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Weed Control Efficiency of Some Herbicides in Upland Rice Ecology of Kano State Nigeria

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***Abstract**:*
Rice is infested with a wide variety of weeds and the losses due to weeds could go as high as 43%, a range of herbicides is being used for the effective management of weeds in upland rice. The experiments were conducted in 2016 and 2017 raining seasons at Audu Bako College of Agriculture Dambatta research farm in Kano State of Nigeria to evaluate the efficacy of some pre and post emergence herbicides on weed control efficiency in upland rice. The experiment consisted of twenty weed control strategies by the use of Butachlor at two levels i.e. 1.0 and 1.5 kg a.i. ha^{-1} (pre-emergence), Orizo-plus (2,4-D+Propanil) at two levels i.e. 2.8 and 4.5 kg a.i. ha $^{-1}$, Rainbow-OD (Penoxsulam) at two levels i.e. 0.025 and 0.030 kg a.i. ha^{-1} and Solito 320 EC (Pretilachlor+Pyribenzoxim) also at two levels i.e. 0.320 and 0.480 kg a.i. ha^{-1} (post-emergence). All the post-emergence herbicides were applied in various combinations with Butachlor and in some cases followed by supplementary hoe weeding (SHW) at 4, 8 and 4 & 8 weeks after sowing (WAS). Weed free and weedy plots were employed to serve as control. The experiments were laid out using randomized complete block design and replicated four times. The result indicated that use of Butachlor at 1.5 kg a.i. ha^{-1}fb Orizo plus at 4.5 kg a.i. ha^{-1} to produce significantly lower weed cover score and dry weight, as well as higher weed control efficiency and paddy yield. However, similar result was obtained by manual hoe weeding (MHW at 2, 4, 6 & 8 WAS) treatment, but it was not economically rewarding.

Keywords: *Herbicides, management, rice, weed*

1. Introduction

Weed is a serious constraint to rice production which resulted from continuous rice cropping and this allows weeds to emerge in successive flushes. Identification of weeds is the basic step for planning sound weed management programme. Depending upon the weed species, different weed management options are given keeping in view their susceptibility when growing in a crop (Walia, 2006). Cultural and/or chemical methods are generally employed to control weeds. Manual weeding though effective is getting increasingly difficult due to labor scarcity, rising wages and its dependence on weather conditions. Thus, herbicides usage seems indispensable for weed management in direct seeded rice (Azmi *et al.*, 2005). Weed management in direct seeded systems is more critical than transplanted systems as weeds in direct seeded system can emerge at the same time or before the rice plants, resulting in a serious problem of competition (Johnson *et al.*, 2004). Weed species resistant to herbicides have been reported in countries with high adoption rates and this might be as a result of the use of the same herbicides for long time.

Nigeria has the potential to be self-sufficient in rice production, both for food and industrial raw material needs and for export. However, a number of constraints have been identified as limiting to rice production efforts by farmers. Ukungwu and Abo (2004) reported that weed is the greatest bottleneck to increased yields and quality of rice in Nigeria, particularly in the upland ecology and rank only second to drought stress. Accurate estimates of weed population's abundance and distribution variables are very important if we are to manage agricultural land for higher productivity. The objectives of this study were to determine the efficacy of some pre and post emergence herbicides at different levels for effective weed control in upland rice production system

2. Experimental Sites

The experiments were conducted in 2016 and 2017 raining seasons at (11^0 39'N;08'02E) in Audu Bako College of Agriculture Dambatta research farm in Kano State of Nigeria within the Sudan savanna agro-ecological zone of Nigeria. The total amount of rainfall received in the area was 863 mm and 820 mm for 2016 and 2017 respectively. The minimum and maximum temperatures were 24.1^{0}C and 32.6^{0}C for 2016, and 23.8^{0}C and 33.4^{0}C for 2017 respectively. The soil was sandy loam and the soil pH was neutral. Total nitrogen content was generally low; very low organic carbon and high available P. It also indicated moderate potassium and calcium content and low cation exchange capacity (CEC).

3. Treatments and Experimental Design

This consisted of twenty weed control strategies by the use of Butachlor at two levels (1 and 1.5 kg a.i. ha^{-1}), Orizo-plus at two levels 2.8 kg a.i. ha^{-1} (1.0 2,4-D +1.8 Propanil) and 4.5 kg a.i. ha^{-1} (1.6 2,4-D + 2.88 Propanil), Penoxsulam (Rainbow-OD) at two levels (0.025g and 0.030g a.i. ha^{-1}) and Pretilachlor + Pyribenzoxim mixture (Solito 320 EC) also at two levels 0.320 g a.i. ha^{-1} and 0.480 g a.i. ha^{-1} they were all applied in various combinations with Butachlor as pre-emergence and in some cases followed by supplementary hoe weeding (SHW). Weed free and weedy plots were employed to serve as control among the treatments. The experiment was laid out using randomized complete block design and replicated four times. The gross size of the plot was 3x3m while the net plot is 2.4x2.4m. However, a discard of 1m and 50cm was provided between the blocks and individual plots respectively.

4. Rice Variety Used

The rice variety used for the trial is NERICA 8 (FARO 59). It is a hybrid between *Oryza sativ*a and O*ryza glabberima* developed by WARDA in 1994. The variety is an upland type, medium height, it has 50% days to heading of 55 - 60 days, it matures in 80 -90 days, it has long grain and potential yield of 5 t ha^{-1}. It is resistant to leaf blast disease and lodging. (Gridley *et al.*, 2002) The seed was supplied by Greenspore Agric. Nigeria Ltd.
DATA COLLECTION

4.1. Weed Species Composition

Weeds were harvested from the 1m ^{2} quadrant placed randomly once in each of the treatment plots at harvest. The harvested weed samples were identified, classified by species with the help of hand book of West African Weeds by Akobundu and Agyakwa (1998). The weeds were counted to get the number of individual species.

4.2. Weed Cover Score

The weed cover score was taken by determining the population of the weed species in each of the treatment plots through visual observation. A scale of 1-9 was assigned, where 1 represented total absence of weed and 9 represented plots completely covered by weeds.

4.3. Weed Dry Weight (G)

This was done by harvesting all the weeds that were within the 1m^2 quadrant that was placed at random in each of the plots, the weeds were oven dried to a constant temperature of 70 ^{0}C.

4.4. Weed Control Efficiency (WCE) (%)

This was done by using 1m^2 quadrant that was placed in each of the treatments plot at random and the weeds within the quadrant were harvested and oven dried to get the WCE by the use of the formulae below.

$$WCE = \frac{\text{weed dry weight in weedy check - weed dry weight of treatment in question}}{\text{weed dry weight in weedy check}} \times 100$$

4.5. Paddy Yield (Kg Ha^{-1})

The paddy yield was measured after threshing the sun-dried plants harvested from each net plot and the yield was adjusted at 10 % seed moisture content.

4.6. Harvest Index (HI %)

This was estimated by dividing the paddy yield with the biological yield and multiplied by 100 to get percentage for each of the plots by using the formula below

$$HI = \frac{\text{Paddy yield (kg ha}^{-1}\text{)}}{\text{Total biological yield (kg ha}^{-1}\text{)}} \times 100$$

5. Data Analysis

Data generated were subjected to analysis of variance as described by Snedecor and Cochran (1967) using the general linear model in SAS (SAS, 1987). Where significant, the treatments

6. Results

6.1. Weed Cover Score

Effect of weed control strategies on weed cover score in 2016 and 2017 raining seasons is presented in Table 1. Data recorded on weed cover score (WCS) produced significant differences ($P \leq 0.05$) at all the seasons and sampling periods. The weedy check recorded the highest WCS but was at par only with Butachlor at 1.0 kg a.i.ha^{-1} fb Orizo plus at 4.5 k g a.i. ha^{-1}, Butachlor at 1.5 kg a.i.ha^{-1} fb Rbow at 0.030 kg a.i.ha^{-1} and Butachlor at 1.5 kg a.i.ha^{-1} fb Solito at 0.320 kg a.i.ha^{-1}. Similarly in 2017 during 4 WAS the weedy check had the highest WCS but was at par with Butachlor at 1.0 kg a.i.ha^{-1} fb Orizo plus at 2.8 kg a.i.ha^{-1}, Butachlor at 1 kg a.i.ha^{-1} fb Orizo plus at 4.5 kg a.i.ha^{-1} and Butachlor at 1 kg a.i.ha^{-1} fb Solito at 0.32 k g a.i. ha-1. During 8 WAS sampling the least WCS was produced by Butachlor 1.5 kg a.i.ha^{-1} fb Orizo plus at 4.5 kg a.i.ha^{-1} though was at par with all of the treatments except Butachlor 1.0 kg a.i.ha^{-1} fb 1.5 kg a.i.ha^{-1}, Butachlor at 1 kg a.i.ha^{-1} fb Solito at 0.32 k g a.i. ha-1, Butachlor at 1 kg a.i.ha^{-1} fb SHW at 8 WAS. The weedy check recorded the highest WCS throughout the experiment by statistical ranking.

6.2. Weed Dry Weight (G)

Effect of weed control strategies on weed dry weight in 2016 and 2017 Wet seasons is presented in Table 2. The result on weed dry weight (WDW) was significantly different ($P < 0.05$) at both growing seasons. Weedy check produced the significantly heaviest WDW while the least WDW was recorded by Butachlor at1.0 kg a.i.ha^{-1} fb SHW at 8 WAS in 2016 and by HWC at 2,4,6 and 8 WAS in 2017 wet season.

6.3. Weed Control Efficiency (%)

Effect of weed control strategies on weed control efficiency (WCE) for 2016 and 2017 raining seasons is presented in Table 3. Weed control efficiency was significantly affected by the methods of weed control in both growing seasons. Application of Butachlor at 1.5 kg a.i.ha^{-1} fb SHW at 4 & 8 WAS produced the highest control efficiency but was at par with application of Butachlor at 1.5 kg a.i.ha^{-1} fb SHW at 4 WAS, at 4 & 8 WAS, MHW at 2,4,6 & 8 WAS and Butachlor at1.5 kg a.i.ha^{-1} fb Orizo plus at 4.5 kg a.i.ha^{-1} in 2016 raining season. In 2017 raining season however the highest WCE was produced by HWC at 2, 4, 6 & 8 WAS but at par with considerable number of treatments.

2016			2017		
Weed species	Common name	Frequency (%)	Weed species	Common name	Frequency (%)
Grasses			**Grasses**		
*R. cochinchinensis (*Lour.) Clayton	Itch grass	1.1	*R. cochinchinensis (*Lour.) Clayton	Itch grass	0.7
I. cylindrica (L.) Raeuschel	Spear grass	0.5	*I. cylindrica* (L.) Raeuschel	Spear grass	0.4
P. maximum Jacq	Guinea grass	7.4	*P. maximum* Jacq	Guinea grass	7.4
D. horizontalis Willd	Crab grass	7.7	*D. horizontalis* Willd	Crab grass	7.7
C. dactylon (L) Pers.	Bahama grass	8.1	*C. dactylon* (L) Pers.	Bahama grass	8.1
E. indica (Gaertn.)	Goosegrass	6.4	*E. indica* (Gaertn.)	Goosegrass	6.4
*O. longistminata (*A) Chev.	Wild rice	2.1	*O. longistminata (*A) Chev.		
Broad leaved			**Broad leaved**		
I. asarifolia (Desr.) Roem.	water spinach	7.2	*I. asarifolia* (Desr.) Roem.	Water spinach	7.2
S. occidentalis (L.) Link	Coffee senna	8.3	*S. occidentalis* (L.) Link	Coffee senna	8.3
*A. spinosus (*L).	spiny amaranth	5.5	*A. spinosus (*L).	Spiny amaranth	3
A. hispidum (DC).	Star burr grass	8.3	*A. hispidum* (DC).	Star burr grass	8.3
T. procumbens (L.)	coat buttons	6.9	*T. procumbens* (L.)	Coat buttons	6.9
P. amarus (Schum.&Thon).	___	6.8	*P. amarus* (Schum.&Thon).	___	6.8
C. retusa (L.)	Rattlebox	8.1	*C. retusa* (L.)	Rattlebox	8.1
Sedges			**Sedges**		
L. hexandra (Sw.)	Cut grass	1.4	*L. hexandra* (Sw.)	Cut grass	0.7
C. esculentus (L)	Yellow nut sedge	7.9	*C. esculentus* (L)	Yellow nut sedge	10
K. squamulata (Thonn.)	___	7.2	*K. squamulata* (Thonn.)	____	7.2
F. ferruginea (L.) Vahl	___	8.5	*F. ferruginea* (L.) Vahl	____	5.5
			L. martinisensis (L)	Wild tea bush	3.5
A. aspera (L)	devil's horsewhip	_	*A. aspera* (L)	Goat weed	2.5

Table 1: Weed Species Composition at DBT in 2016 and 2017 Wet Seasons

Treatments	Rate(kg a.i. ha^{-1})	2016		2017	
		4 WAS	8WAS	4WAS	8WAS
Buta fb Orizo	1.0 fb 2.8	3.3a-d	3.0ab	3.3a-d	3.0ab
Buta fb Orizo	1.0 fb 4.5	5.8ef	5.8cd	5.8ef	5.8cd
Buta fb Orizo	1.5 fb 2.8	7.5f	7.5de	7.5f	7.5de
Buta fb Orizo	1.5 fb 4.5	4.3b-e	2.5ab	4.0a-d	2.8ab
Buta fb Rbow	1.0 fb 0.025	4.3b-e	3.5abc	4.3a-d	3.5abc
Buta fb Rbow	1.0 fb 0.030	4.0b-e	4.5bc	4.0a-d	4.5bc
Buta fb Rbow	1.5 fb 0.025	4.0b-e	3.5abc	4.0a-d	3.5abc
Buta fb Rbow	1.5 fb 0.030	6.3fe	3.8abc	4.0a-d	3.8abc
Buta fb Solito	1.0 fb 0.32	6.3ef	5.8cd	5.3de	5.8cd
Buta fb Solito	1.0 fb 0.48	4.5def	4.3bc	4.5bcd	4.3bc
Buta fb Solito	1.5 fb 0.32	4.5def	4.5bc	4.8bcd	4.5bc
Buta fb Solito	1.5 fb 0.48	5.0def	4.5bc	5.0bcd	4.5bc
Buta fb SHW @ 4 WAS	1	3.3a-d	3.0ab	3.3a-d	3.0ab
Buta fb SHW @ 8 WAS	1	4.8def	3.3ab	4.4bcd	3.3ab
Buta fb SHW @ 4 WAS	1.5	5.3ef	4.4bc	5.3ef	4.3bc
Buta fb SHW @ 8 WAS	1.5	2.8abc	2.3ab	2.8abc	2.3ab
Buta fb SHW @ 4 & 8 WAS	1	1.5a	1.8a	1.5a	1.2a
Buta fb SHW @ 4 & 8 WAS	1.5	3.0a-d	2.8ab	3.0a-d	2.8ab
HWC @ 2, 4, 6 & 8 WAS	_	2.0ab	2.8ab	2.0ab	2.8ab
Weedy check	_	7.8f	8.0e	7.8f	8.0e
SE ±		1.42	1.44	1.89	0.95

Table 2: Weed Cover Score of Upland Rice as Affected by Weed Control Strategies in 2016 and 2017 Wet Seasons

Means with the same letter in the same column are not significantly different P ≤ 0.05 using SNK, WAS – Week after sowing, WCS – weed cover score, SHW – supplementary hoe weeding, HWC= Hoe weeded control, Buta – Butachlor,

6.4. Paddy Yield (Kg Ha^{-1})

Effect of weed control methods on paddy yield of upland rice in 2016 and 2017 raining seasons is presented in Table 4. Paddy yield was significantly affected (P < 0.05) by weed control strategies at both locations and growing seasons. Application of Butachlor at 1.5 kg a.i.ha^{-1} fb Orizo at 4.5 kg a.i.ha^{-1} produced the statistically the highest paddy yield in both 2016 and 2017 raining seasons. The second higher position was occupied by all the treatments except the application of Butachlor at 1.5ha^{-1} fb Rainbow at 0.025 kg a.i.ha^{-1}, Butachlor at 1.5 kg a.i. ha^{-1} fb Rainbow at 0.030 kg a.i.ha^{-1}, Butachlor at 1.0 kg a.i. ha^{-1} fb Solito at 0.480 kg a.i.ha^{-1}, Butachlor at 1.5 kg a.i. ha^{-1} fb Solito at 0.320 kg a.i.ha^{-1}, Butachlor at 1.5 kg a.i. ha^{-1} fb Solito at 0.480 g a.i.ha^{-1} and the weedy check which was the least in 2016. Similarly in 2017 raining season the significantly highest paddy yield treatment (Butachlor at 1.5 kg a.i.ha^{-1} fb Orizo at 4.5 kg a.i.ha^{-1}) was at par with the application of Butachlor at 1.5 kg a.i. ha^{-1} fb Solito at 0.320 kg a.i.ha^{-1}, Butachlor at 1.5 kg a.i.ha^{-1} fb Solito at 0.480 kg a.i.ha^{-1}, Butachlor at 1.0 kg a.i.ha^{-1} fb SHW at 4 WAS, Butachlor at 1.0 kg a.i.ha^{-1} fb SHW at 8 WAS, Butachlor at 1.5 kg a.i.ha^{-1} fb SHW at 8 WAS and the weed free control (HWC at 2, 4, 6, & 8 WAS). The weedy check had the least paddy yield in both seasons.

7. Discussions

Weeds are usually best adapted to survive in a crop with a similar life cycle, germination time, or growth habit. The most effective control methods often are based on the life cycle of a weed. Different weed management options are given, keeping in view their susceptibility when growing in a crop (Walia, 2006). Weed characteristics that allow them to grow and be competitive with desirable plant species include the ability to germinate and grow in different environments, rapid seedling growth that allows them to be competitive quickly, ease of pollination, ability to reproduce vegetatively, and the ability to tolerate adverse environmental conditions. In a report by Akobundu (1987) and Zimdhl (2007) they asserted that, most grasses and sedges were adopted to overcrowding and can survive in a densely populated area.

The weed flora of the experimental site was similar during both seasons and comprised of *Rottboelia cochinchinensis, Digitaria horizontalis, Cynodon dactylon, Cyprus rotundus*, *Ipomae asarifolia*, *Eluecine indica*, *Fimbriyalis ferruginea, Kyalingya squamulata* etc. All the weed control treatments significantly reduced the weed population over the weedy check. Maximum reduction in total weed density and total weed dry weight and weed cover score was recorded by the application of Butachlor at 1.5 kg a.i.ha^{-1} fb Orizo plus at 4.5 kg a.i.ha^{-1} and hoe weeded plots. High weed density and frequency retard crop growth, encourages disease problems, serve as alternate host for deleterious insects and diseases, slow down harvesting operation, increase the cost of production and reduce the market value of crops (Akobundu, 1987). *Digitaria horizontalis, Cynodon dactylon are* prevalent weeds at the experimental site are very aggressive and difficult to control due to its characteristic features like waxy and pubescent leaf surface, rapid growth, mimicry habit and very strong root system that enable them to withstand difficult environmental conditions. Effect of legume weed like *Ipomae asarifolia* is less on crop growth compared to grasses like *Rottboelia cochinchinensis, Digitaria horizontalis, Cynodon dactylon etc*. Similar result was recorded by Yahaya (1993) and Ishaya & Mahadi (2004) who both reported greater reduction in weed dry weight due to herbicides application in rice field. It could also be observed that weedy control plots recorded higher weed cover score and weed dry weight and this also corroborated with the work of Ibrahim (2001) and Ishaya (2004) who also registered higher weed dry weight in weedy plots compared to herbicides control treatments and hoe weeded control plots..

It could be observed that higher dose of Orizo-plus (Propanil-2,4-D mixture) at 4.5 kg a.i. ha^{-1} recorded higher paddy yield and harvest index in both growing seasons. The increase in paddy yield with efficient weed control treatments may be attributed to better crop growth in the absence of weed-crop competition for any of the growth factors. The weed free environment thus created helped the rice crop to put forth better growth without any competition for nutrients and in turn resulted in higher paddy yields. Sultana (2000) observed that weed infestation of 100 to 200 weeds per meter square reduced paddy yield by 51 to 64% compared with weed-free conditions. Mahajan *et al.* (2009) concluded that herbicides are the most effective means of securing rice yields against weeds. In another report Yawale *et al. (*2015*)* confirmed the Application of Butachlor at the rate of 2.25 kg a.i. ha $^{-1}$ followed by Propanil - 2, 4 - D mixture at the rate of 2.52 and 1.44 kg a.i. ha^{-1} respectively, produced higher number of tillers per plant, grain bearing panicles and grain yield per hectare.

8. Conclusion

Base on the findings of this research work on upland rice production in the Sudan savanna tropics, farmers shall apply both pre and post emergence herbicides especially Butachlor at1.5 kg a.i.ha^{-1} fb Orizo plus 4.5 kg a.i.ha^{-1} for better weed management or the use of pre-emergence Butachlor at 1.5 kg a.i.ha^{-1} fb supplementary hoe weeding at 4 & 8 WAS, particularly in areas where manual labor is readily available and relatively cheaper.

Treatments	Rate (kg a.i.ha^{-1})				
		WDW (g)		WCE (%)	
		2016	2017	2016	2017
Buta fb Orizo	1 fb 2.8	168.0b-f	133.0b-e	44.2efg	42.6c-f
Buta fb Orizo	1 fb 4.5	138.3c-h	151.8bcd	50.0b-g	37.7def
Buta fb Orizo	1.5 fb 2.8	109e-h	92.5def	66.2a-e	64.1abc
Buta fb Orizo	1.5 fb 4.5	93.5f-i	72.0ef	69.2a-e	70.3ab
Buta fb Rbow	1 fb 0.025	130.5e-i	108.8def	69.2a-e	54.8-d
Buta fb Rbow	1 fb 0.030	222b	186.5bc	29.5g	23.8efg
Buta fb Rbow	1.5 fb 0.025	191b-e	86.4def	34.3fg	66.0abc
Buta fb Rbow	1.5 fb 0.030	210.8bcd	119.3def	46.8c-g	51.1a-d
Buta fb Solito	1 fb 0.320	154.3b-h	18.0b	46.8c-g	23.3efg
Buta fb Solito	1 fb 0.480	161.9b-g	196.0b	44.9d-g	18.8fg
Buta fb Solito	1.5 fb 0.320	218.5bc	107.8def	26.3g	53.9a-d
Buta fb Solito	1.5 fb 0.480	125.3e-i	136.0b-e	56.6a-f	44.1cde
Buta fb SHW @ 4 WAS	1	75.3hi	89.3def	73.7abc	62.4a-d
Buta fb SHW @ 8 WAS	1	61.3i	139.0b-e	79.5a	40.5c-f
Buta fb SHW @ 4 WAS	1.5	80.3igh	97.5def	71.8a-g	61.3a-d
Buta fb SHW @ 8 WAS	1.5	61.5i	117.8def	79.6a	51.9a-d
Buta fb SHW @ 4 & 8 WAS	1	79.0igh	121.3c-f	74.1ab	45.6b-e
Buta fb SHW @ 4 & 8 WAS	1.5	66.5i	134.3b-e	77.5ab	45.3b-e
HWC @ 2, 4, 6 & 8 WAS	_	92.3igh	59.8f	69.7a-e	74.1a
Weedy check	_	305a	262.3a	_	_
SE ±		50.9	40.1	16.3	15.4

Table 3: Weed Dry Weight and Weed Control Efficiency of Upland Rice as Affected by Weed Control Strategies in 2016 And 2017 Wet Seasons

Means with the same letter in the same column are not significantly different P < 0.05 using SNK, WAS – Week after sowing, WDW – weed dry weight, WCE – weed control efficiency, SHW – supplementary hoe weeding, HWC= Hoe weeded control, Buta – Butachlor

Treatments	Rate (kg a.i.ha^{-1})	2016		2017	
		Paddy yield		Paddy yield	
		Kg ha^{-1}	HI %	Kg ha^{-1}	HI %
Buta fb Orizo	1.0 fb 2.8	1952bcd	72.9ab	1683bcd	67.0abc
Buta fb Orizo	1.0 fb 4.5	1790bcd	77.3a	1640bcd	74.8abc
Buta fb Orizo	1.5 fb 2.8	1599cde	68.0ab	1956abc	74.1abc
Buta fb Orizo	1.5 fb 4.5	2470a	80.1a	2327a	80.3a
Buta fb Rbow	1.0 fb 0.025	1678b-e	66.8ab	1768bc	68.2abc
Buta fb Rbow	1.0 fb 0.030	2107ab	72.5ab	1909abc	72.9abc
Buta fb Rbow	1.5 fb 0.025	1895bcd	70.6ab	1620bcd	70.6abc
Buta fb Rbow	1.5 fb 0.030	2029bc	73.0ab	1840abc	61.8bc
Buta fb Solito	1.0 fb 0.32	1586cde	74.9ab	1809abc	71.8abc
Buta fb Solito	1.0 fb 0.48	1558cde	65.0ab	1589bcd	70.5abc
Buta fb Solito	1.5 fb 0.32	1805bcd	71.0ab	1741bcd	77.2ab
Buta fb Solito	1.5 fb 0.48	1790bcd	74.7ab	1951abc	72.6abc
Buta fb SHW @ 4 WAS	1	1834bcd	69.1ab	1449cd	69.5abc
Buta fb SHW @ 8 WAS	1	1526de	64.6ab	1643bcd	74.0abc
Buta fb SHW @ 4 WAS	1.5	1608cde	67.8ab	2020ab	62.6bc
Buta fb SHW @ 8 WAS	1.5	1549cde	64.6ab	1648bcd	61.5bc
Buta fb SHW @ 4 & 8 WAS	1	1503bcd	73.2ab	1958abc	72.2abc
Buta fb SHW @ 4 & 8 WAS	1.5	1972bcd	65.3ab	1912abc	73.6abc
HWC @ 2, 4, 6 & 8 WAS	_	1902bcd	73.0ab	1883abc	66.3abc
Weedy check	_	1214e	59.6b	1226d	60.4c
SE ±		290	10.21	315	9.6

Table 4: Paddy Yield and Harvest Index of Upland Rice as Affected by Weed Control Strategies in 2016 and 2017 Wet Seasons

Means with the same letter in the same column are not significantly different P ≤ 0.05 using SNK, WAS – Week after sowing, SHW – supplementary hoe weeding, HWC= Hoe weeded control, Buta – Butachlor, HI – harvest index

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