* 1 x1 or x2 of recommended rates

Particularly phytotoxic herbicides at the rates tested were:

paraquat : to all varieties but particularly N55/805 and NCo 293.

2,4-D amine in combination with diuron or ametryne — to most varieties except N55/805 and N11.

Particularly safe herbicides at the rates tested were:

ioxynil + 2,4-D : applied alone to all varieties tested in the pot experiments.

Bladex Plus on most varieties.

MSMA in combination with diuron was less phytotoxic than paraquat combinations to most varieties (NCo 376, N55/805, NCo 293, N11) and was no more phytotoxic than paraquat combinations on any cane variety.

Under favourable growth conditions and with correct herbicide application methods and rates all herbicide combinations tested should not seriously effect growth and yield of any variety tested. However, extreme care should be exercised with herbicide application in fields of N8, N14 and J59/3. Indications from the results obtained are that pre-emergence herbicides applied before the crop emerges or as soon after harvesting as possible combined with hand weeding where necessary would be the most suitable weed programme in fields planted to the three most sensitive varieties.

Under unfavourable growing conditions the effects of herbicides on even the less sensitive varieties could be severe.

REFERENCES

1. Richardson, F. E. (1972). Critical growth stages for 2,4-D phytotoxicity to sugarcane in South Africa. *SASTA Proc* **46**: 168-176.

APPENDIX

Chemicals and formulations used in the experiments

Common name	Trade name	Manufactor/distriburot	Formulation*
alachlor	Lasso 384 EC	Monsanto	384 g/*l* ec
ametryne	Gesapax 500 fw	Ciba-Geigy	500 g/*l* sc
atrazine	Gesaprim 500 fw	Ciba-Geigy	500 g/*l* sc
atrazine + cyanazine	Bladex Plus Sc	Shell	167 + 333 g/*l* sc
2,4-D dimethyl/amine salt	Farmers 2,4-D amine	Triomf Farmers Organisation	720 g/*l* sol c
2,4-D + ioxynil	Actril DS	May & Baker	600 + 100 g/l ec
diuron	Farmers diuron	Triomf Farmers Organisation	800 g/kg wp
diuron + tebuthiuron	Bimate 75 wp	Elanco	500 + 250 g/kg wp
hexazinone	Farmers du Pont Velpar	du Pont	900 g/kg sol p
metolachlor	Dual 720 EC	Ciba-Geigy	720 g/*l* ec
metribuzin	Sencor 70% wp	Bayer	700 g/kg wp
MSMA	Daconate 6	Diamond Shamrock	720 g/*l* ec
paraquat	Gramoxone	Triomf Farmers Organisation	200 g/*l* sol c

* ec = mulsifiable concentrate sc = suspension concentrate sol c = soluble concentrate wp = wettable powder sol p = soluble powder