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EFFECT OF TILLAGE AND VARIETY ON WEED CONTROL AND YIELD PERFORMANCE OF UPLAND RICE

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ABSTRACT
Weeds are a constant pest of rice and can cause huge crop failure. Field trials were carried out to determine the impact of tillage and variety on weed suppression and yield of upland rice during 2018 and 2019 cropping seasons in Jalingo (8^0 54′ N 11^0 22′ E). The experiments were 2 factor design comprised of four tillage treatments (minimum tillage, disc plough, disc harrow and disc plough/harrow) and three rice varieties (NERICA 2, NERICA 7 and Local var.) laid out in a Randomized Complete Block Design (RCBD) and replicated three times. Data were gathered on weed density, weed biomass, yield and yield components of rice. Results indicated that minimum tillage recorded significantly lower average weed density (97.60 no/m^2) (47.80 no/m^2) and weed biomass (19.09 g/m^2) (7.03 g/m^2) compared to average weed density (124.75 no/m^2) (80.32 no/m^2) and weed biomass (29.49 g/m^2) (18.56 g/m^2) in disc plough/harrow treatment plots at 5 and 8 WAP. Similarly local var. recorded significantly higher average weed density (107.55 no/m^2) (66.30 no/m^2) and weed biomass (21.82 g/m^2) (14.05 g/m^2) compared to weed density (81.09 no/m^2) (52.70 no/m^2) and weed biomass (15.92 g/m^2) (8.33 g/m^2) in NERICA 2 treatment plots at 5 and 8 WAP. Significantly higher average grain yield were recorded in disc ploughed/harrowed (3129 kg/ha) and NERICA 2 (3102 kg/ha) treatments plots in both years.
Key words: Weed control, Upland rice, Tillage, Variety

INTRODUCTION

Rice is one of the major cultivated food crops in Nigeria due to its wide acceptance as a food item (Adigbo *et al*; 2018). It is considered as the most important grain with regard to human nutrition and caloric intake, providing more than a fifth of the calories consumed by human species (Wagan *et al;* 2015). Rice production in Nigeria is hampered by several factors such as poor soil fertility, erratic rainfall distribution, lack of access to chemical fertilizers and improved rice varieties, weed interference and inappropriate tillage practice (Dada *et al;* 2017).

Tillage is the use of machine, animal or man power (energy) for physical manipulation of soil to provide condition favourable for plant growth (Kishor *et al;* 2013). The objectives of tillage among others include creating suitable seedbed, promotion of higher crop profits, increase crop yields, soil improvement and protection, optimum use of water resources by plants and weed control (Hanna *et al;* 2009).

The choice of crop cultivars as biological weed control method to suppress weeds is an important tool in weed management in rice (Kolo *et al;* 2012), however, this is often overlooked (Ferrell *et al;* 2006). Currently, there is increasing interest in determining the genetic ability of rice variety to overcome weed pressure in other to maintain high yield (Bhagirathy, 2012). Rice growth attributes (vegetative traits) such as plant height, number of tillers, number of leaf, leaf area and leaf area index have been assessed to understand their effects on weed suppression and yield performance of rice (Gibson *et al;* 2001).

Weeds remain the major production constraint in rainfed upland rice production (Rondenburg *et al;* 2009). Management of weeds in upland rice ecology have often been accomplished majorly by herbicide application and hand (hoe) weeding (Toure *et al;* 2013). Manual hand (hoe) weeding is an effective means of controlling weeds in upland rice production, but a declining labour force have led to increase in its cost of production compared to the increase in the crop prices (Anwar *et al*. 2014), hence, encouraging the use of herbicide (Fischer *et al;* 2004). There is also growing concerns about the impact of herbicides on human health problems of resistance and weed shift in weeds (Bhagirath *et al;* 2012) which necessitated the need for alternative approaches for weed management in rice. Surveys showed that reduction in use of agrochemicals can improve the sustainability of the agroecosystem in long term (Pardo *et al;* 2011). Growing competitive rice varieties along with appropriate tillage practice may help farmers to sustainably manage weeds at low cost (Beckie, 2011). Therefore, this study was conceived with the objective of evaluating the effect of tillage and variety on weed suppression and yield performance of upland rice in Jalingo.

MATERIALS AND METHODS

The field trials were conducted during 2018 and 2019 cropping seasons at the Teaching and Research farm of Taraba state College of Agriculture, Jalingo (8^0 54′ N 11^0 22′ E) in the guinea savannah zone of Nigeria. The treatments consisted of four tillage (minimum tillage, disc plough, disc harrow and disc plough/harrow) and three rice varieties (NERICA 2, NERICA 7 and Local var.). The twelve (12) treatment combinations were laid out in a Randomized Complete Block Design (RCBD) with three replications. Disc plough and disc plough/harrow operations were carried out with tractor-mounted disc plough while disc harrow was done with tractor-mounted disc harrow. In the minimum tillage plots, weeds were killed with Roundup (a glynhosate herbicide), applied at the rate of 4 litres per hectare with 15 litres capacity Knapsack sprayer. Before seeds were planted each plot was measured 5m x 4m. A 5m x 2m path separated between one treatment and another and between the three replicates. This was to enable easy turning of the tractor at end of rows in disc plough, disc plough/harrow and disc harrow treatments (Olaoye, 2002). The elite rice varieties were sourced from National Cereals Research Institute (NCRI) Baddegi, Niger state, while the local var. was obtained from a farmer in Jalingo. The rice seeds were soaked in water for 24 hours, removed and kept in dark corner of the room and cover with jute bag for 48 hours. The sprouted seeds were sown four per hill using 20cm x 25 cm spacing and thinned to two seedlings per hill at 2 WAP. Manual hand weeding was done at 2, 5 and 8 WAP. Birds were controlled by covering the entire farm with fishing net. Harvesting was done manually with sickle and left in the field for four days to dry. Threshing was done manually by beating the panicle against old drum on tarpaulin, then winnowed, bagged and labeled according to plot. Weed density and weed biomass data were determined at 2, 5 and 8 WAP. Yield and yield components data (panicle weight, panicle length, and number of grains/panicle, number of panicle/m^2, 1000-grain weight and grain yield) were taken from net plot of $1m^2$ at harvest. All data collected were subjected to analysis of variance (ANOVA) using Genstat package version 8.1. Means separation was accomplished using Duncan Multiple Range Test (DMRT) at 5% level of probability.

RESULTS/DISCUSSION

Tillage and variety had significant effect on weed density and weed biomass at 5 and 8 WAP and not at 2 WAP (Table 1 & 2). Disc ploughing/harrowing recorded significantly higher average weed density (124.75 no/m^2) and 80.32 no/m^2) and weed biomass (29.49 g/m^2 and 18.56 g/m^2) compared to average weed density (97.60 no/m^2 and 47.80 no/m^2) and weed biomass (19.09 g/m^2 and 7.03 g/m^2) recorded in minimum tillage treatment at 5 and 8 WAP in both years. Dis plough (117.19 no/m^2 and 62.15 no/m^2) and disc harrow (116.42 no/m^2 and 60.18 no/m^2) had similar effect on weed at 5 and 8 WAP in both years.

The significantly higher weed density and weed biomass obtained in disc plough/harrow is in line with Shrestha et al. (2002) who reported that though disc plough/harrow operation incorporated plant residues in to the soil and killed weeds, it also brought weed seeds to the soil surface due to more disturbance which had favoured their (weed seeds) germination and emergence. Hartman et al. (1990) observed that soil disturbance through disc plough and harrow stimulated weed seed germination and infestation. Minimum tillage recorded lower weed density and weed biomass. This is in agreement with Okorie *et al.* (2001) who reported higher mean annual weed populations in more disturbed than less disturbed (minimum tilled) soils.

Similarly, variety significantly impacted on weed density and weed biomass at 5 and 8 WAP and not at 2 WAP as indicated in Table 1 and 2. The local variety had significantly higher average weed density (107.55 no/m^2 and 66.30 no/m^2) and weed biomass (21.82 g/m^2 and 14.05 g/m^2) compared to average weed density (81.09 no/m^2 and 52.70 no/m^2) and weed biomass (15.92 g/m^2 and 8.33 g/m^2) recorded in NERICA 2 at 5 and 8 WAP in both years.

The result showed that the effect of variety on weed density and weed biomass were in the order. Local var.>NERICA 7>NERICA 2. This revealed that NERICA 2 reduced significantly weed density and weed biomass than NERICA 7 and the local var. This could be attributed to superior vegetative performance of the cultivar (NERICA 2). So, it could be obvious that the vegetative attributes of NERICA 2 helped in enhancing its competitiveness against weeds, therefore suppressing them. This is in line with Ahmed et al. (2014) who reported that vegetative attributes of crops are essential for their weed suppression.

The interaction between tillage and variety on weed density and weed biomass was significant at 5 and 8 WAP (Table 1 & 2). Planting of local var. in seedbed resulted to significantly higher average weed density (128.86 no/m^2 and 76.67 no/m^2) and weed biomass (26.10 g/m^2 and 22.14 g/m^2) compared to average weed density (77.36 no/m^2 and 42.51 g/m^2) and weed biomass (12.47 g/m^2 and 7.16 g/m^2) in the minimum tillage plots planted with NERICA 2 at 5 and 8 WAP in both years. The grain yield and yield related parameter were significantly influenced by tillage and variety in both years as presented in Tables 3 and 4. Disc plough/harrow seedbed recorded significantly higher average panicle weight (3.46g), panicle length (28.82cm), grains/panicle (147.85), panicles/m^2 (64.96), 1000-grain weight (34.74g) and grain yield (3129 kg/ha) than average panicle weight (1.49g), panicle length (20.54 cm), grains/panicle (97.03), panicles/m^2 (49.01), 1000-grain weight (26.06g) and grain yield (2288 kg/ha) recorded in minimum tillage in both years.

Among the tillage treatments, disc plough/harrow maximized grain yield and yield components of rice. This is in agreement with Polthanee *et al*. (2002) who reported higher cowpea grain yield and yield components in disc plough/harrow than maximum tillage. Ujo *et al*. (2014) also reported higher rice yield with disc plough/harrow compared with disc plough, disc harrow and minimum tillage treatments. Similarly, Bangura *et al*. (2016) also reported higher grain yield of rice in disc plough/harrow than with minimum tillage.

Similarly, NERICA 2 had significantly higher average panicle weight (3.12g), panicle length (29.36 cm), grains/panicle (163.46), panicles/m^2 (69.63), 1000-grain weight (30.64g) and grain yield (3102 kg/ha) compared to average panicle weight (1.31g), panicle length (19.58 cm), grain/panicle (92.65), panicles/m^2 (43.97) , 1000-grain weight (21.89g) and grain yield (2009 kg/ha) in the local var. during 2018 and 2019 farming seasons.

The significantly higher yield performance observed in NERICA 2, could be attributed to vegetative performance due to genetic makeup. This is in line with Ahmed et al. (2014) who reported that vegetative attributes of crops are essential for their yield performance. Adigbo, *et al*. (2018) also reported that differences in grain yield and yield components of rice are greatly influenced by genetic factor and the environmental condition under which the crop was cultivated.

There was significant interactive effect between tillage and variety on grain yield and yield components of rice (Table 3 & 4). NERICA 2 planted in disc ploughed/harrowed plots recorded significantly higher average panicle weight (3.22g), panicle length (30.47cm), grains/panicle (222.71), panicles/m^2 (79.47), 1000-grains weight (30.84g) and grain yield (3232 kg/ha) than average panicle weight (1.08g), panicle length (17.50 cm), grains/panicle (91.78), panicles/m^2 (40.32), 1000-grains weight (17.75g) and yield (1886 kg/ha) in local var. planted in minimum tillage plots in both years.

CONCLUSION

Population of fresh weeds and weed biomass were significantly reduced under minimum tillage and NERICA 2 treatments. Significantly higher grain yield and yield components were recorded in disc plough/harrow and NERICA 2 treatments. It is concluded that when NERICA 2 is planted in disc ploughed/harrowed seedbed, it will lead to higher grain yield.

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Table 1: Weed density as influenced by tillage and variety during 2018 and 2019 cropping seasons

Weed density (no/m^2)						
		2018 WAP			2019 WAP	
Treatments	2	5	8	2	5	8
Tillage						
Min. tillage	221.62a	111.08c	52.40c	249.04a	84.12c	43.20c
Disc plough	222.43a	127.83b	73.20b	251.70a	108.00b	51.10b
Disc harrow	219.16a	125.62b	71.11b	252.31a	107.25b	49.26b
Disc plough/harrow	225.15a	139.10a	82.33a	253.00a	110.41a	78.30a
Variety						
NERICA 2	241.68a	89.43c	58.18c	258.44a	72.75c	47.22c
NERICA 7	239.45a	93.72b	62.96b	256.04a	92.11b	50.11b
Local Var.	240.13a	102.62a	71.09a	257.90a	112.48a	61.51a
Interaction						

Tillage x	Variety						
Minimum till	NERICA 2	220.77a	92.62l	48.10i	222.54a	62.11i	36.19k
	NERICA 7	218.34a	124.20hi	53.60g	220.32a	72.00h	45.26j
	Local Var.	219.52a	136.34d	69.25cd	223.61a	83.80g	51.30i
Disc plough	NERICA 2	217.61a	121.11j	53.32g	219.82a	85.20ef	64.28def
	NERICA 7	221.16a	146.00a	63.27e	217.31a	89.77d	66.43d
	Local Var.	218.66a	152.30b	77.61b	220.25a	94.22b	70.15b
Disc harrow	NERICA 2	220.41a	119.34k	50.14h	217.66a	81.09g	62.44g
	NERICA 7	224.30a	129.42fg	57.84f	220.11a	86.10e	57.24h
	Local Var.	219.00a	132.20e	70.80c	221.42a	93.70bc	62.00g

	NERICA 2	217.92a	125.60h	57.30f	218.32a	83.17g	65.14de
Disc plough/harrow	NERICA 7	223.24a	130.25f	70.31c	220.25a	89.22d	68.11c
	Local Var.	219.30a	159.62a	80.34a	223.71a	98.10a	73.00a

There are no significant differences among means with the same letters in the column (DMRT=0.005).

Table 2: Weed biomass as impacted by tillage and variety 2018 and 2019 cropping seasons

Weed biomass (g/m^2)						
		2018 WAP			2019 WAP	
Treatments	2	5	8	2	5	8
Tillage						
Min. tillage	92.86a	20.01d	8.24d	85.83a	18.17d	5.82d
Disc plough	89.78a	23.70c	11.05c	83.11a	21.43c	8.10c
Disc harrow	90.24a	26.43b	17.82b	84.18a	24.64b	12.12b
Disc plough/harrow	92.29a	30.17a	21.81a	86.20a	28.82a	15.31a
Variety						

NERICA 2		95.71a	17.52c	7.08c	89.89a	14.33c	9.58c
NERICA 7		96.92a	18.88b	9.92b	90.14a	17.28b	12.00b
Local Var.		98055a	23.17a	13.11a	92.23a	20.47a	15.00a
Interaction							
Tillage x	Variety						
Minimum till	NERICA 2	93.88a	12.72k	7.52k	79.41a	12.23h	6.81j
	NERICA 7	92.10a	18.12fghi	11.28gh	77.25a	14.90fg	9.00bcdefgh
	Local Var.	95.67a	21.40f	14.14ef	78.10a	17.80bcde	11.62bcdef
Disc plough	NERICA 2	94.52a	23.04e	10.40i	80.53a	14.13fg	8.96bcdefghi
	NERICA 7	93.81a	26.18c	12.05g	77.40a	19.83bc	10.28bcdefg
	Local Var.	92.11a	29.14b	14.02ef	78.63a	21.18b	13.40bcd

Disc harrow	NERICA 2	90.53a	16.08j	15.10e	81.30a	15.00f	9.36bcdefgh
	NERICA 7	91.25a	18.17fghi	18.09bcd	79.25a	15.41f	12.32bcde
	Local Var.	93.55a	20.25fg	21.25b	80.73a	18.57bcd	15.15b
Disc plough/harrow	NERICA 2	94.10a	19.41fgh	18.10bcd	82.00a	17.03bcde	12.00bcde
	NERICA 7	92.15a	24.32d	19.35bc	80.55a	21.02b	14.40bc
	Local Var.	93.17a	32.40a	24.11a	79.21	29.80a	20.16a

There are no significant differences among means with the same letters in the column (DMRT=0.005).

Table 3: Effect of tillage and variety on grain yield and yield components of upland rice 2018 cropping season

Treatments	2018					
	Panicle wt (g)	Panicle length (cm)	No. of grains per panicle	No. of panicle/m^2	1000-grain wt (g)	Grain yield (kg/ha)

Tillage							
Minimum till		1.41c	21.03c	95.24c	46.38d	27.81d	2345d
Disc plough		2.92b	25.60b	134.10b	57.25c	32.08c	2879a
Disc harrow		2.89b	26.73b	132.13b	60.33b	35.29b	2898b
Disc plough/harrow		3.81a	29.44a	157.20a	68.53a	38.40a	3106a
Variety							
NERICA 2		3.10a	28.43a	200.10a	70.81a	34.01a	2994a
NERICA 7		2.31b	23.62b	180.34b	61.34b	28.53b	2783b
Local Var.		1.38c	19.82c	87.25c	42.82c	22.51c	2011c
Interaction							
Tillage x	Variety						
Minimum till	NERICA 2	2.46b	25.70bc	133.00h	55.70g	26.52bcde	2789g
	NERICA 7	2.22b	21.83e	126.50g	49.43i	23.90fg	2542h
	Local Var.	1.01d	15.58h	82.25l	40.82l	18.18h	1883l

Disc plough	NERICA 2	2.51b	26.10b	184.63d	73.68d	29.32b	2952d
	NERICA 7	2.17b	23.18d	169.83f	62.51f	26.00bcde	2875f
	Local Var.	1.30c	19.22f	95.24j	45.90k	22.41fgh	1920k
Disc harrow	NERICA 2	2.92b	26.32b	182.51c	77.38b	28.33bc	3095c
	NERICA 7	2.44b	25.81bc	179.27e	70.24c	27.06bcd	2884e
	Local Var.	1.37c	18.10fg	89.30k	48.10j	23.71fg	1957j
Disc plough/harrow	NERICA 2	3.34a	28.66a	218.25a	81.64a	32.85a	3215a
	NERICA 7	2.62b	25.42bc	192.54b	72.66de	29.15b	3034b
	Local Var.	1.82c	19.00f	97.30i	51.11h	24.43f	1988i

There are no significant differences among means with the same letters in the column (DMRT=0.005).

Table 4: Effect of tillage and variety on grain yield and yield components of upland rice 2019 cropping season

Treatments	2019 Panicle wt (g)	Panicle length (cm)	No. of grains per panicle	No. of panicle per m^2	1000-grain wt (g)	Grain yield (kg/ha)
Tillage						
Minimum till	1.58c	20.05c	98.81c	51.63d	24.31d	2231d
Disc plough	2.08b	24.11b	128.62b	53.24c	26.06c	2698c
Disc harrow	2.17b	25.17b	129.22	56.76b	28.49b	2972b
Disc plough/harrow	3.10a	28.20a	138.50	61.40a	31.08a	3152c
Variety						
NERICA 2	3.14a	30.30a	126.82a	68.44a	27.27a	3210a
NERICA 7	2.03b	27.50b	119.08b	59.63b	24.92b	2870b
Local Var.	1.34c	19.34c	98.06c	45.12c	21.27c	2008c

Interaction							
Tillage x	Variety						
Minimum till	NERICA 2	2.18b	25.11bcde	209.61 b	60.10def	22.22e	2654h
	NERICA 7	1.58f	22.20g	182.40 j	57.92g	19.54efgh	2465i
	Local Var.	1.16h	17.42k	101.32 n	39.81k	15.32j	1889l
Disc plough	NERICA 2	3.10a	27.15bc	208.66 bc	68.31bc	25.10bc	2979d
	NERICA 7	1.92c	24.81bcdef	188.36 h	62.58d	21.52ef	2910g
	Local Var.	1.21fg	20.77ghi	116.15k	45.10j	18.61efghi	1900k
Disc harrow	NERICA 2	2.93b	26.25bcd	201.41 def	69.54b	24.81bcd	3011c
	NERICA 7	2.25b	24.09bcdef	190.62 g	61.82de	22.42e	2963f
	Local Var.	1.83cd	19.72fghij	111.00 l	49.11i	19.17efgh	1961e

	NERICA	3.11a	32.29a	227.11	77.30a	28.82a	3249a
	2	2.84b	28.10b	6a	68.41bc	26.63b	3171b
Disc	NERICA	1.68cde	21.42fgh	202.14	51.18h	20.34efg	2084j
plough/harrow	7			de			
	Local			110.66l			
	Var.			m			

There are no significant differences among means with the same letters in the column (DMRT=0.005).

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