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EVALUATION OF RATES OF PROPANIL FOR WEED CONTROL IN RICE (*Oriza sativa* (L.)) AT YOLA, NORTHERN GUINEA SAVANNA OF NIGERIA

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Abstract: **Field experiment was conducted at the Research Farm of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola during 2010 and 2011 raining seasons to study rates of propanil for weed control in rice (Oriza sativa (L.)) at Yola Northern Guinea Savanna of Nigeria. The experimental design used was split plot. The treatments were five propanil rates (0 kg a. i. /ha, 2 kg a. i. /ha, 4 kg a. i. /ha, 6 kg a. i. /ha and 8 kg a. i. /ha) assigned to sub plots and were replicated four times. Data collected were establishment count, crop vigour, plant height, weed count, weed dry weight, number of productive tillers, number of grains per panicle, grain yield (kg/ha) and 1000-grains weight. The data collected was subjected to analysis of variance (ANOVA) appropriate to split plot design as described by Gomez and Gomez (1984). Means were separated using least significance difference (LSD) at 5% probability level. The result revealed that all the parameters measured (establishment count, crop vigour, plant height, wed count, weed cover, wed dry weight, number of productive tillers, number of grains per panicle, 1000-grains weight and yield (kg/ha)) were significantly affected. Effect of propanil rates on establishment count, crop vigour, plant height, at 30 DAS, weed count and weed dry weight revealed that 0 kg a. i. /ha proved the best while yield parameters measured revealed that 4 kg a. i. /ha proved the best in two years raining season followed by 6 kg a. i. /ha. Effect of propanil rates on yield parameters revealed that propanil rate of 4 kg a. i. /ha proved the best. Based on the result obtained, it can be concluded that propanil rate of 4 kg a. i. /ha should be adopted in rice fields in Yola and its surrounding environs within the same ecological zone.**

Keywords: **Evaluation, rates of propanil, and weed control.**

I. INTRODUCTION

Rice is one of the most important cereal crops in the world and a stable food for more than half of the population of the world (Ginigaddara and Ramanukharaechchi, 2009). It is the main livelihood of the rural population living in subtropical and tropical Asia and hundreds of millions of people living in Latin America (Juliano, 1993). Rice is a very important source of foreign exchange earnings giving about US $ 932.6 million annually through its export in Thailand (Anon, 2004). It is the most important food crop in developing countries and account for 29 % of the total calorie in-take of this population (Jonhson, 1996). The global rice production is estimated at 454.6 million tonnes annually with an average yield of 4.25 tonnes per hectare (Fazlollah *et al.*, 2011).

In Nigeria, rice is cultivated virtually in the entire Northern Guinea Savanna agro ecological zone (Usman, 2012). Land under rice cultivation in Nigeria has increased from 1,609,890 ha in 2005/2006 to 2,012,740 ha in 2009/2010, while production has moved from 3,286,500 metric tonnes in 2005/2006 to 4,080,940 metric tonnes in 2009/2010 (Usman, 2012). An average Nigeria consumes about 24.8 kg of rice per year (Usman, 2012). Rice importation in Nigeria has grown from less than 500,000 metric tonnes in 1994 to 2.1 million metric tonnes in 2011. Between 2008 and 2011, Nigeria spent an average of US $ 2.5 billion on rice importation (Ibrahim, *et al.*, 2011).

The main problem with rice production is weed control, which demands constant weeding. Successful weed control is essential for economic rice production (Ishaya, *et al*., 2007). This can be made easier by sowing in closer spacing, and it can be practically eliminated through the use of herbicides (Anon, 1970). Its production is often limited by weed competition. The competition of weeds often reduces rice yield up to 60-80% in lowland and 60-100% in upland rice (Sen *et al.*, 2002). Balyan (1993) and Singh *et al*., 1992) reported that weeds reduce yield of rice up to 85% and need for weed free period up to 50 days after sowing.

The production of a crop requires a particular set of condition in order to maximize growth and yield. These conditions include time of cultivation, time of planting, spacing, irrigation, fertilizer application and use of herbicides (Biswas and Solakhe, 2001). Herbicides have improved weed control and contributed substantially to yield increase in rice production in Nigeria (FAO, 2009 and Hill and Hawkins, 1996).

Small holder farmers often face a number of problems related to herbicides use, due to either an inadequate rate of herbicide being applied or herbicide being applied too late to provide good effect on the weed. A major cause of this is likely to be the serious lack of information available to the farmer and lack of technical know-how (Johnson, 1996). Chemical weed control through responsible use of herbicides technology such that will guarantee efficient management of weeds is emerging in our farming systems (Ndarabu and Anudu, 2010). The advantages derivable from the use of herbicides generally, can easily be marred by hazards from misuse and out right abuse of the herbicides. Most active ingredients may only give effective control of certain group of weeds at a specific rate and growth stage (Ndarabu and Anudu, 2010). Because of the stated problems above, there is need for this study to determine the most appropriate rate that will control weeds and hence optimum yield of rice.

II. METHODOLOGY

Field experiment was conducted at the Research Farm of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola Adamawa State in Northern Guinea Savanna zone of Nigeria, during 2010 and 2011 raining seasons. The annual mean minimum and maximum temperature of the area are 20.2^0C and 43.5^0C respectively (AD ADP, 2001). Total annual rainfall ranges from 700 mm-1000 mm, and the soil is sandy loam (Adebayo, 1999). The rainy season in Yola ranges from150-160 days mostly from May to October (Adebayo and Tukur, 1999). Yola is located within latitude 9^0 19' and longitude 12^0 30' E at an altitude of 185.8 m above sea level (Bashir, 2000).

The experimental area was marked out into 20 main plots of 2 m X 14 m including the walk ways and 100 sub plots of 2 m X 2 m each as shown in figure 1 giving a total land area of 28 m X 28 m. walk ways of 1 m was created between the main plots and subplots. Sowing of crop was by direct seeding when rainfall was established in July. Propanil rates were applied 21 days after sowing as post emergence herbicide to control weeds.

The experimental design used was split plot. The main plot treatments were five spacing (13 cm X 13 cm, 18 cm X 18 cm, 23 cm X 23 cm, 28 cm X 28 cm and 33 cm x 33 cm) and the subplot treatments were five propanil rates (0 kg a. i/ha, 2 kg a. i./ha, 4 kg a. i./ha, 6 kg a. i./ha and 8 kg a. i./ha). The treatment were replicated four times. The variety used was New Rice for Africa 2 (NERICA 2) obtained from Adamawa Agricultural Development Programme (AD ADP) Yola. The variety was medium in height and early maturing and has dark brown grains.

Data collected were: establishment count, crop vigour, plant height, number of productive tillers, number of grains per panicle, grain yield (kg/ha), 1000-grain weight (g), weed count and weed dry weight (g). Data collected were subjected to analysis of variance (ANOVA) as described by Gomez and Gomez (1984). The means were separated using least significant difference (LSD) at 5% level of probability.

III. RESULT AND DISCUSSION

There were different types of weeds found at the experimental site which include shrubs, sedges, grasses and broadleaf weeds all of which have life span of one year (annual weeds). All the weeds were susceptible to herbicide application as reported by Ahmed and Moody (1980) that propanil is most effective in the control of both grasses and broadleaf weeds if applied within three weeks of rice and weed emergence, older weeds are not control.

Table 1 shows effect of propanil rates on establishment count in 2010 and 2011 raining seasons. In 2010 raining season, effect of propanil rates shows that control have the highest establishment count followed by 2 kg a. i. /ha with the value of 94.75 while in 2011, propanil rates produced 100 percent establishment count at control followed by 2 kg a. i. /ha with the

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value of 95.50. The highest establishment count obtained at 0 kg a. i./ha followed by 2 kg a. i. /ha was because there was no herbicides phyto-toxicity or injury at 0 kg a. i. /ha while the stress due to the effect of herbicides rates was less at 2 kg a. i. /ha. Jayakumar and Jagannathan, (2007) reported that a herbicide which is selective at a lower rate may become non selective at higher rate.

Table 1 shows effect of propanil rates on crop vigour in 2010 and 2011 raining seasons. Effect of propanil rate on crop vigour in 2010 raining season shows that control produced crop vigour of 7. 55 followed by 2 kg a. i. /ha with the value of 6.60. In 2011 raining season, effect of propanil rate on crop vigour shows that control produced crop vigour of 7.85 followed by 2 kg a. i. /ha (7.20). The highest crop vigour at control is as a result of the fact that control plots did not suffer from stress due to herbicide application as the plots were not treated with herbicide and the effect of weed at the early stage of the crop growth was minimal. Walia (2010) reported that the direct and indirect effects of the herbicide on crop can be determined in one trial by including appropriate control treatments such as manual achieved weed treatment and un-weeded treatment to isolate the effects of herbicide from the effects of weeds.

Table 1 shows effect of propanil rates on plant height at 30, 52 and 72 DAS in 2010 and 2011 raining seasons. Effect of propanil rate on plant height at 30 DAS in 2010 raining season. Effect of propanil rates on plant height at 30 DAS in 2010 raining season shows that control produced the tallest plants (30.08 cm) followed by 2 kg a. i. /ha with the value of 29.5 cm. The shortest plants were obtained at 8 kg a. i. /ha (24.03 cm). Effect of propanil rates on plant height at 30 DAS in 2011 raining season shows that control produced the tallest plants of 30.22 cm followed by 4 kg a. i. /ha (29.90 cm) which was at par with 2 kg a. i. /ha. The variation in plant height at 30 DAS due to propanil rates implies that there were differences in the performance of propanil rates on plant height. As the rate increases, the direct effects of herbicides on the crop also increases as reported by Jayakumar and Jagannathan (2007) that a herbicide which is selective at lower rate may become non selective at higher rate.

In 2010 raining season, effect of propanil rate on plant height at 51 DAS shows that 4 kg a. i. /ha produced the tallest plants (52.25 cm) while control produced the shortest plants of 45.55 cm. In 2011 raining season, effect of propanil rates on plant height at 51 DAS shows that 2 kg a i. /ha produced the tallest plants of 55.68 cm followed by 4 kg a. i. /ha (55.35 cm) with the shortest plants coming from 8 kg a. i. /ha (48.73 cm). Plant height at 51 DAS was significantly affected by propanil rates. This could also be as a result of the injury of different rates of propanil applied.

Table 1. Effect of propanil rates on crop vigour in 2010 and 2011 raining seasons

Treatment	Estab. Count			crop vigour			PLT HT at 30 DAS			PLT HT at 51 DAS			PLT HT at 72 DAS		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Propanil rates (kg a. i/ha)															
0	100.00	100.00	100.00	7.55	7.85	7.7	30.08	30.22	30.16	45.55	54.50	50.03	55.77	57.39	56.58
2	94.75	93.50	94.13	6.60	7.20	6.9	29.54	29.10	29.32	51.25	55.68	53.47	76.55	75.98	76.27
4	89.85	88.65	89.25	6.00	6.25	6.1	28.61	27.90	28.26	52.25	55.35	53.8	78.75	75.86	77.31
6	73.75	69.05	71.4	4.80	4.90	4.9	26.35	27.92	27.14	50.92	52.61	51.77	76.79	74.64	75.72
8	61.75	57.50	59.63	0.10	0.04	0.07	24.03	24.81	24.42	49.64	48.73	49.19	76.05	74.56	75.31
Mean	84.02	81.74	82.88	5.01	5.24	5.13	27.72	28.41	28.07	49.95	53.38	51.67	72.73	71.68	72.21
P of F	<,001	<.001	<.001	<.001	<.001	<.001	<.001	0.001	0.001	0.001	<.001	0.001	0.001	<.001	<.001
LSD	5.484	2.410	2.187	0.2944	0.5367	0.2342	0.948	1.168	0.645	1,226	1.370	0.794	2.142	2.287	1.329

KEY

DAS= Days after sowing

Kg= kilogram

Ha= hectare

a.i.= active ingredients

LSD= least significant difference

PLT HT = plant height

Effect of propanil rates on plant height at 72 DAS in 2010 raining season shows that 4 kg a. i. /ha produced the tallest plants with the value of 78.75 cm while control produced the shortest plants (55.77 cm). In 2011 raining season, effect of propanil rates on plant height at 72 DAS shows that 2 kg a. i. /ha produced the tallest plants (75.98 cm) followed by 4 kg

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a. i. /ha (75.86 cm) while control produced shortest plants with the value of 57.39 cm. The variation in plant height due to propanil rates in 2010 and 2011 raining seasons could be as a result of differences in concentration of the active ingredient of the herbicide applied on different plots. Jayakumar and Jagannathan (2007) reported that for every herbicide, there is an optimum rate at which it maintained its selective characteristics and this rate varies from one crop to the other. Harding *et al*., (2012) reported that with increase in rates of application of herbicides, there were corresponding increases in percent reduction in weed population which also affect rice growth.

Table 2 shows effects of propanil rates on weed count at 3 and 7 WAAH in 2010 and 2011 raining seasons. Effect of propanil rates on weed count at 3 WAAH in 2010 raining season shows that control produced more number of weeds (55.85) while 8 kg a. i. /ha produced least number of weeds (0.20). In 2011 raining season, it shows that propanil rate of 0 kg a. i. /ha produced more number of weeds (55.35) with the least weed count coming from 8 kg a. i. /ha (2.10). Effect of propanil rates on weed count at 7 WAAH in 2010 raining season shows that control had more weed count (84.50) followed by 2 kg a. i. /ha (15.75) while propanil rate of 8 kg a. i. /ha produced least number of weeds with the value of 10.25. In 2011 raining season, effect of propanil rates on weed count shows that control produced more number of weeds (67.35) while propanil rate of 8 kg a. i. /ha produced the least number of weeds (17.05). The highest weed count obtained at 0 kg a. i. /ha at 3 and 7 WAAH in the two years cropping seasons shows that weed control by the use of post emergence herbicide is effective in controlling weeds in rice fields as least weeds were obtained at 8 kg a. i. /ha. Similar result was obtained by Imoloame *et al*., (2010) who reported that lower rate of herbicide was not effective in controlling weeds as the dose could have been sub-lethal to the weeds which resulted in high weed cover. Rao (2000) in his findings reported that for proper weed control with post emergence herbicide, propanil is to be applied at the rate of 3-5 kg a. i. /ha in rice fields.

Table 2: Effects of propanil rates on weed count and weed dry weight at 3 and 7 WAAH in 2010 and 2011 raining seasons in Yola Adamawa State

Treatment	weed count at 3 WAAH			weed count at 7 WAAH			weed dry weight (g) at 3 WAAH			weed dry weight (g) at 7 WAAH		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Propanil rates (kg a i/ha)												
0	55.85	55.35	55.6	84.50	67.35	75,93	41.86	53.16	47.51	110.35	111.33	110.84
2	3.40	8.50	5.95	15.75	21.04	18.40	1.72	7.88	4.8	19.02	35.73	27.38
4	1.o5	6.30	3.68	12.70	19.25	15.98	0.54	5.17	2.86	17.19	32.41	24.8
6	0.30	3.75	2.03	10.55	19.15	14.85	0.06	2.37	1.22	14.86	26.37	20.62
8	0.20	2.10	1.15	10.25	17.05	13.65	0.08	1.73	0.91	14.39	22.18	18.29
Mean	12.16	15.20	13.68	26.75	28.77	27.76	8.85	14.06	11.46	35.16	45.60	40.38
(P of F)	<.001	<.001	<.001	<.001	<.001	<.001	0.001	<001	<001	0.001	<.001	<001
LSD	1.681	2.627	1.442	2.817	3.126	1.992	1.075	3.580	1.697	3.944	6.281	3.581

KEY

WAAH= Weeks after application of herbicides

Kg = kilogram

a.i. = active ingredients

ha = hectare

LSD = least significant difference

Table 2 shows effect of propanil rates on weed dry weight at 3 and 7 WAAH in 2010 and 2011 raining seasons. Effect of propanil rate on weed dry weight at 3 WAAH in 2010 raining season shows that control produced more weed dry weight of 41.86 g followed by 2 kg a. i. /ha with the value of 1.72 g. The least weed dry weight was obtained from 6 kg a. i. /ha (0.01 g). In 2011 raining season, effect of propanil rates on weed dry weight at 3 WAAH shows that control produced more weed dry weight (53.16 g) followed by 2 kg a. i. /ha (7.88 g) while the least weed dry weight was obtained from 8 kg a. i. /ha with the value of 1.73 g. Effect of propanil rates on weed dry weight at 7 WAAH in 2010 raining season shows that 0 kg a. i. /ha produced higher weed dry weight of 110.35 g followed by 2 kg a. i. /ha with the value of 19.02 g while the least weed dry weight was obtained from 8 kg a. i. /ha with the value of 14.39 g. In 2011 raining season, effect of propanil rates on weed dry weight at 7 WAAH shows that control produced highest weed dry weight of 111.33 g followed

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by 2 kg a. i. /ha (35.33 g). The least weed dry weight was obtained at 8 kg a. i. /ha with the value of 22.18 g. The highest weed dry weight obtained at control in the two years cropping seasons is as a result of the fact that check plots did not have any herbicide treatment and the weeds were allowed to grow freely without control. Herbicides are undeniably the most effective, reliable technology available today for weed control in rice (Marwat *et al*., 2004). Adigun *et al*., (2000) reported that herbicides when used at recommended rate, offers good weed suppression and increased yield in rice production. The result also confirmed the report by Lado *et al*., (2010) that weed dry matter was highest in the weedy checked and was statistically different from other regimes.

Table 2 shows effect of propanil rate on number of productive tillers in 2010 and 2011 raining seasons. In 2010 raining season, effect of propanil rates on number of productive tillers shows that 6 kg a. i. /ha produced high number of productive tillers of 8.65 followed by 4 kg a. i. /ha with the value of 8.60. The least number of productive tillers was obtained from the control (1.11). In 2011 raining season, effect of propanil rates on number of productive tillers shows that 6 kg a. i. /ha produced more number of productive tillers (8.64) followed by 4 kg a. i. /ha with the value of 8.27. Control produced the least number of productive tillers (1.88). Highest productive tillers obtained at 6 kg a. i. /ha in 2010 and 2011 raining seasons and least productive tillers obtained at 0 kg a. i. /ha was as a result of effectiveness of the high dose (6 kg a. i. /ha) in controlling weeds in rice fields which leads to high number of productive tillers because of less competition by the weeds. Walia (2000) reported that the increased yield of crops particularly with tillering habits is not directly correlate with increase in seed rates but these yield improvements are due to reduced crop –weed competition.

Table 2 shows number of grains per panicle in 2010 and 2011 raining seasons. Effect of propanil rates on number of grains per panicle in 2010 raining season shows that 4 kg a. I, /ha produced more number of grains per panicle (150.8) followed by 8 kg a. i. /ha with the value of 150.8. The least number of grains per panicle was obtained from control with the value of 60.7. In 2011 raining season, effect of propanil rates on number of grains per panicle shows that 6 kg a. i. /ha produced more number of grains per panicle (143.22) followed by 8 kg a. i. /ha with the value of 142.25. Control produced the least number of grains per panicle (53.61). The highest number of grains per panicle obtained at 4 kg a. i. /ha and 6 kg a. i. /ha in 2010 and 2011 raining seasons respectively is as a result of the performance of propanil at these rates as recommended by Rao (2000) that propanil is to be applied at the rate of 3-5 kg a. i. /ha in rice fields. Smith Jr. (1974) reported that apply propanil at the rate of 6-7 kg a. i. /ha in rice fields.

Table 3 shows effect of propanil rates on grain yield (kg/ha) in 2010 and 2011 raining seasons. Effect of propanil rates on grain yield in 2010n raining season shows that 4 kg a. i. /ha produced the highest grain yield (1151.40 kg) with the least grain yield from control (59.60 kg). In 2011 raining season, effect of propanil rates on grain yield shows that 4n kg a. i. /ha produced the highest grain yield (138.99 kg) followed by 6 kg a. i. /ha with the value of 137.01 kg. Control produced the least grain yield with the value of 45.56 kg. The highest grain yield obtained in two years cropping season at the rate of 4 kg a. i. /ha and the least grain yield obtained at control indicated that propanil rate of 4 kg a. i. /ha control weeds better and finally lead to highest grain yields. This confirmed the report by Rao (2000) that propanil is to be applied at the rate of 3-5 kg a. i. /ha in rice fields.

Table 3: Effects of propanil rates on number of productive tillers, number of grains per panicle, grain yield (kg/ha) and 1000-grain weight (g) of rice in 2010 and 2011 raining seasons in Yola Adamawa State

Treatment	Number of production tillers			Number of grains/panicle			Grain yield (kg/ha)			1000 grain weight (g)		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Propanil rates (kg a.i./ha)												
0	1.11	1.11	1.50	60.7	53.61	57.16	59.60	45.56	52.58	20.60	20.35	20.48
2	8.45	8.26	8.36	150.3	130.18	140.24	148.36	124.79	136.58	27.25	23.18	25.22
4	8. 60	8.27	8.44	152.8	142.12	147.46	151.40	138.99	145.20	28.75	25.40	27.08
6	8.65	8.64	8.66	149.8	143.22	146.51	148.66	137.01	142.84	28.18	25.19	26.69
8	8.21	8.20	8.21	150.8	142.25	146.53	149.79	135.29	142.54	27.05	25.05	26.05
Mean	7.02	7.02	7.02	132.9	122.28	127.59	131.57	116.33	123.95	26.37	23.84	25.11
(P of F)	0.001	<.001	<.001	0.001	<.001	<.001	0.001	<.001	<.001	0.001	<.001	0.366
LSD	0.5086	0.721	0.3993	4.773	3.926	2.948	3.276	3.955	2.263	0.687	0.6183	0.4287

KEY

kg = kilogram

G = gram

Ha= hectare

a.i.= active ingredients

LSD= least significant difference

Table 3 shows effect of propanil rates on 1000-grain weight in 2010 and 2011 raining seasons. Effect of propanil rates on 1000-grain weight in 2010 raining season shows that 4 kg a. i. /ha produced the heavier 1000-grains of 28.75 kg followed by 6 kg a. i. /ha with the value of 28.18 kg. The least 1000-grain weight was obtained from control with the value of 20.60 kg. In 2011 raining season, effect of propanil rates on 1000-grain weight shows that 4 kg a. i. /ha produced grain weight of 25.40 kg followed by 6 kg a. i. /ha with the value of 25.19 kg. The least weight was obtained from control with the value of 20.55 kg. The highest 1000-grain weight obtained at the rate of 4 kg a. i. / ha in 2010 and 2011 raining seasons and least 1000-grain weight from control for the two years cropping seasons indicated that propanil rate of 4 kg a. i. /ha is effective in controlling weeds in rice as recommended by Rao (2000) that the rate of 3-5 kg a. i. /ha of propanil is to be applied in rice fields.

IV. CONCLUSION

Based on the findings in this research, it can be concluded that propanil rates has significant effect on the growth and yield of rice. Also, propanil rate had effect on weed control in rice fields. Propanil rate of 4 kg a. i. /ha control weeds better and subsequently proved to be the best in terms of yield parameters measured during the two years raining seasons.

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