

Weed Control in Sugarcane (*Saccharum officinarum* L.) with Asulam and Actril DS.

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Abstract

Field studies were conducted at Ilorin between 1986 and 1987 to evaluate the efficacy of different concentrations and times of application of asulam (methyl (4-aminophenyl) sulfonyl) - carbamate), alone and in combination with Actril DS (a formulated mixture of ioxynil (4-hydroxy-3, 5-diiodobenzonitrile) and 2, 4-D (2, 4-(dichlorophenoxy) acetic acid)), for weed control in plant and first ratoon crops of sugarcane. Whether applied alone or in combination with Actril DS, the rate of application of asulam did not significantly affect the level of weed control in both plant and ratoon crops. The mixture of asulam with Actril DS was, however, more effective than asulam alone in the plant crop. Increasing asulam concentration beyond 3.5kg/ha resulted in slight reductions in cane yield in the plant crop, whereas yields increased with increasing concentration of asulam used in the ratoon crop. Cane yields in both the plant and ratoon crops decreased with an increase in the concentration of asulam combined with Actril DS. The time of application of the herbicides did not influence their weed control effectiveness in both the plant and ratoon crops. The herbicides were, however, more phytotoxic to the crop when applied at 10 than when applied at either 6 or 3 weeks after planting in the plant crop. There was no difference in the level of phytotoxicity in the ratoon crop.

Introduction

Previous studies on weed management in sugarcane in Nigeria have largely been limited to the evaluation of herbicides with pre-emergence properties for weed control on the crop (Fadayomi *et. al.* 1984; Fadayomi, 1988, Oworu, 1980). However, because of operational delays commonly encountered by the sugarcane estates, these herbicides are often applied after the emergence of weeds and or canes. This situation has necessitated the evaluation, lately, of herbicides with selective post-emergence weed control activities in the crop (Oworu, 1988).

Asulam is a benzylsulphonyl carbamate herbicide with both pre-emergence and post-emergence weed control activities. It has been reported to give effective control of grass and broad-leaved weeds in both plant and ratoon fields of sugarcane, as well as in fallow land (Millhollon, 1976; 1985; 1986; Oworu, 1988). Millhollon (1986) reported variable performance of asulam in different years and/or in different locations. The general performance of the herbicide was also reported to be enhanced by additions of dalapon (2, 2-dichloropropanoic acid), diclofop [(±)-2-(4-[2,4-dichlorophenoxy] propanoic acid); or terbacil [5-chloro-3 (1, 1-dimethyl ethyl) -6-methyl-2, 4(1H, 3H) pyrimidinedione]. In preliminary studies with the herbicide, we obtained variable levels of weed control which were inferior to that

given by a mixture of diuron [3, (3, 4-dichlorophenyl)-1, 1-dimethyl urea] and hexazinone [3-cylohexyl-6- (dimethylamino) -1-methyl -1, 3, 5-triazine (1h, 3H)- dione].

The present study was aimed at determining the optimum level of asulam, alone or in combination with Actril DS, required for the control of a broad spectrum of weeds in plant and ratoon fields of sugarcane. The study was also aimed at determining the best time for the application of these herbicides.

Materials and Methods

The study was conducted at the Ilorin University Sugar Research Institute farm during the 1986 and 1987 cropping seasons, on a sandy loam soil (0.8% OM; pH 5.5; 12.4% clay; 80.8% sand; 6.8% silt). The crops (variety Co 957) were maintained under rainfed conditions between June and the end of October each year, after which the fields were irrigated by overhead sprinklers until April 1987, in the case of the plant crop, and December 1987, in the case of the ratoon crop. The ratoon crop was also irrigated from two weeks after ratooning until the rains became steady in 1987. The plant crop received basal fertilizer applications of 160 kg N/ha, 100 kg P₂O₅/ha, and 80 kg K₂O/ha at planting. The same level of fertilization was applied, as side-dressings, at 15 weeks after harvest (WAH), to the ratoon field. The herbicide treatments were applied as over-the-top broadcast sprays using CP3 knapsack sprayers with poli-jet nozzles delivering 300l/ha of spray solution. Individual plots were made up of six rows, 1.5m apart and 5m long (45m²). All component treatments were replicated three times. The fields were burnt prior to harvest, each year.

Both the plant and ratoon crop experiments were designed as randomized complete blocks with a factorial arrangement. There were 10 weed control treatments made up of four levels of asulam, each applied alone and in combination with 1.75kg a.i./ha of Actril DS, a hand-weeded control, and a weedy control. The 1986 crop was planted on 30 June 1986 and the herbicide treatments were applied at 3, 6, or 10 weeks thereafter. Weed control effectiveness was evaluated at 15 weeks after planting (WAP) through visual scoring of the entire plots, (using the rating scale of 0 = no control, to 100 = perfect control), and weed weights from single 1M² quadrats, randomly located in each of the plots. At the same time, crop phytotoxicity was scored on a scale of 0 = no injury to 100 = complete kill. The canes were harvested at 40 WAP from the four middle rows for the determination of millable stalk population, total soluble solids in juice (brix), and cane yield (Meade, 1964).

The experiment was repeated in the ratoon crop using the same field. One week after harvest, the remaining trash were manually removed from the plots and the individual weed control treatments were assigned to the different plots after a fresh randomization. The herbicide treatments were applied at 6, 10 or 12 WAH. Weed population per unit area was estimated from single quadrats randomly located in any of the three middle inter rows at 21 WAH, while weed fresh weights per unit area was obtained from quadrats placed at the centre of the third interrow, in each plot, at 30WAH. Cane yield, millable stalk population, and brix were obtained from the plots at 35 WAH, as described above.

All data were subjected to analysis of variance and where the F-ratio for the weed control treatments (df = 9) was significant, the variance was partitioned

among the following orthogonal pairs: (a) between asulam levels (df = 3), (b) between different levels of asulam plus Actril DS (df = 3), (c) asulam alone vs. asulam + Actril DS (df = 1), (d) hand-weeded control vs weedy control (df = 1), and (e) hand-weeded + weedy controls vs herbicide treatments (df = 1).

Results and Discussion

The weed control treatments significantly affected all the parameters investigated except % brix and cane yield in the plant crop, and millable stalk population, % brix and cane yield in the ratoon crop. Time of application, on the other hand, affected only crop phytotoxicity in the plant crop. There was no significant interaction between weed control treatment and time of application for most of the parameters investigated, except for weed control rating at 15 WAP in the plant crop and weed weight at 30 WAH in the ratoon crop. Consequently, further discussion of the results is limited to the main treatment effects.

A partitioning of the variance due to the weed control treatments, in the plant crop, showed that there was no difference in the weed control effectiveness of the various levels of asulam used alone or in combination with Actril DS. There was however, a significantly lower weed biomass in the asulam + Actril DS — treated plots compared to the asulam treated plots (Table 1 & 2). The level of control obtained in the hand-weeded control plots was superior to that obtained in all the herbicide-treated plots, with the exception of plots treated with the mixture of asulam and Actril DS at the rate of 3.5 + 1.75 kg/ha. Asulam + Actril DS at the rate of 3.5 + 1.75 kg/ha was in turn superior to all treatments except asulam + Actril DS at 4.0 + 1.75 kg/ha; all other herbicide treatments were not different from one another, but were significantly better than the weedy control. These results are in agreement with those of Millhollon (1986), who reported enhanced performance of asulam when combined with either dalapon or diclofop compared to when used alone. The lack of an enhancement in the level of weed control with increasing concentration of asulam suggests that the lowest rate of the herbicide used might be optimal under the conditions of this study. Millhollon (1986) reported the same level of weed control with 3.5, 4.5 and 6.0 kg ai/ha of the herbicide. Similar results were obtained in the ratoon crop, except that there was no significant difference between the performance of asulam alone and its mixture with Actril DS (Tables 1 & 3). Weed control effectiveness, though not significant, increased with increasing concentration of asulam, when used alone, in line with the findings of Millhollon (1986). There was, generally, less weed growth in the ratoon crop compared with the plant crop, both in terms of biomass (Tables 2 & 3) and species diversity. The common weeds encountered in the plant crop were *Aspilia africana* (Pers.) C.D. Adams, *Cassia*, Spp., *Celossia trigyna* L., *Corchorus aestuans* L., *Croton lobatus* L., *Phyllanthus amarus* Schum & Thonn., *Physalis angulata* L., *Eleusine indica* L., *Imperata cylindrica* (L.) Beauv., *Rottboellia cochinchinensis* (Lour.) Clayton, and *Paspalum orbiculare* Forst; whereas those encountered in the ratoon crop were *A. africana*, *C. spp.*, *C. trigyna*, *C. lobatus*, *P. angulata*, *Fimbristylis* Spp., *Mariscus squarosus* L., and *R. cochinchinensis*. This lower weed growth must have been responsible for the lack of a difference between the performance of

Table 1: ANOV TABLE SHOWING PARTITIONING OF VARIANCE DUE TO WEED CONTROL TREATMENTS IN THE PLANT AND RA-TOON CROPS.

Source of Variation	df	Sum of squares ¹								
		Plant Crop					Ratoon Crop			
		WCR	WDW	PhyR	MSP	CY	WP	WFW	MSP	CY
(a) Between asulam rates	3	592.67	84887.0	35.42	11.78	106.47	753.0	39529	241.47	910.8
(b) Between asulam + Actril DS	3	2356.30	64733.8	644.44*	7.34	205.67	874.1	3364	965.88	546.4
(c) Asulam alone vs asulam + Actril DS	1	1672.35	196501.8*	528.13***	8.90	145.41	396.7	15298	11.40	20.0
(d) Hand-weeded vs. weedy	1	22755.56*** ²	705711.6***	0.0	8.70*	23.74	1530.9***	191870***	1162.91*	33.8
(e) Handweeded + weedy vs others	1	1651.22	44001.1	225.63	0.35	46.67	189.2	65524*	143.60	0.0
Total (weed control treatments)	(9)	29028.1***	1095835.3***	1433.61**	36.44**	527.96	3742.9*	315314	2525.26*	1511.0
Error	58	20555.9	1992201.0	3295.0	101.03	3949.28	9836.9	740726	8254.03	9037.9

1. WCR = weed control rating; WDW = weed dry weight; WFW = weed fresh weight; PhyR = phytotoxicity rating; MSP = Millable stalk population; and CY = cane yield.
2. F — ratio significant at: — 0.05%; ** — 0.01% and *** — 0.005% levels of probability.

Table 2: INFLUENCE OF HERBICIDE TREATMENTS AND TIME OF APPLICATION ON WEED CONTROL EFFECTIVENESS AND CROP PHYTOTOXICITY AT 15 WAP IN THE PLANT CROP.

Herbicides	Rate (Kg a.i. or a.e./ha)	Weed control rating (%)			Weed Weight (kg/ha)			Phytotoxicity rating (%)					
		3 WAP	6 WAP	10 WAP	Mean	3 WAP	6 WAP	10 WAP	Mean	3 WAP	6 WAP	10 WAP	Mean
Asulam	3.0	71.7	79.7	60.0	70.4	1.9	0.8	0.9	1.2	0.0	0.0	0.0	0.0
Asulam	3.5	45.0	77.6	62.3	61.7	2.1	0.7	1.5	1.4	0.0	0.0	3.2	1.1
Asulam	4.0	80.0	89.3	45.0	71.4	0.6	0.7	1.0	0.8	0.0	6.7	1.7	2.8
Asulam	5.0	90.7	61.7	61.0	71.1	0.2	1.8	0.4	0.8	0.0	0.0	3.3	1.1
Asulam + Actril DS	3.0 + 1.75	88.0	72.3	43.3	70.2	0.0	0.9	1.5	0.8	0.0	0.0	13.3	4.4
Asulam + Actril DS	3.5 + 1.75	75.0	93.3	93.3	91.6	0.5	0.0	0.0	0.2	6.7	6.7	23.3	12.2
Asulam + Actril DS	4.0 + 1.75	70.0	92.0	66.0	77.7	1.3	0.0	0.5	0.6	0.0	0.0	3.3	1.1
Asulam + Actril DS	5.0 + 1.75	98.7	46.7	98.7	73.8	0.3	1.0	0.0	0.4	0.0	0.0	26.6	8.9
Hand-weed control	—	3.3	43.3	35.0	98.3	0.0	3.0	0.0	2.1	0.0	0.0	0.0	0.0
Mean	—	72.3	75.5	66.2	—	0.90	0.91	0.73	—	0.7	1.3	7.1 (3.55)	—
LSD (0.05) for comparing:													
(a) two weed control means			17.7 (8.87)*				0.94 (0.47)					7.1 (3.55)	
(b) two time of application means			NS (4.86)				NS (0.26)					3.9 (1.95)	
(c) two weed control treatments at the same or different time of application			30.7 (15.37)				NS (0.81)					NS (6.15)	

*values in parenthesis are standard errors.

Table 3: INFLUENCE OF HERBICIDE TREATMENTS AND TIME OF APPLICATION ON WEED CONTROL EFFECTIVENESS IN THE RATOON CROP

Herbicides	Rate (Kg a.i. or a.e./ha)	Weed population at 21 WAH (no/m ²)				Weed fresh weight at 30 WAH (g/m ²)			
		6 WAH	10 WAH	12 WAH	Mean	6 WAH	10 WAH	12 WAH	Mean
Asulam	3.0	36.7	43.0	42.1	40.6	800.7	22.6	7.0	276.8
Asulam	3.5	41.2	21.5	26.9	29.9	102.7	370.6	9.4	160.9
Asulam	4.0	17.0	92.3	79.8	63.0	7.4	99.9	199.6	102.3
Asulam	5.0	75.3	20.6	17.9	37.9	27.1	3.5	74.6	35.0
Asulam + Actril DS	3.0 + 1.75	39.4	17.0	4.5	20.3	128.7	32.3	20.6	60.5
Asulam + Actril DS	3.5 + 1.75	62.7	14.3	80.6	52.6	151.0	22.9	7.0	60.3
Asulam + Actril DS	4.0 + 1.75	41.2	3.6	16.1	20.3	15.73	0.2	303.5	106.4
Asulam + Actril DS	5.0 + 1.75	53.8	29.6	0.0	27.8	100.8	2.2	0.0	34.3
Hand-weeded control	—	14.3	28.7	21.5	21.5	0.8	3.9	20.4	8.4
Weedy control	—	44.8	79.8	88.7	71.1	66.5	599.1	1024.7	563.4
Mean		42.7	35.0	37.8	—	140.1	115.7	166.7	

LSD (.05) for comparing:

- (a) two weed control means 33.0 (16.50)* 286.4 (143.21)
- (b) two time of application means NS (9.04) NS (78.44)
- (c) two weed control treatments at the same or different time of application NS (28.58) 607.6 (303.79)

* values in parenthesis are standard errors

asulam alone and its mixture with Actril DS, in the ratoon crop. Millhollon (1976), reported that two applications of 3.4 kg/ha of asulam were required for effective control of johnsongrass (*Sorghum halepense* (L.) Pers.) in the first of a two-year study. In the second year, however, a single application of the herbicide was sufficient to maintain the control of the weed at the same level as the previous year, or to improve on it.

The herbicide treatments caused moderate injuries in the plant crop and very negligible injuries in the ratoon crop. The mixture of asulam with Actril DS was more phytotoxic than asulam alone (Tables 1 & 2). This is in line with the results of previous studies where it had been reported that combinations of asulam with dalapon or diclofop caused moderate injuries to the crop (Millhollon, 1976; 1986).

The weed control treatments did not significantly affect the percentage brix, and cane yield in the plant crop, and the percentage brix, millable stalk population, and cane yield in the ratoon crop. The millable stalk population was however significantly lower in plots treated with the mixture of asulam and Actril DS than in plots treated with asulam alone in the plant crop (Table 1). The highest cane yield in the plant crop was obtained from plots treated with 3.5 kg/ha of asulam alone (Table 4). These yields were similar to those obtained from plots treated with a combination of the same concentration of asulam and 1.75 kg/ha of Actril DS. Whether applied alone or in combination with Actril DS, there was generally a decline in cane yield with an increase in the concentration of asulam beyond 3.5 kg/ha. This decline, which must be due to the increased phytotoxicity associated with these concentrations, was more severe where the herbicide mixture was used. In the ratoon crop, the highest yield was obtained from plots treated with the highest concentration of asulam alone (Table 5). These yields, were, however, not significantly different from those obtained from plots treated with the other weed control treatments. Unlike in the plant crop, there was an increase in cane yield with increasing concentration of asulam used. This must be an indication of greater tolerance to the herbicide by the ratoon than the plant crops. Oworu (1988) reported yield increases with increasing concentration of asulam used in both plant and ratoon crops. Cane yield decreased with increasing concentration of asulam in the mixture with Actril DS just like in the plant crop. Yields obtained from the ratoon crop were generally higher than those obtained from the plant crop. This is due to the fact that more moisture was available for the growth of the ratoon crop compared to the plant crop. In addition, the generally lower weed growth in the ratoon than in the plant crop could have been responsible for this.

The times of application (3, 6, & 10 WAP; and 6, 10 & 12 WAH) of the herbicides did not significantly affect weed control effectiveness and cane yield (Tables 2, 3, 4, & 5). The phytotoxicity of the herbicide treatments was however affected by the time of application in the plant crop. Application of the herbicides at 10 WAP resulted in significantly higher phytotoxicity than application at either 3 or 6 WAP. There was no such effect in the ratoon crop.

On the basis of the weed control effectiveness, selectivity, and cane yield, there is no advantage in using more than 3.5 kg/ha of asulam in the plant crop. On these same bases, the rate could be as high as 5.0 kg/ha in the ratoon crop.

Table 4: INFLUENCE OF HERBICIDE TREATMENTS AND TIME OF APPLICATION ON CANE YIELD AND YIELD ATTRIBUTES IN THE PLANT CROP.

Herbicides	Weed Control treatment Rate (Kg a.i. or a.e./ha)	Millable stalk population (no. x 10 ⁴)					Brix (%)					Cane yield (t/ha)				
		3 WAP	6 WAP	10 WAP	Mean	3 WAP	6 WAP	10 WAP	Mean	3 WAP	6 WAP	10 WAP	Mean			
Asulam	3.0	6.4	5.8	6.0	6.1	21.8	21.0	21.2	21.3	27.1	24.0	16.2	22.5			
Asulam	3.5	7.9	6.9	6.6	7.1	21.8	20.5	21.0	21.1	28.2	29.8	23.3	27.1			
Asulam	4.0	6.8	6.9	7.0	6.9	21.3	21.2	21.2	21.2	16.2	24.2	31.3	23.9			
Asulam	5.0	6.9	4.8	5.5	5.7	21.7	21.5	21.5	21.6	22.2	29.1	19.8	23.7			
Asulam + Acril DS	3.0 + 1.75	6.9	5.6	5.7	6.2	21.5	22.0	21.7	21.7	28.9	20.7	16.9	22.2			
Asulam + Acril DS	3.5 + 1.75	7.3	5.9	6.4	6.1	21.3	21.7	22.0	21.7	32.5	24.7	18.0	25.0			
Asulam + Acril DS	4.0 + 1.75	5.9	5.9	5.4	5.7	20.8	21.7	20.8	20.8	21.6	22.7	15.0	19.7			
Asulam + Acril DS	5.0	5.0	6.6	5.4	5.7	20.8	20.7	20.8	20.8	21.6	22.7	15.0	19.7			
Hand-weeded control	—	4.4	5.1	5.6	5.0	22.0	21.0	20.8	21.3	28.4	13.8	14.5	18.9			
Weed control	—	8.2	5.9	6.6	6.9	21.2	21.7	21.7	21.5	22.9	23.6	20.2	22.2			
Mean	—	5.3	5.1	6.3	5.6	21.0	21.5	21.0	21.2	18.9	16.2	24.7	22.2			
LSD (.05) for comparing:		6.4	5.9	6.1	—	21.5	21.3	21.3	—	24.7	22.9	19.9	—			
(a) two weed control means																
(b) two time of application means																
(c) two weed control treatment at same or different time of application																

* — values in parenthesis are standard errors

1.2 (0.62)*
NS (0.34)
NS (1.09)

NS (0.42)
NS (0.23)
NS (0.74)

NS (3.89)
NS (2.12)
NS (6.74)

Table 5: INFLUENCE OF HERBICIDE TREATMENTS AND TIME OF APPLICATION ON CANE YIELD AND YIELD ATTRIBUTES IN THE RATOON CROP.

Herbicides	Weed Control treatments Rate (kg a.i. or a.e./ha)	Millable stalk population (no.x10 ⁴)				Brix (%)			Cane yield (t/ha)				
		6 WAP	10 WAP	12 WAP	Mean	6 WAP	10 WAP	12 WAP	Mean	6 WAP	10 WAP	12 WAP	Mean
Asulam	3.0	8.0	8.9	9.6	8.8	17.3	16.2	15.0	16.2	44.4	36.9	53.6	45.0
Asulam	3.5	7.5	8.2	9.4	8.4	18.3	17.2	15.2	16.9	44.0	28.9	45.6	39.5
Asulam	4.0	8.8	9.2	8.8	8.9	15.0	14.7	17.3	15.7	46.4	55.3	49.6	50.4
Asulam	5.0	8.5	7.6	9.0	8.4	17.5	17.7	16.7	17.3	44.2	56.4	56.4	52.3
Asulam + Actril DS	3.0 + 1.75	9.4	9.8	8.5	9.2	15.7	15.7	17.2	16.2	41.1	52.9	62.0	52.0
Asulam + Actril DS	3.5 + 1.75	8.3	7.4	7.6	7.8	16.0	17.3	16.7	16.7	43.1	58.4	35.4	46.0
Asulam + Actril DS	4.0 + 1.75	8.1	8.8	9.1	8.7	17.2	16.2	16.2	16.5	42.4	51.6	35.3	43.1
Asulam + Actril DS	5.0 + 1.75	8.8	8.0	8.7	8.5	15.5	15.6	16.5	15.9	38.4	40.2	47.1	44.9
Hand-weeded control	—	9.3	9.0	8.9	9.1	16.3	15.5	15.8	15.9	49.6	42.9	50.4	47.6
Weedy control	—	6.3	8.5	7.6	7.5	15.8	15.3	17.5	16.2	58.9	34.2	41.6	44.9
Mean		8.3	8.5	8.7	—	16.5	16.11	16.4	—	45.3	45.8	47.8	—

LSD (.05) for comparing:

(a) two weed control means

(b) two time of application means

(c) two weed control treatments at the same or different time of application

* — values in parenthesis are standard errors.

NS (5.62)*

NS (3.05)

NS (9.74)

NS (0.82)

NS (0.45)

NS (1.42)

NS (5.88)

NS (3.22)

NS (10.19)

While the addition of Actril DS enhanced the weed control effectiveness of asulam in the plant crop, there was no such enhancement in the ratoon crop. Thus, the decision to use asulam alone or in combination with Actril DS should be determined by the weed spectrum and density of infestation. Whether used alone or in combination with Actril DS, asulam should be applied before 6 WAP in plant crops and before 10 WAH in ratoon crops of sugarcane.

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