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Effect of pre-emergence herbicides on yield and yield components of rice

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Abstract

Field trials were conducted during 2001 and 2002 rainy seasons at Samaru in the Northern Guinea Savanna of Nigeria to evaluate the performance of some herbicides for weed control in rice. Cinosulfuron at 0.06 kg a.i/ha and the two hoe weedings in 2001and piperophos at 1.0 kg a.i/ha, cinosulfuron at 0.06 and 0.08 kg a.i/ha and the two hoe weedings in 2002, significantly reduced weed dry weight at harvest. All the treatments with the exception of cinosulfuron at both rates significantly increased crop vigour, plant height and plant dry matter per stand of rice. Panicle number per stand was significantly enhanced by all the treatments except cinosulfuron at 0.06 kg a.i/ha in 2001 and piperophos at 1.0 kg a.i/ha, cinosulfuron at 0.06 and 0.08 kg a.i/ha and the weedy check in 2002. All treatments significantly increased the number of tillers per stand except cinosulfuron at both rates in 2001 and piperophos, cinosulfuron and the weedy check in 2002. Grain yield of rice was significantly increased when oxadiazon and piperophos at 1.0 kg a.i/ha and the two hoe weedings treatments in 2001 were applied. In 2002, all the treatments significantly increased rice grain yield except cinosulfuron and the weedy check.

Key words: Weedy check, hoe weeding, butachlor, oxadiazon, piperophos.

Introduction

Rice (*Oryza sativa* L.) is a cereal crop adapted to both flooded and non-flooded soils [9]. It is the second most important cereal crop after wheat in the world [4]. The earliest cultivation of rice in Nigeria dates back to 1890, when upland varieties were introduced into the rain forest zone of Nigeria [9]. Each year about 11 million hectares of upland rice is planted in Asia, compared with 2 million hectares in Africa and 6 million hectares in Latin America [5]. The estimated world paddy rice production between 1993/94 seasons stood at 520.2 metric tonnes out of which Africa contributed 14.8 metric tonnes, about 3.4 metric tonnes was produced in Nigeria [5].

Rice grains are boiled and eaten whole with spiced stew, soup and vegetable, it is also used in industries for making rice wines, alcohol, beverages and textile manufacture [7, 9]. The rice bran is also high in protein and hence ideal for use in livestock feed to act as roughage and protein source [16]. Rice production in Nigeria is seriously constrained by weed infestation. Weeds affect rice crop by competing for nutrients, light, water and space. In Nigeria an average yield reduction due to uncontrolled weed growth in the field is given to range between 80-100% [2]. Total crop failure may occur in upland rice if weed are not controlled effectively [12]. Methods used to control weeds in rice include manual, mechanical and biological which are known to be labour intensive, costly and may not be easily available at the time of need. Consequently, an innovative technology devoid of the above constraints such as the use of herbicides could be considered as an alternative option in weed control of rice. Therefore, the study was undertaken with the objective of evaluating the performance of some pre-emergence herbicides effect on weeds, yield components and yield of rice.

Materials and Methods

Pre-emergence herbicide field trials were conducted at the farm of the Institute for Agricultural Research, Samaru (11°11'N, 7°38'E) in the Northern Guinea Savanna of Nigeria during the wet seasons of 2001 and 2002. The annual rainfall received during the respective cropping seasons was 1228 and 1007 mm. The soils of the area are broadly classified as Alfisols, which are formed on drift materials overlying the basement complex. The experimental land was ploughed and harrowed twice to obtain a fine tilth at the beginning of the rainy season. The land was thereafter formed into basins of gross and net plots sizes of 12 m^2 and 8 m^2, respectively. Planting was done by drilling method at the rate of 100 kg/ha at inter and intra row spacing of 25 cm using rice variety BG90 which is early maturing. The rice was sown on 23rd June 2001 and 14th July 2002, respectively. The treatments consisted of butachlor, oxadiazon and piperophos at 1.0 and 1.5 kg a.i/ha and cinosulfuron at 0.06 and 0.08 kg a.i/ha with two-hoe weedings and a weedy check included in a randomized complete block design of four replicates.The pre-emergence herbicides were applied a day after sowing using a CP3 Knapsack sprayer in 250 L/ha spray volume at a pressure of 2.1 kg/cm^3 using a green deflector nozzle. Weeding was carried out at 3 and 6 weeks after sowing (WAS) for the two hoe weeded treatment. Fertilizers were applied by broadcasting at the rate of N 70 kg at two split applications at 3 and 6WAS while 30 kg P_2O_5 and 30 kg K_2O per hectare were applied at 3WAS only to the rice using urea, single super phosphate and muriate of potash as sources of N, P and K respectively. Data was collected on weed cover score, weed dry weight, crop vigour score, plant height, plant dry matter per stand, number of panicles per stand, number of rice tillers per stand and grain yield at harvest. The data collected were subjected to

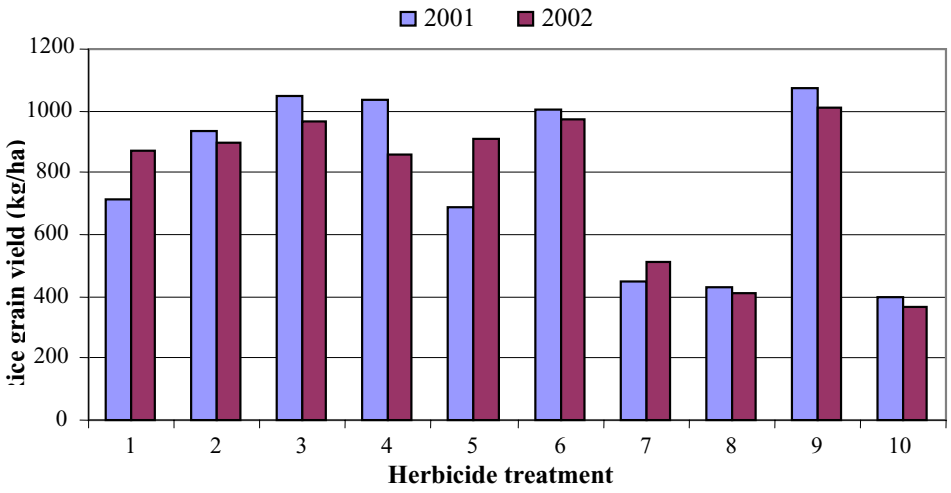

Figure 1. Rice grain yield (kg/ha).

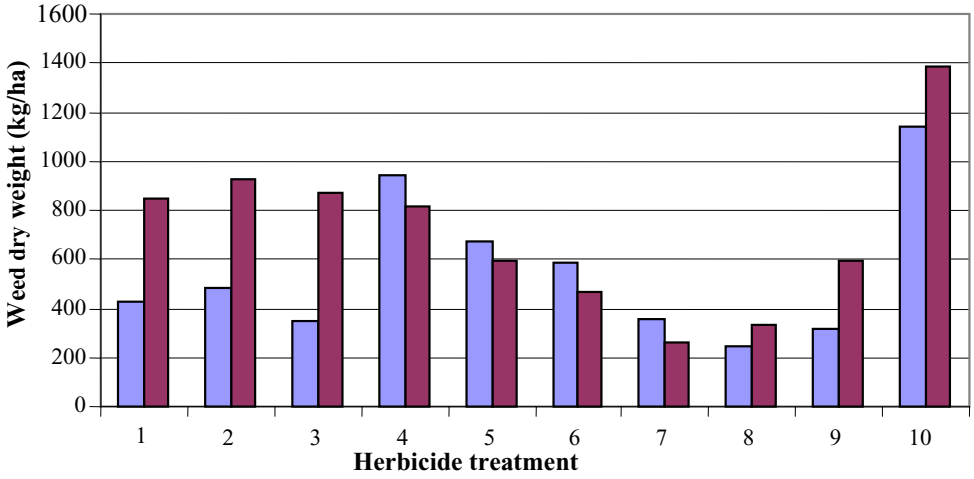

Figure 2. Weed dry weight (kg/ha).

Key = Butachlor (1.5 kg a.i/ha),2=Butachlor (1.0 kg a.i/ha)
3=Oxadiazon (1.5 kg a.i/ha),4=Oxadiazon (1.0 kg a.i/ha),
5=Piperophos (1.5 kg a.i/ha),6=Piperophos(1.0 kg a.i/ha),
7=Cinosulfuron(0.08 kg a.i/ha),8=Cinosulfuron(0.06 kg a.i/ha),
9=Hoe weddings (3 and 6WAP),10=Untreated, *a.i=active ingredient

statistical analysis of variance and the significant difference among the means were compared using Duncan multiple range test Duncan [8].

Results

Effect of herbicides on weeds: The most dominant weed flora observed on the experimental site included the broadleaved species *Commelina bengalensis, Chenopodium album, Eclipta prostata, Convulvulus arvensis* and the sedge *Cyperus rotundus*. Weed infestation was generally worst in 2002 and less in the other season (Tables 1 and 2). Oxadiazon at 1.5 kg a.i/ha, cinosulfuron at 0.06 and 0.08 kg a.i/ha in both seasons resulted in the least weed cover score than the highest which was recorded by the weedy check and butachlor at 1.5 kg a.i/ha in 2001 and the weedy check only in 2002. Oxadiazon at 1.5 kg a.i/ha, cinosulfuron at 0.06 and 0.08 kg a.i/ha and the two hoe weeding significantly reduced weed dry weight at harvest in 2001. However, in 2002 the application of piperophos at 1.0 kg a.i/ha, cinosulfuron at 0.06 and 0.08 kg a.i/ha and the two hoe weeding significantly reduced weed dry weight at harvest. The weedy check significantly had the highest weed dry weight at harvest than all the other treatments in both years with the exception of oxadiazon at 1.0 kg a.i/ha in 2001 and butachlor at 1.0 kg a.i/ha in 2002, which was statistically similar to the weedy check (Tables 1 and 2).

Effect of herbicides on crop growth: In 2001 and 2002 seasons all the herbicide treatments enhanced crop vigour except cinosulfuron at 0.06 and 0.08 kg a.i/ha and the weedy check, which had the poorest rice growth (Tables 1 and 2). All the herbicide treatments consistently increased the height of rice crop except cinosulfuron at 0.06 and 0.08 kg a.i/ha in both years and the weedy check in 2001 that produced the shortest plants. Significantly heavier plant dry matter of rice was produced by most of the herbicide treatments and the two hoe weeding than when butachlor at 1.0 kg a.i/ha, cinosulfuron at both rates were applied and weedy check in 2001. In 2002 cinosulfuron at both rates and the weedy check recorded the least rice dry matter (Tables 1 and 2).

Effect of herbicides on yield components: Most of the herbicides applied and the two hoe weeding had resulted in significantly more tillers per stand than that obtained with the application of cinosulfuron at 0.06 and 0.08 kg a.i/ha and the weedy check in both seasons as well as piperophos at 1.0 and 1.5 kg a.i/ha in 2002 (Tables 1 and 2). The number of panicles per stand was increased by all the herbicide treatments, except cinosulfuron at 0.06 kg a.i/ha in 2001, piperophos at 1.0 kg a.i/ha, cinosulfuron at 0.06 and 0.08 kg a.i/ha and the weedy check in 2002 (Tables 1 and 2). All the herbicide treatments with the exception of butachlor at 1.5 kg a.i/ha, piperophos at 1.5 kg a.i/ha, cinosulfuron at 0.06 and 0.08 kg a.i/ha and the weedy check had significantly increased the grain yield of rice in 200. In 2002 rice grain yield was significantly enhanced when two hoe weedings and all the herbicide treatments except cinosulfuron at 0.06 and 0.08 kg a.i/ha were applied as well as in situation when the plots were left weedy (Tables 1 and 2).

Discussion

Weed cover score and weed dry matter production was significantly influenced by the imposed herbicide treatments. Cinosulfuron at 0.06 and 0.08 kg a.i/ha and oxadiazon at 1.5 kg a.i/ha significantly reduced these parameters compared to the other treatments during the course of this investigation. While

Table 1. Effect of Pre—emergence herbicides on weed dry matter, yield components and yield of Rice at Samaru 2001 wet season.

Treatment	Rate kg a.i/ha	Weed score[1] 6WAP[3]	Weed weight at harvest, kg/ha	Crop vigour[2] WAP	Plant height 9WAP, cm	Dry matter/ stand g	Panicle/ stand	Tillers/ stand	Grain yield at harvest kg/ha
Butachlor	1.5	6.4ab[4]	428cde	5.8ab	70.31a	33.6a	14.00a	8.0ab	712bc
"	1.0	5.5b	480bcde	5.2abc	67.3ab	25.8b	14.00a	8.0ab	933ab
Oxadiazon	1.5	2.4c	347c	5.7ab	68.1ab	30.1a	11.00ab	11.0a	1047a
"	1.0	5.7b	943ab	4.5bcd	73.7a	31.5a	13.00a	10.0a	1037a
Piperophos	1.5	5.2b	673b	4.3cd	70.5a	36.9a	11.00ab	7.0abc	691bc
"	1.0	5.6b	583bcd	6.0a	73.5a	30.7a	13.00ab	7.0abc	1007a
Cinosulfuron	0.08	2.7c	355c	2.2e	50.5b	2.5c	10.00ab	4.0cd	449cd
"	0.06	2.3c	248e	2.7e	52.3b	21.7c	8.00b	3.0cd	431d
Hoe weeding at 3 & 6 WAP		5.5b	315e	5.6ab	69.2ab	35.2a	14.00a	12.0a	1072a
Weedy check		7.6a	1138a	3.2de	56.7b	23.5c	11.00ab	5.0bc	401d
SE ±		0.27	3.70	0.32	1.68	3.97	1.11	0.19	1.40

[1]Weed cover score using a scale of 0-10; whereas, 0 means no weed cover at all, while 10 means complete weed cover. [2]Crop vigour score using a scale of 0-10; whereas, 0 means dead plants, while 10 means very healthy plants. WAP = Weeks after sowing [4]Means within a column do not differ at 0.05 level of probability using Duncan Multiple Range Test (DMRT).

Table 2. Effect of pre-emergence herbicides on weed dry matter, yield components and yield of Rice at Samaru 2002 wet season.

Treatment	Rate kg a.i/ha	Weed score[1] 6WAP[3]--	Weed dry weight at harvest, kg/ha	Crop vigour[2] 6WAP	Plant height 9WAP, cm	Dry matter/ stand, g	Panicle number/ stand	Tillers/ stand	Grain yield at harvest, kg/ha
Butachlor	1.5	4.7b	847b	6.2ab	80.00a	43.3ab	13.00ab	13.0ab	871ab
"	1.0	4.9b	929ab	5.1cd	87.00a	43.7ab	12.00ab	12.0ab	897ab
Oxadiazon	1.5	3.0e	875b	6.5a	82.40a	39.9ab	14.00a	12.0ab	965a
"	1.0	5.1b	812bc	6.0abc	87.7a	50.0ab	13.00ab	14.0a	862ab
Piperophos	1.5	4.2c	591cd	5.5bc	82.1a	44.6ab	18.00ab	10.0b	911ab
"	1.0	5.3b	498d	6.5a	86.6a	61.2ab	9.00bc	10.0b	970a
Cinosulfuron	0.08	2.9e	259e	2.6e	55.4b	29.6c	9.00bc	10.0b	512cd
"	0.06	2.4e	329de	2.8e	53.5b	30.1c	11.00bc	10.0b	412d
Hoe weeding at 3 & 6 WAP		4.8bc	594d	5.6abc	82.1a	42.4ab	15.00a	14.0a	1011a
Weedy check		8.0a	1388a	4.3d	89.0a	38.7bc	7.00c	3.0c	366d
SE ±		0.28	7.74	0.19	1.79	4.92	0.78	0.17	4.92

[1]Weed cover score using a scale of 0-10; whereas, 0 means no weed cover at all, while 10 means complete weed cover. [2]Crop vigour score using a scale of 0-10; whereas, 0 means dead plants, while 10 means very healthy plants. [3]WAP = Weeks after sowing [4]Means within a column do not differ at 0.05 level of probability using Duncan Multiple Range Test (DMRT).

piperophos at 1.0 kg a.i/ha was effective in depressing weed dry weight only in 2002 as compared to the other treatments. Cinosulfuron is a broad spectrum herbicide which controlled most of the weed species in the field thus reducing weed cover score and weed dry matter. Oxadiazon was also able to reduce weed cover score and weed dry matter probably due to its low solubility in water and could remain on the soil surface were its herbicidal activity persists for several months [2]. Piperophos at 1.0 kg a.i/ha was able to depress weed dry weight only in 2002, which might have been due to the high rainfall received in 2001which might have resulted in increase in the solubility of the chemical and in turn resulted in it to be leached below the root zone of the weeds. Cinosulfuron + piperophos has been recommended for the control of weeds in cereal crops such as rice and wheat [6]. Oxadiazon and its mixture with propanil have been reported to be selective on small grain cereals crops such as flooded and upland rice varieties under both rain fed and irrigated conditions [3, 13, 15]. Post emergence application of oxadiazon plus propanil effectively controlled weeds and gave comparable rice grain yield to two hoe weedings at 3 & 6 WAP in USA [15]. In Philippines [3] and Chad Basin of Nigeria [13] reduction in weed dry weight was observed when cinosulfuron at 0.06 and 0.08 kg a.i/ha and oxadiazon at 1.5 kg a.i/ha were applied. This is as a result of the chemical efficacy to reduce the level of weed infestation, whereas the weedy check treatment was left weedy throughout the growing period thereby increasing the weed dry matter yield. The general positive effect of the herbicides in suppressing the weeds might be responsible for the promotion of crop growth, crop vigour score, number of tillers, plant height and grain yield of rice.

Such herbicides as butachlor, oxadiazon and piperophos at the given rates were apparently selective on rice since the said crop parameters were generally promoted by the use of these herbicides when compared to the untreated control. Weed control by the herbicides reduced weed competition in rice thereby giving the crop a better growing environment for enhanced growth and development. The high grain yields obtained from the application of oxadiazon at 1.0 kg a.i/ha and 1.5 kg a.i/ha and piperophos at 1.0 kg

a.i/ha and the two hoe weedings was due to the effective control of weeds in the field achieved from the use of these herbicides and with the good tolerance expressed by the rice crop to the chemicals. Pradhan and Choudhary [14] found that oxadiazon increased rice grain yield because it promotes the formation of more panicles, while Kulimi [11] reported that yields are increased with effective weed control in rice. The high yields obtained from the two hoe weedings was due to the effective weed control, which reduced weed interference and also increased the formation of more tillers which might have contributed to the grain yield increase, respectively. Imeokparia [10] reported that two hoe weeding produced higher grain yield of rice than that obtained when herbicides were applied. The weedy check treatment and cinosulfuron at 0.06 and 0.08 kg a.i/ha was observed to depress rice productivity. The reduction of yield by the weedy check can be attributed to the negative effect of weeds on the rice crop as a result of the weeds competition for nutrients, water, space and light. The depressive effect on rice productivity by cinosulfuron could be due to the depressive effect of cinosulfuron on rice growth and development caused by physiological inhibition of the synthesis of the enzyme acetolactate synthase in the crop by the chemical applied. This corroborates with earlier reports by Adu-Tutu and Drennan [1] that sulfonylurea herbicides particularly cinosulfuron applied at the rate of 40-60 g a.i/ha damaged maize under striga infestation.

Table 1 shows that weed dry matter production and rice grain yield were higher in both seasons. The production of higher grain yield of rice in 2001even with the high weed infestation could be due to the high rainfall received in that season. Although the variety used was an upland variety, researchers have shown that rice generally responds well under adequate moisture condition. The availability of moisture might have enhanced uptake of nutrients thereby leading to good growth and development of the crop thus able to withstand the stiff competition from the companion weeds.

Conclusions

From this study it could be concluded that the two hoe weedings or pre-emergence application of oxadiazon at 1.0 and 1.5 kg a.i/ha, butachlor at 1.5 kg a.i/ha and piperophos at 1.0 kg a.i/ha, can be adopted for effective control of weeds in rice fields in order to obtain high grain yield.

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