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EFFECTS OF SPACINGS AND BUTACHLOR LEVELS ON WEED CONTROL, GROWTH AND YIELD OF NERICA 1 RICE (*ORYZA SATIVA* L. X *ORYZA GLABERRIMA* L.)

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Abstract: Poor agronomic practices coupled with herbicide mismanagement influence crop performance, yield, weed infestation and environmental hazards. Thus, field experiments were carried out to investigate the effect of spacing and reduced levels of butachlor on weed control and yield of NERICA 1 rice (*Oryza sativa* L. x *Oryza glaberrima* L). The experiments were conducted in the 2011 rainy season at the Teaching and Research Farm of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola, and Lake Gerio, Yola in the 2012 dry season. Yola is located between latitude 9°14′ N and longitude 12°28′ E in the Northern Guinea Savanna ecological zone of Nigeria. Treatments consisted of four spacings (20 cm x 20 cm, etc.) and four butachlor levels (3, 2, 1, and 0 kg ha-1 a.i.). The experiments were laid out in a split-plot design with spacings assigned to the main plot and butachlor levels assigned to the sub-plot and were replicated three times. Data were taken on percentage establishment, number of leaves per plant, general weed cover, panicle length and grain yield per hectare. Data generated were subjected to analysis of variance. Means showing a significant F-test were separated using LSD. Results obtained showed that butachlor at 1 kg ha-1 and 14 cm x 14 cm spacing gave the highest grain yield of 1441 kg ha-1 and maximum weed control. They are, therefore, recommended for adoption by farmers in Yola and similar environments.

Key words: spacing, butachlor levels, weed control, NERICA 1 rice variety, yield increase.

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Introduction

Rice (*Oryza* spp.) is an increasingly important commodity in Africa (Balasubramanian et al., 2007). Trends show that production is rapidly increasing in Africa and it is now competing with Latin America (Meinke et al., 2009). Due to the world's population growth, there is a large increase in rice consumption of about 2% with an increase in the demand to an average of 4.9% per year (Anon, 1995). Rice cultivation in Nigeria is widespread within the country, extending from the northern to southern zones with most rice grown in the eastern and middle belt of the country. The cultivation occurs between April and November in the rainy season and between December and April in the dry season. The annual rice production in Nigeria is about 4 million metric tons and in spite of the total production, Nigeria is still among the rice importing countries. This is because rice production in the country is characterised by low yield due to high weed infestation and poor agronomic practices.

Important weeds of rice include the perennials: *Imperata cylindrical, Cyperus rotundus,* and *Chromolaena odorata,* the annuals: *Digitaria horizontalis* and *Euphobia heterophylla* and the parasitic weeds: *Striga hermonthica* and *Striga asiatica.* Common weed management practices in rice-based cropping systems include tillage, flooding, fallow and crop rotations, clearance by fire, hand or hoe weeding and use of herbicides. These practices are often used in combination with other methods of weed control, for example, use of herbicides (Rodenburg and Johnson, 2009). Butachlor is a selective systemic herbicide effective against a wide range of both annual grass weeds and certain broadleaf weeds. Herbicidal weed control methods offer an advantage to save labour and money (Ahmed et al., 2000). The indiscriminate use of herbicides has resulted in the development of weed resistance. Herbicides may also become a burden if appropriate measures are not taken at early stages regarding their safe use for sustainable production and environment (Singh et al., 2005).

Another factor that affects yield in rice production is spacing. In Nigeria, different research works have been carried out at the optimum densities of rice and different results revealed that different genotypes showed a different response to increasing plant population per unit area. Many reports have indicated that planting of rice at the closer spacing increased the number of tillers, panicle and grain yield (Ighalo et al., 1998). It was found that yield was more than doubled by decreasing spacing from 40 x 30 cm to 20 x 30 cm (Oghalo, 2011).

In view of increasing population of Nigeria coupled with the high demand for food, there is need for farmers to adopt appropriate production techniques, recommended herbicide levels and spacing in Adamawa state and particularly Yola. Farmers abuse herbicide recommendation by overdosing or using low dosage. For these reasons, it is important to study the effects of reduced butachlor levels and spacing on the performance of NERICA 1 rice variety.

Materials and Methods

Field experiments were carried out at the Teaching and Research Farm of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology (MAUTECH), Yola during the 2011 rainy season and in Lake Gerio, Yola during the 2012 dry season. Yola is located between latitude 9°14′ N and longitude 12°28′ E in the Northern Guinea Savanna ecological zone of Nigeria. Treatments consisted of four inter and intra row spacings (20 cm x 20 cm, 17 cm x 17 cm, 14 cm x 14 cm and 11 cm x 11 cm) and four butachlor levels (3, 2, 1 and 0 kg ha-1 a.i). The experiment was arranged in a split-plot design with spacings assigned to the main plots and butachlor levels to the sub-plot. These were then replicated three times. NERICA 1 obtained from the Adamawa State Agricultural Development Programme was sown in the experiments. Fertiliser at 60 kg N-13 kg P-:25 kg K ha-1 was applied at sowing, and was followed by top dressing with 40 kg N ha-1 at tillering. Butachlor was applied as a pre-emergence herbicide three days after sowing (DAS) using a 20-L knapsack sprayer. Data were collected on percentage establishment, number of leaves per plant, length of panicle, general weed cover score (by visual observation of weed population in each of the plots six weeks after sowing (WAS) using a scale of 1−9 where 1 represents the complete absence of weeds in a plot and 9 represents the complete coverage of a plot by weeds) and grain yield per hectare. Data generated were subjected to analysis of variance (ANOVA) appropriate to the split-plot design using SAS system for windows (SAS v8, 2000). Means showing the significant F-test were separated using the least significant difference (LSD) test at 5%.

Results and Discussion

Table 1 shows the effect of butachlor levels and spacings on percentage establishment and panicle length of NERICA 1 rice at MAUTECH and Lake Gerio. No significant ($P > 0.05$) effect of butachlor levels was recorded on percentage establishment both at MAUTECH and Lake Gerio. This may be attributed to the ability of the herbicide to act on some weeds. This result is not in conformity with the findings of Horn et al. (1980) that butachlor applied at 2.0 kg ha^{-1} showed a higher percent injury on seedlings than butachlor at 1.5 or lower rates. The results also disagreed with those obtained by Isma'il et al. (2011) that butachlor applied 3 DAS showed the highest percent injury to rice seedlings. Nangju et al. (1976) indicated that the lethal injury could be attributed to the uptake of herbicides by emerging seedlings. Similarly, Table 1 shows that no significant effect of spacing was recorded on percentage germination. This may be due to a less competitive effect between seedlings at this stage. No interaction between butachlor levels and spacings was recorded.

Table 1. Effects of butachlor levels and spacings on percentage establishment (%) and panicle length (cm) of NERICA 1 rice at MAUTECH (2011 rainy season) and Lake Gerio (2012 dry season).

Treatment	Establishment count		Panicle length	
	MAUTECH	Lake Gerio	MAUTECH	Lake Gerio
Butachlor (B)				
3 kg ha^{-1} a.i	92.50	90.80	22.76	23.69
2 kg ha^{-1} a.i	91.70	94.20	22.03	23.68
1 kg ha^{-1} a.i	95.00	93.30	20.79	23.77
0 kg ha^{-1} a.i	94.20	94.20	20.35	23.16
P of F	0.765	0.815	0.121	0.779
Spacing (S)				
20 x 20cm	95.80	93.30	22.98	26.09
17 x 17cm	91.70	92.50	23.21	25.05
14 x 14cm	90.00	91.70	22.43	24.48
11 x 11cm	95.80	95.00	17.31	18.68
P of F	0.285	0.455	0.001	0.001
LSD			1.657	1.470
Interaction B x S	NS	NS	NS	NS

NS = Not significant at the 5% level of probability using LSD.

The effects of butachlor levels on panicle length (Table 1) show no significant ($P > 0.05$) effect at both MAUTECH and Lake Gerio. A significant ($P \leq 0.05$) effect of spacings on panicle length was recorded at both locations. At MAUTECH, 17 cm x 17 cm gave the longest panicle length of 23.21 cm while the shortest panicle length was recorded in 11 cm x 11 cm (17.31 cm). In Lake Gerio, 20 cm x 20 cm spacing gave the longest panicle length (26.09 cm) while 11 cm x 11 cm spacing recorded the shortest panicle length of 18.68 cm. The significant effect of spacing on panicle length may be due to a less competitive effect between plants at the wider spacing. The result of this study conforms to that of Alam et al. (2012), who reported longer panicle length with the wider spacing. No effect of the interaction between butachlor and spacing on panicle length was recorded.

The effect of butachlor levels and spacings on the number of leaves per plant of NERICA 1 in MAUTECH and Lake Gerio is shown in Table 2. No significant effect of butachlor levels on the number of leaves per plant was recorded at both MAUTECH and Lake Gerio. A significant effect of spacing was recorded on the number of leaves per plant at both locations during the periods of observation except at 12 WAS at MAUTECH. At 8 WAS in MAUTECH, the highest number of leaves per plant (6.75) was recorded in a spacing of 20 cm x 20 cm, and in

Lake Gerio, the spacing of 17 cm x 17 cm gave the highest number of leaves (6.42). At 12 WAS in Lake Gerio, the spacing of 14 cm x 14 produced the highest number of leaves (6.67). The result of this study agreed with the report of Harding et al. (2012), who found that the number of functional leaves per hill was higher in the wider spaced plants. No effect of the interaction between butachlor levels and spacings on the number of leaves per plant was observed.

Table 2. Effects of butachlor levels and spacings on the number of leaves per plant of NERICA 1 rice at MAUTECH (2011 rainy season) and Lake Gerio (2012 dry season).

Treatment	Number of leaves per plant			
	8 WAS		12 WAS	
	MAUTECH	Lake Gerio	MAUTECH	Lake Gerio
Butachlor (B)				
3 kg ha-1 a.i	6.583	6.083	6.500	6.250
2 kg ha-1 a.i	6.583	6.417	6.667	6.083
1 kg ha-1 a.i	6.750	6.083	6.667	6.250
0 kg ha-1 a.i	6.667	6.333	6.667	6.083
P of F	0.794	0.182	0.699	0.768
Spacing (S)				
20 x 20cm	6.750	6.250	6.667	6.500
17 x 17cm	6.667	6.417	6.583	6.333
14 x 14cm	6.667	6.167	6.667	6.667
11 x 11cm	6.500	6.083	6.583	5.167
P of F	0.050	0.022	0.859	0.001
LSD	0.1665	0.1861		0.2761
Interaction B x S	NS	NS	NS	NS

NS = Not significant at the 5 % level of probability using LSD.

Table 3 shows the effect of butachlor levels and spacings on general weed cover and grain yield of NERICA 1 at MAUTECH and Lake Gerio. No significant effect of butachlor levels on general weed cover was recorded at both locations. There was a significant effect of spacing on general weed cover at both locations; namely, the spacing of 20 cm x 20 cm significantly gave the lowest weed cover at both MAUTECH and Lake Gerio, 3.08 and 2.92, respectively. The highest weed cover was found in the spacing of 11 cm x 11 cm; 7.50 and 7.75 in MAUTECH and Lake Gerio, respectively. The lowest weed cover at the highest spacing rate may be due to the enabling environment for the plants to exploit environmental factors with little competition, and this gave the plants more room to tiller and

suppressed weeds. In addition, as can be seen in Table 3, butachlor levels had no effect on grain yield at MAUTECH, but a significant effect was recorded at Lake Gerio where 0 kg ha-1 a.i gave the highest yield (1354 kg ha-1). Similarly, spacing had a significant effect on yield of NERICA. The highest yields of 1149 kg ha-1 and 1426 kg ha-1were recorded in MAUTECH and Lake Gerio, respectively at the widest spacing of 20 cm x 20 cm. The lowest yield was recorded at the closer spacing of 11 cm x 11 cm in the two locations (Table 3). The lowest yield recorded at the closer spacing may be due to the inability of plants to maximally utilise soil and environmental factors as a result of competition. This result disagrees with the findings of Powar et al. (2001) that closer spacing produced more grain yield and straw yield than wider spacing.

Table 3. Effects of butachlor levels and spacings on general weed cover and grain yield (kg ha-1) of NERICA 1 rice at MAUTECH (2011 rainy season) and Lake Gerio (2012 dry season).

Treatment	General weed cover		Grain yield (kg ha-1)	
	MAUTECH	Lake Gerio	MAUTECH	Lake Gerio
Butachlor (B)				
3 kg ha-1 a.i	4.58	4.25	803	889
2 kg ha-1 a.i	4.67	4.17	831	870
1 kg ha-1 a.i	4.08	4.17	838	974
0 kg ha-1 a.i	4.00	4.67	977	1354
P of F	2.276	0.530	0.640	0.068
Spacing (S)				
20 x 20cm	3.08	2.92	1149	1426
17 x 17cm	3.33	3.50	982	1154
14 x 14cm	3.42	3.08	1089	1295
11 x 11cm	7.50	7.75	229	212
P of F	0.001	0.001	0.001	0.008
LSD	0.953	1.016	315	588.6
Interaction B x S	NS	NS	NS	**

NS = Not significant at the 5% level of probability using LSD. ** = Highly significant at the 1% level of probability using LSD.

The interaction between butachlor levels and spacings showed a significant effect on grain yield in Lake Gerio; namely, the highest grain yield of 1441 kg ha-1 was obtained with butachlor at 1 kg ha-1 a.i at a spacing of 14 cm x 14 cm while the lowest yield was recorded at a spacing of 14 cm x 14 cm and butachlor at 0 kg ha-1 a.i (Table 4). This shows that integrated weed control gave maximum yield control compared to where only one method was used.

Table 4. Interaction of butachlor levels and spacings on grain yield (kg ha^{-1}) at Lake Gerio in the 2012 dry season.

Treatment Spacing	20 cm x 20 cm	17 cm x 17 cm	14 cm x 14 cm	11 cm x 11 cm
Butachlor				
3 kg ha-1a.i	963	752	836	215
2 kg ha-1 a.i	931	1182	1172	987
1 kg ha-1a.i	1285	1217	1441	1266
0 kg ha-1 a.i	204	251	175	252
LSD		502.8		

Conclusion

Based on the results of this study, the application of butachlor at the reduced rate of 1 kg ha-1 a.i together with a spacing of 14 cm x 14 cm gave maximum weed control and produced the optimum yield. Thus, these findings should be considered for the optimum yield of NERICA 1 rice variety in Yola and similar environmental conditions.

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UTICAJ VEGETACIONOG PROSTORA I RAZLIČITIH DOZA BUTAHLORA NA SUZBIJANJE KOROVA, RAST I PRINOS PIRINČA SORTE NERICA 1 (*ORYZA SATIVA* L. X *ORYZA GLABERRIMA* L.)

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R e z i m e

Neodgovarajuće agrotehničke mere zajedno sa pogrešnim korišćenjem herbicida utiču na učinak useva, prinos, zakorovljenost i opasnost po životnu sredinu. Poljski ogledi se stoga sprovode kako bi se ispitao uticaj vegetacionog prostora i smanjenih doza butahlora na suzbijanje korova i prinos pirinča sorte NERICA 1 rice (*Oryza sativa* L. x *Oryza glaberrima* L). Ogledi su sprovedeni u kišnoj sezoni 2011. godine na Nastavno-istraživačkom gazdinstvu Odseka za ratarstvo i hortikulturu, Tehnološkog univerziteta Modibbo Adama u Joli, i jezeru Gerio u Joli u sušnoj sezoni 2012. godine. Jola je smeštena između $9^{o}14'$ N geografske širine i $12^{o}28'$ E geografske dužine u ekološkoj zoni savane u severnoj Gvineji u Nigeriji. U tretmanima su korišćena četiri rastojanja (20 cm x 20 cm, 17 cm x 17 cm, 14 cm x 14 cm i 11 cm x 11 cm) i četiri doze butahlora (3, 2, 1, i 0 kg ha^{-1} aktivne materije). Ogledi su postavljeni po planu izdeljenih parcela sa tri ponavljanja. Prikupljeni su podaci o procentnoj zasnovanosti, broju listova po biljci, opštoj zakorovljenosti, dužini metlice i prinosu zrna po hektaru. Dobijeni podaci su statistički obradjeni analizom varijanse. Testiranje dobijenih srednjih vrednosti obavljeno je LSD testom za pojedinačna poredjenja. Na osnovu dobijenih rezultata vidi se da je u suzbijanju korova najefikasnija varijanta sa dozom butahlora od 1 kg ha^{-1} u vegetacionom prostoru 14 cm x 14 cm, gde je dobijen najveći prinos pirinča (1441 kg ha^{-1}), a što se može preporučiti poljoprivrednicima u Joli i drugim mestima sa sličnim agroekološkim uslovima.

Ključne reči: vegetacioni prostor, doze butahlora, suzbijanje korova, sorta pirinča NERICA 1, povećanje prinosa.

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