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Effect of weed control treatments and planting method on the yield and yield parameters of rice in Sudan savannah of Nigeria

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Abstract

The experiments were carried out in 2020 and 2021 rainy seasons to determine the performance of rice as influenced by planting method and weed control treatments. The treatments consists of three planting methods (dibbling broadcasting and transplanting and weed control methods (hoe weeding, pre emergence application of gramazone (200g/L of paraquat/ha), pre and post emergence of gramazone (200g/L of paraquat/ha) and propanil (360g/L of propanil + 200g/L 2-4D) and weedy check). The treatments were laid out in a randomized complete block design (RCBD) and were replicated three times. The results revealed the plots weeded twice and those treated with pre and post emergence application of gramazone and propanil respectively resulted in more number of spikelet per panicle, longer panicle, increase in number of effective tillers per hill, more grains per panicle and grain yield. The effect of planting methods on the rice growth revealed that rice sown under transplanting methods gave more number of effective tiler per hill, longer panicle, more grain per panicle and increases in grain yield compared to the others methods while broadcasting resulted in the least value of the parameters than others methods. Therefore, it can be concluded that rice farmers in the sudan savanna zone of Nigeria can adopt pre and post emergence application of gramazone and propanil with transplanting method since the combination of these treatments gave better weed control, growth and yield of paddy rice.

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Introduction

Rice belongs to the genus Oryza and the tribe Oryzeae of the family Gramineae also known as Poaceae. Rice constitutes major staple foods in many parts of the world and It is a source of income to more than 100 million households around the world (Abiwon et al., 2016). Globally, rice ranks third after wheat and maize in terms of production (Ejebe, 2013). The production of the crop has been affected by a number of factors among which include water, nutrient availability and weed management especially in the direct seeded cultivation and this has affected in the yield. Weeds also serve as alternate hosts to pests and pathogens which usually affect crops in the field and during storage (Akobundu, 2013). Previous studies have shown that weed occurrence is a constant component of the ecosystem in comparison to the epidemic nature of other pests which makes farmers

unaware of the significant losses they incur from weed infestation (Johnson, 1999). However, of all the constraints limiting the production of this crop, weeds, appear to have the most deleterious effect causing between 75 and 100% reduction in potential paddy rice yield (Akobundu, 2011; Imeakparia, 2011; Lavabre, 2011). Yield reduction due to weed competition is greater in direct-seeded than in transplanted rice. Inadequate land preparation, use of short-stature early maturing cultivars and increased fertilizer use have resulted in severe weed problems in direct – seeded rice. The limited data available indicate that production losses can reach 30-40% for fields that are poorly weeded (Anon, 1988). With direct seeding, the germination of rice seeds and the emergence of weeds take place almost at the same time. Therefore, weed control at the early stages of the crop growth is important (Street and Lanham, 2016).

Hoe removal of weeds still remains the most practical method of weed control in many developing countries. Hoe weeding is quite effective if employed at the right time. The number of hoe weeding depends on crop and weed growths and the critical period of crop-weed competition. However, the efficiency of hoe weeding as reported by Gianessi, (2013) is often compromised by the continued wet conditions characteristic of the beginning of the rainy season. Hoe weeding under wet conditions often causes weed to re-root and re-establish, necessitating several rounds of weeding to keep the crop weed-free and avert yield losses. According to Ogwuike et al. (2014) and Datta et al. (2017) it is tedious, inefficient, time consuming and associated with high labour demands. In addition, labour for manual weeding is scarce and often too expensive for the average farmer to afford (Adigun et al., 2017; Daramola et al., 2019). Alternatively, herbicides are quite effective and efficient in suppressing weeds in rice if properly used. The underlying strategy behind using herbicides for weed control in rice is to kill or stunt the growth of weedy plants while allowing the rice plants to grow and achieve a competitive height advantage. Herbicides reduce drudgery and protect crops from early weed competition according to Rodenburg et al. (2011). Moreover, herbicides for weed control in rice are often not available to smallholder farmers at the time of need and, when available, farmers lack the requisite knowledge and skill to use herbicides correctly. Although herbicide use alleviates the problem of labour for weeding, incorrect use may complicate crop performance (Ekeleme, 2009). Application characteristics such as herbicide choice, rate and timing, are reported to frequently deviate from the recommendations (Rodenburg and Johnson, 2009). In a related study by Ismaila1 et al. (2012) reported that increasing weed population is caused by wrong use of herbicides, lack of skill in weed identification and correct matching of herbicides with weeds. Poor knowledge on how to use chemicals, inability to read and understand instructions and lack of technical skills to operate the chemical spray machines are the major problems associated with the use chemical by farmers. Danmaigoro et al., 2018 have reported reduction in weed dry matter production due to application of herbicides in rice

In rice crop production, the planting methods have an impact on the growth and yield besides cost of cultivation and labor requirement. Awan, et al. (2007) reported that direct seeding has good stand establishment, higher tillering and higher grain yield. Other advantages are stable growth, reduced transplanting shock but there is weed problem in direct seeding compared to transplanted rice. In most developing countries, rice transplantation is usually performed by hired expensive labor, which is not specialized to maintain the required plant population to achieve higher productivity (Mann et al., 2007). To overcome this problem, direct seeding has been considered as only viable alternatives in

rescuing farmers (Aslam et al., 2008). This technique reduces labour needs by more than 25% in term of working hours. The input requirements and the investment in direct seeded rice are much lower than in transplanted rice (Sunil et al., 2002). Direct seeded rice, if managed properly, can yield as high as transplanted rice (Ali, et al., 2007).

Furthermore, a report by Rani and Jayakiran (2010) transplanting provides crops less competition for growth resources such as Sunlight, moisture, and nutrients; and enables easy crop management like weeding, and herbicides as well as pesticide applications, ensures uniform plant stands and gives the rice crop a head start over emerging weeds. Ismaila et al. (2012) reported that transplanted rice reduces weed population since the crop has an additional advantage due to its age as the result of covering the ground early. Transplanting rice seedlings, gives the crop a 14 to 21 days growth advantage over the weeds, and allows continuous flooding at greater depths. During transplanting, weed seedlings are also trampled and incorporated into the soil. The major planting methods commonly adopted in Nigeria are drilling, broadcasting and transplanting. The objectives of this study were to determine to evaluate the effect of different weed control treatments on the yield attributes of rice and to determine the best planting method that promote better yield of rice.

Materials and Methods

The experiment was carried out during the 2020 and 2021 raining seasons in the Faculty of Agriculture Research Farm, Federal University Dutse (Lat 11°46’39” N, Long 9°20’3” E). The experiment consists of three different planting methods (dibbling transplanting and broadcasting) and four different weed control treatments (hoe weeding at 3 and 6 weeks, pre emergence application of gramazone (200g/L of paraquat/ha), pre and post emergence of gramazone (200g/L of paraquat/ha) and propanil (360g/L of propanil + 200g/L 2-4D and weedy check). The treatments were laid out in a Randomize Complete Block Design (RCBD). NPK 15:10:10 at the recommended dose in two split was applied. Weed control was carried out based on treatments designed for specific plot. Harvesting was done when the crop reached physiological maturity. five plant stands were tagged within each plot for growth parameters sampling. The following parameters were taken:

Number of spikelets per panicle

The number of spikelets per panicle was obtained by counting the spikelet on the panicle from the five tagged plants in each net plot at harvest and the average was recorded.

Number of days to 50% panicle initiation

This was taken by making daily observation from the date of sowing/planting to the time of heading and recording the number of days when half the plants in the plot produced panicle from date of sowing.

Number of effective tillers

This refers to those tillers that produced panicle with filled grains. The total number of effective tillers were determined from five tagged plants from each plot at harvest by counting the number of effective tillers per stand and the average was recorded.

Length of panicle per plant (cm)

The panicle length was taken from five tagged plants per plot at harvest by measuring the panicle from the base of the panicle to its tip using a ruler and the average was recorded.

Number of grains per panicle

The number of grains per panicle were counted from the tagged plants after harvest and the average was used to give number of grains per panicle.

1000 grains weight (g)

After threshing and winnowing in the air, 1000 grains were counted and weighed in a laboratory using electric sensitive weighing balance

Grain yield

Harvested paddy from each net plot was threshed after sun drying, winnowed and grain yield obtained from net plot was weighed on a mettle balance and converted to per ha basis expressed in kg/ha.

Data analysis

Data collected was subjected to analysis of variance ANOVA (GenStat 17th edition). The means obtained were compared and separated using Duncan's Multiple Range Test (DMRT) (Duncan, 1995).

Results

Number of spikelet per panicle

The effect of weed control and planting method on the number of spikelet per panicle is shown in table 1. The result shows that there was significant effect ($p<0.001$) of weed control methods on the number of spikelet per panicle. Hoe weeding at 3 and 6WAP gave the highest number of spikelet per panicle and statistically at par with pre and post emergence application of gramazone + propanil, while weedy check gave lowest number of spikelet per panicle. Significant effect ($p<0.001$) of planting methods on the number of spikelet per panicle was observed. Transplanting resulted in the highest number of spikelet per panicle though statistically at par with dibbling method while broadcasting gave the lowest.

Number of effective tillers per stand

The effect of weed control and planting method on the number of effective tillers is shown in table 1. The result reveals that there was significant effect ($p<0.001$) weed control methods on the number of effective tillers. Hoe weeding at 3 and 6WAP gave the highest number of effective tillers per stand though statistically at par with pre and post emergence application of gramazone + propanil, while weedy check gave lowest number of effective tillers per stand. Significant effect ($p<0.001$) was also observed among the planting methods on the number of effective tillers. Transplanting resulted in the highest number of effective tillers per stand while broadcasting gave the lowest.

Number of grains per panicle

The effect of weed control and planting method on the number of grains per panicle is shown in table 1. There was significant effect ($p<0.001$) of weed control methods on number of grains per panicle. Pre and post emergence application of gramazole + propanil gave the highest number of grains per panicle though statistically at par with hoe weeding at 3 and 6 WAP, while Pre emergence application of gramazole gave the lowest and statistically at par with weedy check. Significant effect ($p<0.001$) of planting methods on the number of grains per panicle was also observed. Dibbling method gave the highest number of grains per panicle though statistically at par while broadcasting gave the lowest

Length of panicle per plant

The effect of weed control and planting method on the length of panicle per plant is shown in table 1. The result indicates that there was significant effect ($P<0.001$) of weed control methods on the length of panicle per plant. Pre and post emergence application of gramazole + propanil gave the tallest length of panicle per plant but statistically at par with hoe weeding at 3 and 6 WAP, while weedy check gave the shortest length of panicle per plant. Significant effect ($P<0.001$) of planting methods on the length of panicle per plant was also observed. Transplanting method gave in the tallest length of panicle per plant though statistically at par with dibbling while broadcasting gave the shortest.

1000 grain weight (g)

The effect of weed control and planting method on 1000 grain weight is shown in table 3. There was significant effect ($p<0.001$) of the weed control methods on 1000 grain weight. Hoe weeding at 3 and 6WAP gave the heavier 1000 grain weight but statistically at par with pre and post emergence application of gramazole + propanil, while weedy check gave the lowest. Significant effect ($p<0.001$) of planting methods on 1000 grain weight was also observed. Transplanting method gave the heavier grain weight but statistically at par with dibbling while broadcasting gave the lowest.

The interaction between weed control methods and planting methods shown in table 2 was significant ($p<0.01$). Combination of hoe weeding at 3 and 6WAP and transplanting gave the heaviest grain weight, while weedy check and broadcasting gave the lowest.

Days to 50% panicle initiation

The effect of weed control and planting methods on days to 50% panicle initiation is shown in table 3. There was significant effect ($p<0.001$) of weed control methods days to 50% panicle initiation. Hoe weeding at 3 and 6 WAP resulted in early to reach 50% panicle initiation followed by pre and post emergence application of gramazone + propanil while weedy check took longer days to attain 50% panicle. Significant effect ($p<0.001$) was also observed on planting methods. On days to 50% panicle initiation, transplanting treated plot reached 50% panicle initiation early while broadcasting took longer days.

The interaction between weed control methods and planting methods shown in table 1 was significant ($p<0.001$). Hoe weeding at 3 and 6 WAP and transplanting resulted in early 50% panicle initiation though statistically at par with pre and post emergence (gramazone + propanil) and transplanting, while weedy check and broadcasting resulted in longer days to 50% panicle..

Grain yield (kg/ha)

The effect of weed control and planting method on grain yield is shown in table 3. The result shows that there was significant effect (P<0.001) of weed control methods on grain yield. Pre and post emergence application of gramazole + propanil gave the highest grain yield though statistically at par with hoe weeding at 3 and 6 WAP, while weedy check gave the lowest. Significant effect (p<0.001) of planting methods on grain yield was also observed. Transplanting method gave the highest grain yield which was statistically at par with dibbling while broadcasting gave the lowest yield.

The interaction between weed control methods and planting methods shown in table 4 was significant (p<0.001) in 2020. Pre and post emergence application of gramazole + propanil and transplanting gave the highest number of grains per panicle while weedy check and broadcasting gave the lowest

Discussion

The present study shown that weeds were adequately and effectively controlled by all the weed methods adopted. The results revealed the plots weeded twice and those treated with pre and post emergence application of gramazone and propanil respectively resulted in taller plant height, large leaf area, higher number of effective tillers and grain yield of rice than the weedy check and also application of gramazone as pre-emergence alone. This is due to the fact that effective weed control was observed by the application of pre and post emergence herbicides which provides large spectrum and long-time effect that suppressed weed infestation in the treated plots and reduced weeds competition for available resources. Ishaya et al. 2012 and Danmaigoro et al., 2018 have reported reduction in weed dry matter production due to application of herbicides in rice. The failure of gramozone applied as pre emergence to give broad spectrum weed control compared to its followed-up application with others herbicides is due to narrow of its weed control. The performance of rice crop in plots weeded twice can be attributed to effective weed control that minimized competition for growth resource between crops and weed specifically during the critical period of weed interference in rice resulting to greater efficiency in utilizing nutrients. This is in line with earlier report by Pamploma et al., (1990) who reported yield increase of maize because the crop was free from weeds during its critical period of weed interference. The result of this trials indicated that weeding of rice field should not be delayed beyond 2WAT to avoid yield losses due to weed interference with crop. Significantly longer number of days to 50% heading observed in the weedy check compared with weed control treated plots may just be the reason for disparity in the yield because it took longer days for the crop in the weedy check to head.

This result is similar to the finding of Adeosun (2008) who reported that weed of rice field should not be delayed beyond 3 weeks of crop establishment to avoid weed interference with crop that might prolong days to heading. The yield contributing parameters such as number of tillers per pant, number of spikes were significantly reduced in weedy check probably due to severe weed competition for light, nutrient and moisture during major part of the crop vegetative growth period of the crop life cycle. The effect of planting methods on the rice growth revealed that rice sown under transplanting methods gave higher yield than others methods. This is due to better weed competitive ability of transplanted rice than direct seeding and broadcasting, initial and better crop establishment and ability to use environmental resources better thus resulting in increases growth performance of crop. The similar finding was reported by Olorukooba et al., (2012).

Table 1: Effect of weed control treatments and planting methods on days to 50% panicle heading, number of spikelets per panicle, number of effective tillers per stand and length of panicle per plant of rice at Dutse in 2020 and 2021 rainy seasons

Treatments	Rate/ha	Days to 50% panicle heading		Number of spikelets per panicle		Number of effective tillers per stand		Length of panicle per plant	
		2020	2021	2020	2021	2020	2021	2020	2021
Weed control methods									
Hoe weeding at 3 and 6 WAP		71.78d	64.78d	20.11a	17.11a	26.33a	30.33a	24.17a	23.89a
Gramazone	200g/l paraquat	91.44b	84.44b	13.00b	10.00b	8.89b	11.78b	15.46b	15.18b
Gramazone + propanil	200g/l paraquat + 360g/l propanil + 200g/l 2-4D	74.89c	67.89c	18.56a	15.56a	25.89a	29.89a	23.93a	24.44a
Weedy check		124.11a	117.11a	7.67c	4.33c	8.33b	3.67c	12.71c	11.89c
SE±		0.418	0.418	0.634	0.628	0.812	0.665	0.842	0.414
Planting methods									
Dibbling	60kg	90.33c	83.33b	16.17a	13.17a	20.25b	21.67b	19.73b	21.03a
Transplanting	25kg	84.83b	77.83c	16.83a	13.75a	22.42a	24.58a	22.71a	21.52a
Broadcasting	80kg	96.50a	89.50a	11.50b	8.33b	9.42c	10.50c	14.76c	14.00b
SE±		0.362	0.362	0.549	0.544	0.703	0.576	0.730	0.358
Interaction									
Weed control*planting method		NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) are not significantly different at 5% level of probability using DMRT.

Table 2: Interaction effect of weed control treatments and planting methods on 1000 grain weight of rice in Dutse in 2020 and 2021 rainy seasons

Treatments		Planting methods					
		2020			2021		
	Rate/ha	Dibbling 60kg	Transplanting 25kg	Broadcasting 80kg	Dibbling 60kg	Transplanting 25kg	Broadcasting 80kg
Weed control							
Hoe weeding at 3 and 6 WAP		31.07a	32.27a	16.10b	35.27a	36.47a	20.30b
Gramazone	200g/l paraquat	7.90c	8.20c	8.83c	12.00c	12.40c	12.73c
Gramazone + propanil	200g/l paraquat + 360g/l propanil + 200g/l 2-4D	26.53a	29.47a	15.67b	30.73a	33.67a	19.87b
Weedy check		5.40c	4.83c	5.83c	7.30c	9.03c	7.20c
SE±		2.185			2.160		

Means followed by the same letter(s) are not significantly different at 5% level of probability using DMRT.

Table 3: Effect of weed control treatments and planting methods on number of grains per panicle, 1000 grain weight (g) and grain yield (rate/ha) of rice at Dutse in 2020 and 2021 rainy seasons

Treatments	Rate/ha	Number of grains per panicle		1000 grain weight (g)		Grain yield (rate/ha)	
		2020	2021	2020	2021	2020	2021
Weed control methods							
Hoe weeding at 3 and 6 WAP		174.6a	186.7a	26.48a	30.68a	3974a	4083a
Gramazone	200g/l paraquat	87.3b	99.4b	8.31b	12.38b	1006b	1115b
Gramazone + propanil	200g/l paraquat + 360g/l propanil + 200g/l 2-4D	175.2a	188.1a	23.89a	28.09a	4026a	4135a
Weedy check		88.6b	100.7b	5.36b	7.84c	430b	478b
SE±		4.87	4.69	1.262	1.247	224.2	227.4
Planting methods							
Dibbling	60kg	152.0a	165.7a	17.73a	21.32a	2812a	2904a
Transplanting	25kg	152.0a	163.3a	18.69a	22.89a	3070a	3164a
Broadcasting	80kg	90.2b	102.2b	11.61b	15.02b	1196b	1291b
SE±		4.22	4.06	1.093	1.080	194.2	197.0
Interaction							
Weed control*planting method		NS	NS	**	**	**	**

Means followed by the same letter(s) are not significantly different at 5% level of probability using DMRT.

Table 4: Interaction effect of weed control treatments and planting methods on grain yield of rice in Dutse in 2020 and 2021 rainy seasons

Treatments		Planting methods					
		2020			2021		
	Rate/ha	Dibbling 60kg	Transplanting 25kg	Broadcasting 80kg	Dibbling 60kg	Transplanting 25kg	Broadcasting 80kg
Weed control							
Hoe weeding at 3 and 6 WAP		4842a	5224a	1858b	4951a	5333a	1967b
Gramazone	200g/l paraquat	996bcd	1039bcd	983bcd	1105bcd	1148bcd	1092bcd
Gramazone + propanil	200g/l paraquat + 360g/l propanil + 200g/l 2-4D	4922a	5507a	1650bc	5031a	5616a	1759bc
Weedy check		489cd	511cd	292d	531cd	559cd	345d
SE±		388.4			393.9		

Means followed by the same letter(s) are not significantly different at 5% level of probability using DMRT.

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