

Comparative Performance of some Recommended Herbicides for Weed Control and increasing Yield of Sugarcane

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ABSTRACT

Seven promising recommended herbicides in different combinations were evaluated under field conditions for the efficacy of controlling weeds in sugarcane at the experimental plots of the National Cereals Research Institute at Moor Plantation, Ibadan during 1990-91 cropping year. Results obtained in both plant and ratoon crops at pre-emergence application of Diuron (3,3, 4-dichlorophenyl)-1, 1-dimethylurea) + Pendimethalin (N-1-1ethylprophyl)-3-4- diemthyl-2, 6 -dinitrobenzamine)+Paraquat (1,1-diemthyl-4-4 bipyridylum) at the rate of 2.8+4.0+0.3 kg a.i./ha showed the best results in terms of weed control and sugarcane tonnage when compared to the hand weeding and no weed control and other recommended herbicides. This was closely followed by hand weed control and thirdly pre-emergence application of Pendimethalin+ Atrazine (2-ctoro-4-triazine ethylamino-6-(isopropylamino)-1,3,5-traizaine) @ 3.5+6.0 kg a.i./ha resulted best than no weed control. Other treatment with different combination and dozes e.g., Diuron+ Hexazinone, Diuron+ Hexazinone fb., Hexazinone+ Paraquat, and Simazine @ 2.0+0.7, 2.0+0.7 fb., 0.5+0.3, and 6.0 respectively showed almost similar result in controlling weed and to increase yield compared to no weed control. Pre-emergence application of Diuron +2,4D+Paraquat @ 2.8+1.6+0.3 and Atrazine+2,4D+ Paraquat @ 3.2+1.6+0.3 did not show good results in controlling weed rather they significantly reduced yield compared to all other treatments except no weed control. In all the treatments, due to chemical control of weed, no significant differences in juice quality as expressed in refractometer solids was not observed.

INTRODUCTION

Sugarcane like many other perennial crops is very sensitive to weed competition particularly during its early stage of growth. The need to control weeds in sugarcane before close in becomes imperative when it is realised that weed infestation occurs quite often because of the apparent long growing period of the crop (Oworu 1988). In Nigeria hand weeding is the most common weed control practice and a large number of sugarcane small holding still indulge in this practice. Apart from being expensive, the unreliability of labour for weeding in terms of availability makes precision difficult to attain (Olunuga and Akobundu, 1980). The mass exodus of the available farm labour to the urban centres and the rising wages demand a less labour intensive and more weed control methods that will attract more producers, increase their unit area of production and

invariable the national production (Ladoke *et al.* 1981). Hand weeding is still an important feature of weed control in small sugarcane holdings although large areas under plantation system are being increasingly treated with herbicide in recent times.

Some scientists in Nigeria have screened and evaluated a number of herbicide for weed control in sugarcane and have found that some to the herbicide used either alone or in combination with other herbicide were quite satisfactory to control of weed and to increase sugarcane tonnage. Odojin (1980) who worked at the Nigerian Sugar Company, Bacita reported that the weed control programme of the company involved a post-emergence combination of residual, translocated and contact herbicide. The author postulated that the weed control programme involved the combined application of diuron, 2, 4D and paraquat which were applied at the rate of 2.8+0.2-0.4 kg a.i./ha respectively. In the higher soil, Atrazine is substituted for Diuron at 3kg a.i./ha. Odojin (1980) also found that neither of the two residual herbicide Diuron and Atrazine could satisfactorily suppress nutsedge (*Cyperus rotundus* L.) and corngrass (*Rottboelia exaltata* L.) reported to be the major weed species at the Bacita Sugar Estate. In an experiment in which six herbicides were evaluated for their efficacy in controlling weeds in sugarcane at Moor plantation, Ibadan, Nigeria, Oworu (1981) found that Simazine applied pre emergent of weeds at 6.0kg a.i./ha gave the best weed control and increased sugarcane tonnage in a plant and ratoon crops. The same author (1988) working on weed control in sugarcane with various herbicide combinations found that pendimethaline+Atrazine applied pre-emergence at the rate of 3.5+6.0 kg a.i./ha gave the best weed control and increased tonnage at the Bacita Sugar Estate.

Fadayomi (1983) working in Ilorin found that early post emergence application of Diuron+Hezaxazine at 2.0+0.7 kg a.i./ha and Diuron+Pendimethalin+ Paraquat at 2.8+4.+0.3 kg a.i./ha, or Diuron+Hezaxazine at 2.0+0.7 kg a.i./ha applied as early post emergence followed by Hexazinone+ Paraquat at 0.5+0.3 kg a.i./ha has direct post-emergence, gave satisfactory weed control without any crop injury. These findings by various workers had pleaded for more vigorous comparative evaluation of the efficacy of some of the promising herbicide and this experiment was undertaken to recommend suitable herbicides and their combination for the Nigerian Sugar Industry.

MATERIALS AND METHODS

The trial, was planted on 27th April 1990 on the experimental sites of the National Cereals Research Institute at Moor Plantation, Ibadan. Sugarcane variety Co 1001 was used in the experiment. The plant crop was harvested after 12 months, and a ratoon crop was further grown for another 12 months. The herbicides used included Atrazine, 2,4-D, Diuron, Paraquat, Pendimethalin, Simazine and Hexazinone (Table 1) and were used either alone or in combination at the recommended rates (Table 3). They were compared with hand weeded and no weeding controls in randomized block design replicated four times.

Table 1. Common and chemical names and formulation concentration of chemicals used.

Common name	Chemical name	Formulation concentration
Atrazine	2-chloro-4-(ethylamino-6-(isoprophylamino)-1,3,5-triazine)	80% wettable powder
2,4D	2,4 -dichlorophenoxy acetic acid	
Diuron	3-(3,4-dichlorophenyl)-1,1-dimethylurea	80% wettable powder
Paraquat	1,1-dimethyl-4,4-bipyridylum	
Stomp	Pendimethalin (N-1-ethylpropyl) 3-4-dimethyl-2,6-dinitrobenzamine)	500g/litre emulsifiable concentrate
Simazine	2-chloro-4-6bi(ethylamino)-s-triazine	80% wettable powder
Hexazinone	3-cyclohexyl-6-dimethylamino-1-methyl-1,3,5-triazine 2,5 (1H,3H)- dione	90% wettable powder

Each plot was made up of six row, 1.5m apart and 6m long with 3m discard rows between each plot. Fertilizers were applied to each plot at planting at the rate of 156,56 and 56 kg of N, P_2O_5 and K_2O per hectare respectively (Oworu, 1988). All the herbicides were applied as pre-emergence within 2-4 days after planting using hand operated "Knapsack" sprayers. Herbicidal phytotoxicity symptoms on the crop were organoleptically scored at fortnightly intervals beginning from forty days after application till February 1991 and 1992 for both plant and ratoon crops respectively, using the rating scale of (1-no toxicity, 5-plant killed) (Table 3). Weed control was also visually scored at fortnightly intervals before close-in using the rating scale (0-no control, 1-excellent control) (Table 3).

From four 1m² quadrates placed in plots at 14, 20 and 24 weeks after herbicide application, the dried weight of weeds were determined. The harvested weeds were oven dried to a constant weight at 80°C for 24 hours and expressed as g/m².

The application of all the herbicide to the ratoon crop was carried out six days after the removal of the plant crop and weeds. All other operations were the same as in the plant crop. Fertilizers were, however, ringed round the ratoon stubble and the two crops were harvested twelve months after planting and ratooning. Refractometer solids (RS) which are the potential juice quality of the crops were measured using a hand refractometer at harvest in the two crops.

RESULTS AND DISCUSSION

The weed species commonly encountered on the experimental plots are shown on Table 2. Most of the weeds are similar to those reported by Oworu (1988). The most serious ones included *Chromola odorata* (L), *Rottboelia exaltata* (L), *F. Imperata cylindrica* (L), *P. beav* and *Paspalum scrobiculatum* (L.).

Table 2. Weed species commonly found on experimental plots at Moor plantation, Ibadan.

Weed	Family
<i>Imperata cylindrica</i> (L.) P. Beauv.	Gramineae
<i>Roettbochia exaltata</i> (L.) f.	Gramineae
<i>Cynodon plectostachyus</i> (Pilger)	Gramineae
<i>Paspalum scrobiculatum</i> (L.)	Gramineae
<i>Setaria anceps</i> (Stafl and Massey)	Gramineae
<i>Crotolaria naragutensis</i> (Hutch.)	Papilionaceae
<i>Hibiscus asper</i> (Hook) f.	Malvaceae
<i>Eleusine indica</i> (L.) Gaerth	Gramineae
<i>Chromolaena odorata</i> (L.)	Compositae
<i>Cyperus rotundus</i> (L.)	Cyperaceae

The phytotoxicity and weed control effectiveness of the various recommended herbicide treatments are presented on Table 3.

Table 3. Effects of herbicides on toxicity and weed control ratings in the plant and ratoon canes.

Herbicide	Weed control treatments						
	Rate	Time of application		Toxicity rating 30 DAA		Weed control rating	
		Plant (DAP)	Ratoon (DAH)	Plant	Ratoon	Plant	Ratoon
Diuron+Hexazinone	2.0+0.7	2	2	1	1	2	2
Diuron+Pendimethalin							
+Paraquat	2.8+4.0+0.3	2	2	1	1	1	1
(Diuron+Hexazinone)fb	2.0+0.7fb						
(Hexazinone+Paraquat)	0.5+0.3	2	2	1	1	2	2
Simazine	6.0	4	4	1	1	2	3
Pendimethaline+Atrazine	3.5+6.0	4	4	1	1	2	1
Diuron+2,4D+Paraquat	2.8+1.6+0.3	2	2	1	1	7	3
Atrazine+2,4D+Paraquat	3.2+1.6+0.3	2	2	1	1	4	4
Hand weeded control	Four times	40,65,	40,75,				
		105,150	110,165	—	—	1	1
No weed control	—	—	—	—	—	9	9

1. DAP—days after planting; DAH—days after harvest.

2. DAA—days after application; Toxicity rating: 1-no toxicity; 2-slight toxicity; 3-moderate toxicity; 4-severe toxicity; 5-plant killed.

3. Weed control rating: 1-excellent; 2-3 good; 4-5 fair; 6-7 poor; 8-9 no control Fb—followed by.

All the herbicides showed no toxicity in both the plant and ratoon crops of sugarcane. The weed control rating was excellent for plots treated with Diuron+Pendimethalin+paraquat applied at the rate of 2.8+4.0+0.3 kg a.i./ha. All the other treatments had good weed control ratings. However, when Atrazine was substituted for diuron at the rate of 2.3 kg a.i./ha and used in combination with 2, 4D+ paraquat at the rate of 1.6+0.3 kg a.i./ha, the weed control rating was only fair. All the treatments where herbicides were used recorded better weed control ratings over the control plots. The identical ratings as the best were recorded in the plots treated with Diuron+Pendimethalin+Paraquat at the rate of 2.8+4.0+0.3 kg a.i./ha and in the hand weeded control plots which received four manual weedings each during the plant and ratoon growing periods.

Table 4. Effects of herbicides on weed weight, tillering, yield and refractometer solids in plant and ratoon crops.

Herbicide	Weed control treatments									
	Rate (kg a.i./ha)	Time of application	Weed weight (g/m ²)		Tillers/plot		Cane yield (t/ha)		RS	
			Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
Diuron+										
Hexazinone	2.0+0.7	2	285 a	247 c	218 e	202 e	47.8 d	44.4 d	17.4	17.6
Diuron+										
Pendimethaline										
+Paraquat	2.8+4.0+0.3	2	135 d	102 d	415 d	289 a	72.8 a	73.0 a	17.8	18.8
Diuron+										
Hexazinone fb	2.0+0.7fb									
Hexazinone+	0.5+0.3									
Paraquat		2	293 c	258 c	258 d	235 d	50.4 d	48.6 d	18.0	17.4
Simazine	6.0	4	148 d	150 d	278 c	259 c	60.1 c	58.5 c	18.3	17.6
Pendimethalin										
+ Atrazine	3.5+6.0	4	140 d	148 d	285 c	248 c	60.7 c	58.5 c	18.6	17.4
Diuron + 2,4D	2.8+1.6+0.3									
+Paraquat		2	320 b	275 b	204 f	200 e	46.9 d	36.8 c	17.4	17.0
Atrazine+2,4D	3.2+1.6+0.3									
+Paraquat		2	328 b	284 b	198 f	188 e	39.6 e	68.8 b	16.8	16.8
Hand weed	Four times									
Control	40,60,105,150		54 e	66 e	400 b	360 b	67.2 b	68.8 b	18.6	18.2
No weed control	-	-	895 a	1085 a	125 g	104 f	23.5 f	21.7 f	17.2	18.8
									NS	NS

1. DAP-Days after application

2. t/ha- tonnes/ha

3. RS- Refractometer solids

4. Means followed by common letters are not significantly at 5% level (DMRT)

5. fb-followed by.

6. NS- Not significant

Tables 4 and 5 showed the effects of the various herbicides used in the experiment on weight, tillering, yield and refractometer solids of sugarcane in both plant and ratoon crops. There were significant differences between treatments. In the plant crop, the weed weight ranged from 54g/m² for the hand weeded control plots to 89g/m² for the no weeding control plots. The plots that received Diuron+Pendimethalin+Paraquat at the rate of 2.8+4.0+0.3 kg a.i./ha had a weed weight of 135g/m² which was not significantly better than those plots which received Simazine at 6.0 kg a.i./ha and Pendimethalin+ Atrazine at 3.5+6.0 kg a.i./ha. There were no significant differences in weed weight when Atrazine was substituted Diuron and applied at the rate of 3.2 kg a.i./ha in combination with 2,4-D+Paraquat applied at 1.6+0.3 kg a.i./ha respectively.

Table 5. Effects of herbicides on weed weight, tillering, yield and refractometer solids in a ratoon crop.

Herbicides	Weed control treatments					
	Rate (kg a.i./ha)	Time of application (DAH)	Weed wt. (g/m ²)	Tillers/ plot	Cane yield (t/ha)	RS
Diuron+Hexazinone	2.0+0.7	2	247 c	202 e	44.4 d	17.6
Diuron+Pendimethaline +Paraquat	2.8+4.0+0.3	2	102 d	289 a	73.0 a	18.8
Diuron+Hexazinone fb	2.0+0.7fb					
Hexazinone+Paraquat	0.5+0.3	2	258 c	235 d	48.6d	17.4
Simazine	6.0	4	150 d	259 c	58.9 c	17.6
Pendimethalin+ Atrazine	3.5+6.0	4	148 d	248 c	58.5 c	17.4
Diuron + 2,4D+Paraquat	2.8+1.6+0.3	2	275 b	200 e	44.7a	17.0
Atrazine+2,4D+Paraquat	3.2+1.6+0.3	2	284 b	188 e	38.8 b	16.8
Hand weed control	Four times					
	40,60,105,150		66 e	360 b	68.8 b	18.2
No weed control	-	-	1085 a	104 f	21.7 f	18.8
						NS

1. DAP-Days after harvest¹.

2. t/ha- tonnes/ha

3. RS- Refractometer solids

5. fb-followed by.

6. NS- Not significant

The tillers/ plot for the plots that received Diuron+Pendimathalin+ Paraquat at the rate of 2.8+4.0+0.3 kg a.i./ha were 415 which was significantly better in tillering and closely followed by the hand weeded control plots (400 tillers/plot). There were, however, no significant differences in tiller numbers between plots that were trated with Simazine at 6.0 kg a.i./ha those that received Pendimethalin+Atrazine at the rate of 3.5+6.0 kg a.i./ha respectively. Similar trend was observed when Atrazine was substituted at the rate of 3.2 kg a.i./ha for Diuron and used in combination with 2,4-D+Paraquat at the rate of 1.6+0.3

kg a.i./ha respectively. The trend in yield showed that the plots which were treated with Diuron+Pendimethalin+Paraquat at the rate of 2.8+4.0+0.3 kg a.i./ha have the best yield of 72.8 t/ha followed by the hand weeded plots (67.2 t/ha). There were no significant differences in yield between the plots that were treated with Simazine at the rate of 6.0 kg a.i./ha and those that were treated with Pendimethalin+Atrazine at the rate of 3.5+6.0 kg a.i./ha. The substitution of Atrazine at the rate of 3.2 kg a.i./ha for Diuron and used in combination with 2,4D+Paraquat at the rate of 2.6+0.3 kg a.i./ha depressed yield by about 7.3 t/ha. When Diuron+Hexazinone at the rate of 2.0+0.7 kg a.i./ha was followed by Hexazinone+Paraquat at the rate of 0.5+0.3 kg a.i./ha, there were no significant differences in yield between the two treatments. No significant differences were obtained in refractometer solids.

Similar trend were obtained in the ratoon crop (Table 4). The weed weight ranged from 102g/m² for the plots were treated with Diuron-Pendimethalin+Paraquat at the rate of 2.8+4.0+0.3 kg a.i./ha to 1085g/m² for the no weeding control plots. There were no significant differences in weight between the plots that were treated with Samzine at the rate of 6.0 kg a.i./ha and those that were treated with Pendimethalin+ Atrazine at the rate of 3.5+6.0 kg a.i./ha. When Atrazine was substituted for Diuron with 2,4-D and Paraquat there were no significant differences in weed weight. Similar trend was observed when Diuron+ Hexazinone was applied at the rate of 2.0+0. 7 kg a.i./ha and was followed by Hexazinone and paraquat of 0.5+0.3 kg a.i./ha This was also reflected in the yield which ranged from 73.9 t/ha for this treatment to 21.7 t/ha for no weeding control plots. As the plant crop, no significant differences in refractometer solids were obtained.

Data presented in this comparative study, indicated that the combined application of Diuron+Pendimethalin+Paraquat at the rate of 2.8+4.0+0.3 kg a.i./ha gave the best weed control sugarcane yield in both plant and ratoon crops (Tables 3 and 4). The highest yields of 72.8 and 73.9 tonnes/ha were obtained from this treatment in both plant and ratoon crops respectively. This treatment was closely followed by Pendimethalin+Atrazine applied at the rate of 3.5+6.0kg a.i./ha. It is possible that the combination of the lower solubility and probably greater persistence in the soil of the Pendimethalin and the translocatory effect of other chemicals presumably may account for their efficacy and better performance.

Fadayomi (1983) found that early post-emergence application of Diuron+ Pendimethalin+Paraquat applied at the rate of 2.8+4.0+0.3 kg a.i./ha gave satisfactory weed control. Oworu (1988) obtained similar good results in both plant and ratoon crops when Pendimethalin+ Atrazine were applied pre-emergence at the rate of 3.5+6.0 kg a.i./ha.

Hoogstraten (1981) obtained satisfactory weed control in experiments conducted in Ivory Coast, Ghana and Upper Volta using a combination of Pendimethalin+Atrazine at 1.5+2.0 kg a.i./ha. At a lower rate of 0.7+1.12 kg a.i./ha, the yields of sugarcane were better than those obtained from the hand weeded plots (Oworu, 1988). In both the crops,

weed competition was also reflected in the tiller number as large quantity of weed was associated with lower tiller number consequently lower yield. This result was corroborated by the findings of Oworu (1988).

The refractometer solids or brix ranged from 18.6 to 17.2 for the Pendimethalin+Atrazine treatment (3.5+6.0 kg a.i./ha) in the plant crop to 18.8 to 16.8 and for the Diuron+Pendimethalin+Paraquat treatment (2.8+4.0+0.3 kg a.i./ha) respectively in the ratoon crop and the control. No significant effect of weed competition was found on the amount and quality of sugar stored in the plant in both the crops. This result is corroborated by the findings of other workers (Hilton and Osgood, 1972; Fadayomi, 1983 and Oworu, 1981).

The results obtained in this experiment showed that the best chemicals for weed control in sugarcane are the combination of Diuron+Pendimethalin+Paraquat and these chemicals may be recommended for further work in the sugar industry and the various ecosystems where sugarcane is grown to confirm the present tentative results.

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