COST-BENEFIT ANALYSIS OF RICE PRODUCTION UNDER WEED CONTROL METHODS IN LAFIAGI AREA OF KWARA STATE, NIGERIA

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Abstract

Field experiments were conducted to evaluate the profitability of rice production at Lafiagi, Kwara State, Nigeria. The treatments consisted of 15 weed control methods. The treatments were laid out in a randomized complete block design replicated three times. Results revealed that the use of Top star (Oxadiargyl 400 g/l)as pre emergence herbicide at the rate of 0.8 liters ha[1] and any of the following post emergence herbicides; Solito (300 g Pretilachlor + 20 g pyribenzoxim) at the rate of 1.5 liter ha[1], Orizo plus (360 g Propanil + 200g 2,4-D) at the rate of 10 liters ha' Nominee Gold (Bisbyribac sodiumlOOS.C) at the rate of 0.4 liters ha[1] and Profit (170 g Pretilachlor +330g propanil) at the rate of 6 liters ha'[1] at 6 WAS produced significantly higher yields and higher gross margin as compared to the control (hoe weeding at 3,6 and 9 WAS) and other treatments considered in this trials. The use of Topstargave the highest cost- benefit return ofN7.1,122% gain over the control, followed by the use ofTopstarand application of Nominee at 6 WAS that produced cost- benefit returns ofNS.8,80% gain over the control. Application ofTop&tar and itoe weeding at 6 WAS also gave N5.6, which is 75% higher than the control. Labour requirements were reduced bv the application of Topstar. It was concluded that herbicides application has increased yield and profitability ofn ce production and labour demand was reduced. It was therefore recommended that for successful rice production the use of pre emergence herbicides and post emergence herbicides should be adopted by farmers in the study area.

Keywords: Grvss *margin, Cost-benefit ratio,* H *rbicide and Rice*

INTRODUCTION

Rice *(Oryza sattva)* is the s'.aple food for more than a half of the world population (Ginigaddara and Ramanukharaechchi, 2009). The global rice production is estimated at 454.6 million tonnes annually which has an average yield of 4.25 tonnes per hectare (Ft dollah *et al,* 2011). In Nigeria Rice is cultivated virtually in the entire Northern Guinea Savannah agru ecological zone. Land under rice cultivation in Nigeria has increased from 1,609,890 ha in 2005/200 '> to 2,012,740 ha in 2009/2010.While production has also moved from 3,286,500 kg ha"[1] in 2005/2006 to 4,080,940 kg ha[1] in 2009/2010 (Ibrahim *et al,* 2012). Average Nigeria consumes about 24.8 kg of rice per year. Rice importation in Nigeria has grown from less than 500,000 metric tonnes in 1994 io 2.1 million metric tonness in 2011. Between 2008 and 2011, Nigeria spent an average of US$ 2.5 Billion on rice importation (Ibrahim *et al.,* 2012). This high level of rice importation may not be sustainable. Therefore, the Nigeria government at the federal level is beginning to ref ocus attention on stimulating domestic rice production through a number of strategies, parts of which is the establishment of rice processing factories in Kano, Kwara, Ogun, and Benue State with a combined installed capacity of 730,000 mt per annum. (Ibrahim *et al,* 2012) It is very important to take advantage of the substantial processing capacity available in the country by boosting paddy rice production. Efficient rice production will create employment, increases incomes and reduce poverty.

Successful weed control is essential for economic rice production (Ishaya *et al,* 2007). Weed can reduce rice yield by competing for moisture, nutrients and light during the growing season. Weed infestation can also interfere with combine operations at harvest and significantly increase harvesting .and drying costs'. Weed seeds contamination of rice grain lower grain quality and may lower the cash value of the crop. Weeds are the cause of serious yield reduction problems in rice production worldwide. Losses caused by weeds vary from one country to another, depending on the predominant weed flora and on the control methods practiced by farmers. Weed competition do not occur during the entire cropping period. Control of weeds in the critical period of competition is important, usually it commence around 2 weeks after seeding and may continue up

to 5-8 weeks. Hence early weeding is important to reduce yield losses (Akobundu, 1987) Yield loss between 40%-100% in upland rice has been reported (Akobundu, 1987; Akobundu and Ahissou, 1984; Ahmed and Moody, 1980). Rice has been found to perform better under good weed management practices (Ishaya *et al.*, 2007). Weeds are one of the primary factors limiting rice yield in Nigeria. Hoe weeding is the commonest method adopted in controlling weeds in the study area. The practice is however expensive, labour intensive and the availability of labour is often not reliable particularly at the peak of the season. Rice being a closely spaced crop, yield losses could even be caused by hoe weeding through crop injury and stand losses, some grass weed which have close resemblance to the rice crop .may escape hand weeding. This necessitates the evaluation of an alternative weed control method that may be more effective with less labour requirements. Herbicides when used at recommended rate offers good weed suppression and increased yield in rice production (Adigunefffl/.,2000).

The use of pre-emergence herbicides has been reported to show some promising results in rice. Mahadi *et al.* (2006) reported that application of pre-emergence herbicides produced grain yield of rice that are significantly comparable to two hoe weeding. The use of herbicides by farmers has been limited because of lack of information on crop injury, efficacy and cost of the herbicides. Therefore the focus of this study is to look at the profitability of each of the control methods available for rice fanners and compare it with the farmer's practice in the study area

MATERIALS AND METHODS

Field experiments were conducted in 2009 and 2010 wet seasons at Demonstration Plot of Kwara State Agricultural Development projects located in Lafiagi Kwara state, (latitude 7° 45[1] and longitude *t3tf)*. Kwara State is located in the Northern Guinea Savannah of Nigeria. Glyphosate was applied at the rate of 4 liters per hectare. After which the plot was left for two weeks before the land was ploughed and then harrowed to obtain a fine tilth, it was then marked out into 18 plots with 1.5 m spacing between blocks and 1.0m spacing between plots. The gross and net plot sizes were 31.5 m^2 and 22.5 m^z respectively. The treatments consisted of 4 post emergence herbicides; hand weeding at 6 and 9 WAS and unwedded check. The treatments were laid out in a randomized complete block design replicated three times. Pre-emergence herbicides Top star (Oxadiargyl 400 g/1) was applied as pre- emergence herbicide at the rate of 0.8 liters per ha with knapsack sprayer in a spray volume of about 200 liters per ha Using a deflector nozzle at a pressure *of 2.1 kg/m.*[2]a day after planting. At six weeks after planting different post emergent herbicides were applied which were, Solito (300 g Pretilachlor + 20 g pyribenzoxim) at the rate of 1.5 liters per ha, Orizo plus (360 g Propanil + 200 g 2,4-D)attherateof 10 liters per ha Nominee Gold (Bisbyribac sodiumlOOS.C) at the rate of 0.4 liters per ha Profit (170 g pretilachlor + 330 g propanil) at the rate of 6 liters per ha. These rates are based on the manufacturers recommendations. Hoe weeding was done at 6 and 9 WAS. The variety used was NERICA1 which is early maturing. The seed were drilled at the rate 80 kg /ha with inter row spacing of 25 cm. Fertilizer was applied at the rate of 300 kg per ha of NPK at 3WAS and 150kg per ha of urea at 6WAS. Data collected were subjected to analysis of variance. The Duncan multiple range test was use for mean separation.

To examine the profitability of the different weed control methods, the gross margin and cost benefit analysis was done. The gross margin analysis is the difference between the total revenue and the total variable cost i.e. GM= TR-TVC Where GM= Gross margin; TR= Total revenue and TVC = Total variable cost. The profitability index, also known as cost- benefits analysis which measures the rate of return on investment was calculated. It gives the amount of profit on any Naira invested in each of the herbicides It is expressed as Cost-benefit ratio = GM/ VC (where GM= Gross margin and V.C. = variable cost of each of the weed control methods). The cost of the inputs and price of the products were obtained from market survey. The variable cost were that of weeding, chemicals and cost of application, the revenue was the farm gate price of rice at 50/kg (During the study US$=160 Naira).

RESULTS AND DISCUSSION Weed Control Methods and Rice Yield.

The use of Topstar as pre emergence herbicides with other control methods at 6 WAS produced higher yields (hoe weeding 31%, Nominee 30%, Orizo plus 28%, Solito 28% and profit 28%) over the farmers practice of 3 hand weeding at 3, 6 and 9 WAS that produced (3072.3 $kgha^{-1}$). The use of Topstar alone as the only weed control method produced grain yields that are 10% higher than the control. The combination of harid weeding at 3 WAS and other method at 6 WAS resulted in grain loss that varies from 0.5% -1.8 %, over the control. The uncontrolled plots recorded the highest grain loss of 82%, while hoe weeding at 3 WAS alone and

6 WAS alone resulted in grain loss of 55% and 39% respectively (Table 1). This shows that weed control in rice must start at planting for successful rice production. The use of pre-emergence herbicide is an important weed control method that must be considered when developing weed control packages. This corroborates the works of Mahdi *et al.* (2000) and Ishaya *et al.* (2007) that found the importance of pre emergence herbicides in rice production in Nigeria. Despite the fact that the critical weed interference in rice starts from 3 - 6 WAS, there was competition from the day both weeds and rice germinates and this greatly affected the yield of rice produced. There is need for selective pre-emergence herbicides for early weed control. Top star used as pre emergence herbicide was able to control weed up to about 4- 5 WAS and when post emergence control were applied at 6 WAS the yield were enhanced. The use of pre-emergence herbicides also requites another post emergence control method to effectively enhance rice productivity.

Gross Margin Analysis

The results of the gross margin analysis (Table 2) and percentage Gross margin over the control in (Table 3) show that the use of Topstar as pre-emergence herbicides with other control methods at 6 WAS gave the highest gross margin of N126, 113 (63% higher than the control) for hoe weeding, N125, 870 (63% higher than the control) when Nominee was applied, N121,363 (57% higher than the control) when Solito was applied, N118, 268 (53% higher than the control) when Profit was applied and N112,125 (45% higher than the control) when Orizo plus was applied which were significantly higher than use of Topstar alone that resulted in gross margin of N102,668. (33% higher than the control). The use of Topstar alone produced gross margin which were significantly higher than Two hoe weeding at 3 and 6 WAS which gave a gross margin of N84,455 (which was 9%higher than the control), hoe weeding at 3 WAS and application of Nominee at 6 WAS which resulted in gross margin of N83,833 (which was 8.6% higher than the control), hoe weeding at 3 WAS and application of Solito at 6 WAS that yielded a gross margin of N83,460 (which was 6.8% higher than the control), hoe weeding at 3 WAS and application Of Profit at 6 WAS that gave N79,888 (which was 3.5% higher than the control) as the gross margin The control resulted in gross margin of N77,215. All other methods resulted in gross margin below the control. The use of hoe weeding and application of Orizo plus at 6 WAS gave 4.7% gross margin lower than the control. Hoe weeding at 3WAS alone and hoe weeding at 6 WAS alone also resulted in 87% and 57% loss in gross margin as compared to the control respectively. The uncontrolled plots resulted in 132% loss in gross margin as compared to the farmers practice. It will be more economical for the farmer to use top star at planting rather than waiting for 3 WAS before hoe weeding and then use herbicides at 6 WAS. There was economic loss when the rice was not weeded as shown in the tables. The use of Orizoplus at 6WAS to complement the hoe weeding at 3WAS resulted in lower gross margin because the quantity required was much which led to high cost of the herbicides

Tablet: Yield of rice produced at Lafiagi under weed control methods in 2009and 2010

Treatment	Grainyield kg/ha/ ™ Rate L/Ha	combined 2009and 2010	Yield gain / loss Percentage yield over the control	again or loss over • Kg/ha
Topstar + Hex; weeding @6WAS	0.8	4019.45*	947.15	31.00
Topstar only	0.8	3390.55 [b]	318.25	10.00
Topstar+ Nominee	0.8+0.4	4001.40.*	929.10	30.00
Topstar+Orizo plus	0.8+10	3919.70*	847.40	28.00
Topstar+Solito	0.8+1.5	3924:45 *	852.15	28.00
Topstar+Profit	0.8+6.0	3922.55*	850.25	28.00
Hoe weeding® 3WAS +Nominee	0.4	3031.45[b]	-40.85	-1.30
Hoe weeding® 3WAS +Orizo plus	10	3021.00[b]	-51.30	-1.70
Hoe weeding® 3WAS+Solito	1.5	3017.20[b]	-55.10	-1.80
Hoe weeding® 3WAS+Profit	6	3025.75''	-46.55	-1.50
Hoe weeding@3 and 6 WAS	3057.10[b]		-15.20	-0.50
Hoe weeding 3WAS	1393.65°		-1678.7	-55.00
Hoe weeding 6WAS	1879.10 [c]		-1193.2	-39.00
Hoe weeding @ 3,6and9WAS	3072.30[b]		0.00	0.00
Uncontrol weed	554.80[d]		-2517.50	-82.00

Means followed by the same letter (s) in a column within treatments are not significantly different at P = 0.05 according to Duncan Multiple Range Test (t>MRT)

Table 2: Gross -Margin and cost benefit analysis of rice production as affected by weed control methods

Treatment	Rate L/Ha	Variable Cost	Other cost Naira	Total variable Cost	Revenue (Yeaild x price)	Gross Margin Naira R-TVC	Benefit-cost Ratio
Topstar +Hoe weeding@6WAS	0.8	22,460	52,400	74,860	200,972	126,113	5.6
Topstar only	0.8	14,460	52,400	66,860	169,527	102,668	7.1
Topstar +Nominee	0.8+0.4	21,800	52,400	74,200	200,070	125,870	5.8
Topstar +Orizo plus	0.8+10	31,460	52,400	83,860	195,985	112,125	3.6
Topstar +Solito	0.8+1.5	22,460	52,400	74,860	196,222	121,363	5.4
Topstar +Profit	0.8+6.0	25,460	52,400	77,860	196,127	118,268	4.6
Hoe weeding@3WAS+Nominee	0.4	15,340	52,400	67,740	151,572	83,833	5.5
Hoe weeding@3WAS+Orizo plus	10	25,000	52,400	77,400	151,050	73,650	2.9
Hoe weeding@3WAS+Solito	1.5	16,000	52,400	68,400	150,860	82,460	5.2
Hoe weeding@3WAS+Profit	6	19,000	52,400	71,400	151,287	79,888	4.2
Hoe weeding@3 and 6 WAS		16,000	52,400	68,400	152,855	84,455	5.3
Hoe weeding@3WAS		8,000	52,400	60,400	69,682	9,283	1.2
Hoe weeding@6WAS		8,000	52,400	60,400	93,955	33,555	4.2
Hoe weeding@3,6 and 9WAS		24,000	52,400	76,400	153,615	77,215	3.2
Uncontrolled weeding		0	52,400	52,400	27,740	-24,660	-0.9

Table *3:* Percentage gain or loss in gross margin and cost benefit analysis and labour requirements in rice production

Treatment	Rate L/Ha	Gross Margin (%)	Cost-benefit (%)	Labour requirement
Topstar +Hoe weeding@6WAS	0.8	63	75	5
Topstar only	0.8	33	122	1
Topstar +Nominee	0.8+0.4	63	80	2
Topstar +Orizo plus	0.8+10	45	11	2
Topstar +Solito	0.8+1.5	57	69	2
Topstar +Profit	0.8+6.0	53	45	2
Hoe weeding@3WAS+Nominee	0.4	8.6	71	5
Hoe weeding@3WAS+Orizo plus	10	-4.7	-8	5
Hoe weeding@3WAS+Solito	1.5	6.8	61	5
Hoe weeding@3WAS+Profit	6	3.5	31	5
Hoe weeding@3 and 6 WAS		9	65	8
Hoe weeding@3WAS		-87	-64	4
Hoe weeding@6WAS		-57	31	4
Hoe weeding@3,6 and 9WAS		0	0	12
No weeding		-132	-127	0

Costbenefit Analysis

The cost- benefit analysis of the farmers practice (Table 2)-was N3.2. Table 3 show the percentage tost benefit ratio over the control. The use of Topstar gave the highest cost-benefit return of N7.1 which was 122% higher "than the control, even though the yield was lower compared to other tnethods of weed control. This is because the cost of Topstar alone as weed control methods was low as compared to other methods that gave higher yield. The combined application of Topstar as pre emergence and Nominee at 6 WAS gave a cost-benefit return of N5.8 which is 80% higher than the control. The application of Topstar and hoe weeding at 6 WAS resulted in gross margin of N5.6 which is 75% higher than the control. Hoe weeding at 3 WAS and application of Nomirte at 6 WAS gave a cost- benefit return of N5.5 exactly 71 % higher than the control. Application of Topstar as pre emergence and Solito at 6 WAS resulted in a cost-benefit return of N5.4 (69% higher than the control) while hoe weeding at 3 and 6 WAS gave a cost-

benefit return of N5.3 which is also 65% higher than the control. Hoe weeding at 3 WAS and the application of Solito at 6 WAS yielded a cost-benefit return of N5.2 (61 % higher than the control). Application of Topstar as pre emergence and Profit at 6 WAS gave cost- benefit return of N4.6 which is 45 % higher than the control. Hoe weeding at 3 V." AS and application of Profit at 6 WAS also gave N4.2 (31% higher than the control) which is the same for hoe weeding at 6 WAS. Application of Topstar at 3 WAS and Orizo plus at 6 WAS also resulted in cost-benefit return of N3.6 (11 % higher than the control). Hoe weeding at 3 W AS and application of Orizoplus resulted in N2.9 cost-benefit returns which is 8% lower as compared to the control. Similarly, hoe weeding at 3WAS alone gave N1.2 which is also 64% lower to the control. For every naira spent in an uncontrolled weed plot, it resulted in a loss of N-0.89 which is 127% lower than the control.

Labour Requirements

For each hand weeding 4 man-day was required and 1 man day was required for herbicides application. The labour requirements for the farmers practice is usually 12 man-day for 3 hand weeding. The use of pre emergence herbicides alone requires the lowest labour while the use of the combination of post-and pre emergence requires 2man day and combination of hand weeding and herbicides requires 5 Manday (Table 3)

CONCLUSIONS

From the result of this research it can be concluded that early weed control using pre emergence herbicides Top star (Oxadiargyl 400 g/1) at the rate of 0.8 liters ha"[1] and any of the following post emergence herbicides; Solito (300 g Pretilachlor + 20 g pyribenzoxim) at the rate of 1.5 liter ha"[1], Orizo plus (360gPropanil +200g 2,4-D) at the rate of 10 liters ha'[1] Nominee Gold (Bisbyribac sodiumlOOS.C) at the rate of 0.4 liters ha'[1] and Profit (170 g Pretilachlor + 330 g propanil) at the rate of 6 liters ha"[1] at 6 WAS produced significantly higher yields and higher gross margin as compared to the control and other treatments considered in this trials.. The use of pre emergence herbicides alone (Topstar) at planting gave the highest cost-benefit return of (N7.1) 122% over the control, followed by the use of Topstar as pre emergence and application of Nominee at 6 WAS that produced cost- benefit returns of (N5.8) 80% over the control and application of Topstar as pre emergence and hoe weeding at 6 WAS that also gave (N5.6) 75% higher than the control. Labour requirements was lowest (1 man-day) by the application of pre emergence alone (Topstar) while the application of pre emergence and hoe weeding resulted in (5 man-day) as compared to the use of pre and post emergence herbicides that requires 2 man-day. It was concluded that herbicides application has increased yield and profitability of rice and labour demand was also reduced. It was therefore recommended that for successful rice production the use of Topstar as pre emergence herbicides and Nomimee as post emergence herbicides should be adopted by farmers in the study area

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