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EVALUATION OF SULFONYL-UREA HERBICIDES FOR PRE AND POST-EMERGENCE WEED CONTROL IN UPLAND RICE (*Oryza sativa* L.) AT SAMARU-ZARIA, KADUNA STATE

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ABSTRACT

Field trials were conducted during the 2010 and 2011 wet seasons at the institute for Agricultural Research farm, Samaru in the Northern Guinea Savannah zone of Nigeria to evaluate sulfonyl-urea Herbicides for Pre-and Post emergence weed control in upland rice. The trial consisted of 18 weed control treatments involving 11 Pre-emergence and four Post-emergence Herbicides, two hoe weeded controls and a weedy check, laid in Randomized complete Block Design (RCBD). The treatments were replicated three times Prosulfuron followed by (fb) Propanil at 0.02 fb 2.0 and 0.0. 2 fb 2.5 kg a.i/ha gave a good weed control in both trials and increased the grain field of paddy rice and was similar to the hoe weeded control. Cinosulfuron followed by propanil at 0.02 fb 2.0 and 0.02 fb 2.5 kg a.i /ha, and prosulfuron alone at 0.04 kg a.i/ha. Cinosulfuron at 0.02kg a.i/ha resulted in low grain yield and were similar to weedy check. Uncontrolled weeds throughout the crop life cycle resulted in 72.9% reduction grain yield compared to the best weed control treatment.

Keywords: Sulfonyl-urea; Herbicides; Weed control; Upland rice

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most widely grown cereal crops in the world (Opeke, 2006). According to Singh *et al.* (2001), growing areas of rice in Nigeria occupies 6.7% of the total area of 31 million hectares devoted to various food crops and it provides more than one fifth of the calories consumed worldwide by humans. Zieglar (2006) reported that in spite of rice been important as staple food the yield remains low due to yield losses caused by weeds which are known to constitute an important constraint to increase in rice paddy yield with losses ranging from 41 to 100% (WARDA 2008; Ishaya, 2004). In China 10 million tons of rice are lost annually due to weed competition (Ze-puzhan, 2001). In Nigeria, rice production is seriously constrained by weed infestation. Lavabre (1991) reported that a total crop failure may occur in upland rice if weeds are not controlled. In Nigeria, farmers adopted different methods of weed management such as cultural, biological, mechanical and chemical weed controls in paddy rice (Akobundu, 1987). At Kadawa in Nigeria hand pulling is the most common method of weed control used by farmers and is done 2 – 4 times before harvest (Kebbeb *et al.*, 2003). Cultural, mechanical and biological methods of weed control are slow and tedious (Akobundu,

1987), hand pulling method is very labourious, expensive, inefficient and only suitable for small scale rice production (Lagoke *et al.,* 1994). Addressing weed competition problem using herbicides is critical requirement for direct seeded rice production throughout the world (Malcom, 2004). In order to avoid these constraints various herbicides have been evaluated for pre-emergence and post-emergence weed control in rice singly or in combination with hoe weeding.

It has been shown that herbicides used at recommended rate offered good weed suppression and increased crop yield (Adekpe and Adigun, 2000; Grichar *et al*. 2004). Chemical herbicides could be selective or non-selective, contact or systemic, pre-emergence, post-emergence or pre-plant incorporated (Ado, 2007). Butachlor used as selective pre-emergence and pre-plant herbicide for the control of germinating annual weeds especially grasses (Akobundu, 1987). It was also reported by Akobundu (1987) that butachlor has good crop tolerance that make it suitable for use in rice based intercropped systems among small scale farmers in the tropics. It inhibits the growth of shoots and roots, as well as mesocotyl development, and this is considered as the mode of action of butachlor. This could be attributed to inhibition of protein synthesis, auxin production and cell expansion possibly by preventing the transfer of amino acyl-t RNA to the polypeptide Chain (Ashton and Craft, 1981). Propanil is a selective post-emergence or post-transplanting herbicide used to control many broad leaf weeds and grasses including *Echinochloa crussgalli* and *E colonum* in rice and it is the widely used herbicide throughout the tropics (Akobundu, (1987). It is light brown to grey black solid with moderate water solubility of about 500ppm (FAO, 1984). It is a contact herbicide and cause chlorosis followed by necrosis when applied on the foliage of susceptible species. A speckle pattern may be observed when it remains as small droplets on the leaves. It is absorbed relatively slowly by the leaves, since a 4 – 8 hours rain-free period after application is suggested. Ashton and Manaco (1991) reported that propanil alters membrane functions as evidenced by increased batacynic linkage from red beet tissue inhibits iron uptake by root and changes in cation permeability of mitochondria is most effective in the control of both grasses and broad leaf weeds if applied within 3 weeks of weed and rice emergence. Sulfonyl - urea herbicides are characterized by low mammalian toxicity and phytotoxicity particularly on broad leaf-weeds (Brown, 1990; Hay, 1990). They are applied either as Pre-emergence or Post emergence because they are taken up by plants through both the roots and foliage (Anon.1992). The sulfonyl urea, herbicides are group of compounds used to control grass and broad leaf weeds in numerous crops such as rice, wheat, soybeans and corn (Ferrero *et al.,* 2001). Examples of sulfonyl- urea herbicides are chlorosufuron, metasulfuron-methyl and sulfomefuron (Akobundu, 1987); other members are cinosulfuron, prosulfuron and nicosulfuron. Rice production in Nigeria is seriously constrained by weed infestation. Farmers have adopted various methods of weed control, such as cultural, biological and mechanical measures in order to curb the menace of weeds in rice (Kehinde *et al.,*2002) This measures are either very expensive to handle or are associated with drudgery. Chemical weed control is cheaper and faster than other methods of weed control especially in upland rice, it has been recorded to provide a better alternative to manual weeding (Akobundu, 1987). Hence the objectives of this trial was to determine the effect of sulfonyl-urea herbicides and their mixture with some pre-and post-emergence herbicides on weeds, as well as to determine the effect of sulfonyl-urea herbicides and their mixture with some pre- and post-emergence herbicides on rice.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out in the rainy seasons of 2010 and 2011 at the Teaching and Research Farm of the Institute for Agricultural Research Ahmadu Bello University Zaria, located on latitude 11^{o} 11,N longitude 7^{o} 38',E and 686m above sea level in the Northern Guinea Savannah Ecological zone of Nigeria

Experimental Design and Field Layout

The land was cleared harrowed, leveled and made into raised seed beds of 4x3m with 1.0m spacing between the seed beds. The seed beds constituted experimental gross plot of (12m^2) and net plot was 2 x 3 (6m^2). The trial was laid out in a Randomized Complete Block Design (RCBD) comprising of pre-emergence application of cinosulfuron and prosulfuron each at two rates (0.02 and 0.04 kg a.i./ha) butachlor at (2.00kg a.i./ha) cinosulfuron and prosulfuron plus butachlor each at two rates (0.02 + 1.0 and 0.02 + 1.5kg a.i/ha) cinosulfuron at 0.02kg a.i./ha followed by (fb) post-emergence application of propanil at 2.00kg a.i/ha and 2.5kg a.i/ha, prosufuron at 0.02kg a.i/ha fb post-emergence application of propanil at 2.0 and 2.5kg a.i/ha, cinosulfuron at 0.02kg a.i/ha fb supplementary hoe weeding (SHW) at 6 weeks after sowing (WAS) and prosulfuron at 0.02kg a.i/ha fb (SHW) at 6 WAS, two hoe weeding at 3 and 6 WAS , three hoe weeding at 3, 6 and 9 WAS and a weedy check. The experiment comprised of 18 treatments replicated three times. The pre-emergence herbicides were applied a day after sowing, while post-emergence herbicides were applied at 2 weeks after sowing.

Data Collection and Analysis

Data were collected using a quadrat of (0.5m^2), weed within it per plot were harvested to determine the effectiveness of different herbicides treatments in weed suppression. The number of grains per panicle was determined by taking 5 panicles in each plot and counting their number of grains and the average number was recorded. The crop was harvested from each net plot threshed and sun-dried to a constant weight and expressed in kilograms per hectare. Data collected were analyzed using analysis of variance procedures at 5% level of probability.

RESULTS AND DISCUSSION

Weed Dry Weight

Table 1 showed the effect of weed control on weed dry weight in rice. In 2010 each weed control treatment significantly reduced weed dry weight throughout the sampling period in relation to the weedy check. At 3WAS, weed dry weight in all the herbicides treatments were at par while weedy check produced significantly higher weed dry weight than the herbicides treatments.

Table 1: Effect of pre-and post- emergence herbicides on weed dry weight in upland rice during the wet season of 2010 at Samaru

Treatment	Rate (kg a.i/ha)	Weed dry weight (g/m^2)			
		3 WAS	6 WAS	9 WAS	12 WAS
Butachlor	2.00	17.13b	27.07c-h	36.03bc	52.27b
Cinosulfuron	0.02	15.83bc	29.70c-e	36.30bc	47.40b
Cinosulfuron	0.04	13.90cd	31.67c	33.50bc	47.43b
Prosulfuron	0.02	12.93cd	24.20h	29.97b-d	43.93b
Prosulfuron	0.04	14.90cd	25.30gh	33.43bc	43.13b
Cinosulfuron + Butachlor	0.02 + 1.0	15.08bc	28.63d-f	32.13bc	49.00b
Cinosulfuron + Butachlor	0.02 + 1.5	16.43cd	30.37cd	36.23bc	48.67bc
Prosulfuron + Butachlor	0.02 + 1.0	14.60cd	26.40fg	32.43bc	44.40bc
Prosulfuron + Butachlor	0.02 + 1.5	14.93cd	26.17fg	33.33bc	45.93bc
Cinosulfuron fb propanil	0.02 fb 2.0	13.20cd	28.13d-f	37.33b	45.50bc
Cinosulfuron fb propanil	0.02 fb 2.5	13.50cd	27.67e-g	33.47bc	50.67bc
Prosulfuron fb^2 propanil	0.02 + 2.0	10.23d	25.07h	29.40cd	41.53c
Prosulfuron fb propanil	0.02 + 2.5	11.03c	24.93h	29.43cd	40.73c
Cinosulfuron fb SHW 3 at 6 WAS	0.02	16.47b	27.07h	32.77bc	51.00bc
Prosulfuron fb SHW at 6 WAS	0.02	14.73cd	26.13f-h	32.27bc	50.60bc
Two hoe weeding at 3 and 6 WAS		14.13cd	20.80i	25.00d	27.93d
Three hoe weeding at 3, 6 and 9 WAS		13.87cd	20.97i	24.80d	23.93d
Weedy check		55.47a	51.83a	67.67a	75.70a
SE ±		1.639	0.892	0.906	1.292

Means in the same column of treatments followed by unlike letter(s) are significantly different at 5% level of significance using Duncan's Multiple Range Test (DMRT)
WAS – Weeks After Sowing; fb - followed by; HW - Hoe Weeded; SHW-Supplementary Hoe Weeding

At 6 WAS all the herbicides treatments were significantly effective but lower than the values obtained by the hoe weeded control. At 9WAS only pro-sulfuron at 0.02kg ai/ha, prosulfuron fb propanil at 0.02+2 and 0.02+2.5kg a.i/ha were comparable to hoe weeded controls. At 12WAS, all herbicides treatments were similarly effective, but less than the hoe weeded control.

In 2011 all the weed control treatments significantly depressed weed dry weight compared to the weedy check (Table 2). The two hoe weeded controls gave significantly ($p<0.05$) better weed dry weight reduction throughout the sampling period. However the herbicide treatments were comparable to the hoe weeded controls, except butachlor at 2.00kg a.i/ha at 3WAS. When sampled at 6WAS, hoe weeded controls resulted in lower weed dry weight than all other herbicide treatments except prosulfuron fb propanil at 0.02fb 2.0 and 0.02 fb 2.5kg a.i/ha, prosulfuron plus butachlor at 0.02+1.0 and 0.02+1.5kg a.i/ha, a prosulfuron at 0.04kg a.i/ha, and fb hoe weeding at 0.02kg a.i/ha, fb HW at 6WAS, cinosulfuron fb propanil at 0.02 fb 2.5kg a.i/ha and cinosulfuron at 0.02 fb hoe weeding at 6WAS. At 9WAS two hoe weeded controls gave lower weed dry weight which was

significantly higher than all other herbicide treatments except prosulfuron fb propanil at 0.02 fb 2.0kg a.i/ha and 0.02 fb 2.5kg a.i/ha. At 12WAS the two hoe weeded controls produced the lowest weed dry weight than all the herbicide treatments.

Table 2: Effect of pre-and post- emergence herbicides on weed dry weight in upland rice during the wet season of 2011 at Samaru

Treatment	Rate (kg a.i/ha)	Weed dry weight (g/m^1)			
		3 WAS	6 WAS	9 WAS	12 WAS
Butachlor	2.00	30.10b	39.23ab	55.50b	62.27b
Cinosulfuron	0.02	20.57bc	31.10a-d	41.23b-d	57.97bc
Cinosulfuron	0.04	15.30bc	39.37ab	43.40b-d	44.33e
Prosulfuron	0.02	18.73bc	29.13a-d	37.97cd	50.67b-e
Prosulfuron	0.04	16.70bc	27.53a-d	39.13cd	50.47b-e
Cinosulfuron + Butachlor	0.02 + 1.0	18.22bc	38.53ab	42.83b-d	55.77b-e
Cinosulfuron + Butachlor	0.02 + 1.5	18.27bc	34.23a-c	50.37bc	49.83b-e
Prosulfuron + Butachlor	0.02 + 1.0	18.73bc	29.73a-d	39.43b-d	50.33b-e
Prosulfuron + Butachlor	0.02 + 1.5	12.03bc	26.70b-d	38.37cd	48.30cd
Cinosulfuron fb propanil	0.02fb 2.0	14.37bc	33.83a-d	49.87bc	58.97bc
Cinosulfuron fb propanil	0.02fb 2.5	14.87bc	30.80a-d	40.50b-d	53.20b-e
Prosulfuron fb^2 propanil	0.02 + 2.0	10.43bc	31.50a-d	38.13cd	44.83de
Prosulfuron fb propanil	0.02 + 2.5	15.27bc	27.70a-d	38.83cd	50.10b-e
Cinosulfuron fb SHW3 at 6 WAS	0.02	24.90bc	24.50cd	38.93cd	53.33b-e
Prosulfuron fb SHW at 6 WAS	0.02	20.23bc	28.53a-d	32.30d	55.67b-e
Two hoe weeding at 3 and 6 WAS		7.10c	23.70d	30.13d	28.53f
Three hoe weeding at 3, 6 and 9 WAS		6.77c	20.87d	29.03d	25.63f
Weedy check		37.43a	39.97a	117.80a	132.10a
SE ±		1.393	1.237	2.017	1.630

Means in the same column of treatments followed by unlike letter(s) are significantly different at 5% level of significance using Duncan's Multiple Range Test (DMRT)
WAS – Weeks After Sowing; fb - followed by; HW - Hoe Weeded; SHW- Supplementary Hoe Weeding

Number of Grains per Panicle

The number of grains per panicle of rice was significantly affected by weed control treatments in the two trials and the combined results (Table 3). In 2010, higher number of grains per panicle of rice was produced by prosulfuron plus butachlor at 0.02+1.0kg a.i/ha and hoe weeding at 3 and 6 WAS, which was superior to all other herbicides treatments except prosulfuron at 0.02kg a.i/ha, prosulfuron fb propanil at 0.02 fb 2.0 and 0.02 fb 2.5kg ai/ha and hoe weeding at 3, 6 and 9WAS. In 2011, three hoe weddings produced significantly the highest number of grains per panicle and which was superior to cinosulfuron at 0.02 and 0.04kg a.i/ha, cinosulfuron at 0.02kg a.i/ha, fb HW, cinosulfuron plus butachlor at 0.02 +1.0kg ai/ha and the weedy check. In the combined result, hoe

weeding at 3and 6 WAS produced the highest number of grains per panicle and was significantly better than the weedy check, cinosulfuron at 0.02 and 0.02+1.0 and 0.02+1.5kg a.i/ha and cinosulfuron at 0.02kg a.i/ha fb SHW. The weedy check consistently produced the least number of grains per panicle in the two years of trials and in the combined result.

Table 3: Effect of pre-and post- emergence herbicides on Number of grains per panicle of upland rice during the wet season of 2010 and 2011 and combined at Samaru

Treatment	Number of grains per panicle			
	Rate (kg a.i/ha)	2010	2011	Combined
Butachlor	2.00	83.67c-e	72.00a-d	77.83a-d
Cinosulfuron	0.02	66.67ef	69.33b-d	68.00d
Cinosulfuron	0.04	76.33d-f	69.33b-d	72..83cd
Prosulfuron	0.02	92.33a-c	93.00a-d	92.67a-c
Prosulfuron	0.04	73.67d-f	78.00a-d	75.83a-d
Cinosulfuron + Butachlor	0.02 + 1.0	68.00ef	68.33cd	68.17d
Cinosulfuron + Butachlor	0.02 + 1.5	74.33d-f	74.00a-d	74.17b-d
Prosulfuron + Butachlor	0.02 + 1.0	81.00c-e	82.33a-d	81.67a-d
Prosulfuron + Butachlor	0.02 + 1.5	101.33a	88.00a-d	94.67a-c
Cinosulfuron fb propanil	0.02 fb 2.0	86.67b-d	83.33a-d	85.00a-d
Cinosulfuron fb propanil	0.02 fb 2.5	92.00a-c	85.00a-d	88.50a-d
Prosulfuron fb[2] propanil	0.02 + 2.0	97.67ab	97.67ab	97.67ab
Prosulfuron fb propanil	0.02 + 2.5	97.33ab	96.67a-c	97.00ab
Cinosulfuron fb SHW3 at 6 WAS	0.02	66.67ef	64.33d	65.50d
Prosulfuron fb SHW at 6 WAS	0.02	72.67ef	82.00a-d	77.33a-d
Two hoe weeding at 3 and 6 WAS		99.67a	98.00ab	98.83a
Three hoe weeding at 3, 6 and 9 WAS		94.33a-c	99.00a	96.67ab
Weedy check		28.00g	38.00e	33.00e
SE ±		4.512	3.435	4.069

Means in the same column of treatments followed by unlike letter(s) are significantly different at 5% level of significance using Duncan's Multiple Range Test (DMRT)
WAS – Weeks After Sowing; fb - followed by; HW - Hoe Weeded; SHW- Supplementary Hoe Weeding

Grain Yield

The grain yield of rice was significantly increased by the weed control treatments in the two seasons of trials and in the combined analysis (Table 4).

Table 4: Effect of pre-and post- emergence herbicides on grain yield of upland rice during the wet season of 2010 and 2011 and combined at Samaru

Treatment	Rate (kg a.i/ha)	Grain yield (Kg/ha) 2010	2011	Combined
Butachlor	2.00	946.4d-f	1184.0c-e	1065.2d-f
Cinosulfuron	0.02	731.2ef	801.0de	766.1ef
Cinosulfuron	0.04	958.8d-f	982.0de	970.4d-f
Prosulfuron	0.02	1545.2b-f	1483.7c-e	1514.4b-d
Prosulfuron	0.04	1710.7a-e	1718.7a-e	1714.7b-d
Cinosulfuron + Butachlor	0.02 + 1.0	976.0d-f	1065.7de	1020.8d-f
Cinosulfuron + Butachlor	0.02 + 1.5	1466.9b-f	1682.0b-e	1574.8d-f
Prosulfuron + Butachlor	0.02 + 1.0	1230.0c-f	1472.7c-e	1351.4c-e
Prosulfuron + Butachlor	0.02 + 1.5	1766.0a-e	1657.0b-e	1711.5b-d
Cinosulfuron fb propanil	0.02 fb 2.0	1384.7b-f	1734.0a-e	1559.4b-d
Cinosulfuron fb propanil	0.02 fb 2.5	1671.8a-e	1763.0a-e	1717.4b-d
Prosulfuron fb[2] propanil	0.02 + 2.0	2222.7a-d	2221.3a-c	2222.0ab
Prosulfuron fb propanil	0.02 + 2.5	1792.3a-d	2250.7a-c	2022.5a-c
Cinosulfuron fb SHW3 at 6 WAS	0.02	919.0d-f	1243.7c-e	1081.3d-f
Prosulfuron fbSHW at 6 WAS	0.02	1391.1b-f	1686.0b-e	1538.5b-d
Two hoe weeding at 3 and 6 WAS		2413.2ab	2681.0ab	2547.1a
Three hoe weeding at 3, 6 and 9 WAS		2569.5a	2780.3a	2674.9a
Weedy check		584.3f	619.7e	602.0f
SE ±		124.96	133.90	128.08

Means in the same column of treatments followed by unlike letter(s) are significantly different at 5% level of significance using Duncan's Multiple Range Test (DMRT)
WAS – Weeks After Sowing; fb - followed by; HW - Hoe Weeded; SHW- Supplementary Hoe Weedings

The three and two hoe weddings produced the highest grain yield in the two years and the combined result. Grain yield by hoe weeding thrice was significantly higher than those of the other treatments, except by two hoe weedings at 3 and 6 WAS, prosulfuron at 0.04kg a.i/ha and cinosulfuron fb propanil at 0.02 + 2., 5kga.i/ha in both trials and prosulfuron fb propanil at 0.02 fb 2.0 and 0.02fb 2.5kg a.i/ha in the two years and the combined result and prosulfuron plus butachlor at 0.02 + 1.5kg a.i/ha in 2010, these treatments resulted in comparable yield to two and three hoe weedings. The least yield was obtained by the weedy check followed by butachlor at 2.00kg a.i/ha, cinosulfuron at 0.02 + 1.0 and 0.02 + 1.5kg a.i/ha and cinosulfuron fb HW at 6 WAS in all trials and the combined result.

DISCUSSION

The optimum crop performance is reduced by inadequacy of weed control. The results of this trial highlighted the effect of weed control methods in upland rice. The consistently poor performance of rice in the control plots (weedy checks) showed that when weeds are not controlled throughout the crop life cycle resulted in 72.9% reduction in grain

yield compared to best chemical weed control treatment .Chemical weed control significantly reduced weed dry weight, increased number of grain per panicle and higher grain yield than weedy check. Application of Prosulfuron fb Propanil at 0.02fb2.0 and 0.02fb2.5kg a.i/ha produced the highest grain yield than the other herbicide treatments and weedy check and was only comparable to two and three hoe weeding. This could be attributed efficacy of the herbicide in suppressing the weed and reduces the devastating effects of weed in upland rice.This is in line with earlier finding by Akobundu (1987) who reported that uncontrolled weed in upland rice caused a significant yield loss of the crop.

CONCLUSION

Based on the result of this trial, it can be concluded that application of prosulfuron fb propanil at 0.02 fb 2.0 and 0.02 fb 2.25 kg a.i/ha significantly produced the highest grain yield than all other herbicide treatments.

Farmers who are into upland rice production are advised to use prosulfuron fb propanil at 0.02 fb 2.0 kg a.i/ha because it produced higher grain yield and was lower than 0.02 fb 2.5kg a.i/ha.

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