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Research Article

Yield of Selected Lowland Rice Varieties as Influenced by Fertilizer Regime in Sudan Savanna Zone of Kebbi State, Nigeria

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Abstract

Field experiments were conducted in lowland research field of the National Cereals Research Institute (NCRI) Birnin Kebbi sub-station, located at Gwadangaji area in Kebbi State (latitude 12^{0}29'N and longitude 4^0 15'E). The location is situated within Sudan savanna agro ecological of Nigeria. The average annual rainfall of the area ranges from 650 mm – 750 mm per annum, the relative humidity ranges from 21 – 40% and 51 – 79% during the rainy and dry seasons, respectively. The aim was to determine the productivity of selected rice varieties as influenced by timing of fertilizer application. The treatments consisted of factorial combination of three varieties (Faro44, Faro52 and Faro62) and four fertilizer regimes (2WAT, 4WAT, 6WAT and untreated control) laid out in a randomized complete block design (RCBD), with three replications. The size of each plot was 3m x 3m (9m^2). Results revealed that application of fertilizer at 2WAT resulted in higher values for plant height, tiller count per stand, mean panicle length, grains number per panicle, mean panicle weight, 1000-grain weight and yield per hectare than all other fertilizer treatments. For rice varieties Faro52 out performed the other varieties on most of the growth and yield parameters tested. The interaction of variety and fertilizer regime on yield showed that the combination of fertilizer rigime at 2WAT and Faro 52, gave the best yield (7.30kg). in conclusion the application of fertilizer at 2WAT inconjuction with Faro 52, could be considered since it recorded better performance among the remaining three regimes 4WAT, 6WAT and Control tested in the study area.

Keywords: *Yield, Rice, Variety, Fertilizer, Regime.*

1.0 INTRODUCTION

Rice (*Oryza sativa* L.) is a grass family crop called *Gramineae* (Poaceae). Rice is one of the world's three main meat plants and is accepted as their staple diet by about quarter of the world's population. Its worldwide output is projected at 776,461457 million metric tons (Fao, 2022). Zhang *et al.* (2014) said rice after corn is the world's second-largest cereal crop. Rice is a significant staple food for most of the world's population. Globally, rice production has grown at an annual average of 1.0% over the past decade, reaching 486.7 million tonnes in 2017. Most of this growth has come from Asia, accounting for 89% of global output. China and India are the largest producers, each with a share of 29.6% and 22.6% of global production, respectively. In the rest of the world (ex-Asia), rice production has raised steadily over the past decades, accounting for 15% of total production by 2017, a marginal increase from 12% in the last two decades. An understanding of crop nutrient requirement, time of application and the use of best fertilizers are vital keys to growing healthy and high yielding rice crop (Bohnert *et al.* 1995). Rice plant requires a large amount of nitrogen at early stage and mid-tiller stages to maximize the number of panicles, thus increase yield. There is a great opportunity to increase rice output, but most producers ' inefficient use of nutrients and regime of application of the nutrient are some of the most limiting factors. This can only be addressed by proper nutrient management, which has become an essential component of contemporary technology for rice production (Chauhan *et al*., 2017). Balanced nutrient application in adequate quantities and at the appropriate and critical periods of plant growth are essential components of plant nutrient management. Different varieties vary in their response to quantities of nutrients applied and the time of application of these nutrients. Critical periods of nutrient demands of genotypes vary significantly owing to their genetic variations and affects nutrient use efficiency and economics of rice production (Awan *et al*., 2011). Jayachandran *et al*. (2002) stated that different genotypes differ in nutrient uptake, translocation and assimilation, and accounts for the superiority of some genotype over the other and make them more nutrients efficient.

2.0 MATERIALS AND METHODS

2.1 Treatments and Experimental design

Field experiments were conducted in lowland research field of the National Cereals Research Institute (NCRI) Birnin Kebbi sub-station, located at Gwadangaji area in Kebbi State (latitude 12^{0}29'N and longitude 4^{0} 15'E). The location is situated within Sudan savanna agro ecological of Nigeria. The average annual rainfall of the area ranges from 650 mm – 750 mm per annum, the relative humidity ranges from 21 – 40% and 51 – 79% during the rainy and dry seasons, respectively (KARDA, 2014). The soil sampling was taken from each plot before and after the exercise in a zigzag pattern across the entire experimental field. The composite soil sample was air-dried and prepared for analysis. The treatments consisted of factorial combination of three varieties (Faro44, Faro52 and Faro62) and four fertilizer regimes (2WAT, 4WAT, 6WAT and untreated control) laid out in a randomized complete block design (RCBD), with three replications. The size of each plot was 3m x 3m ($9m^2$). All the seeds were sourced from the breeding unit of the National Cereals Research Institute, Badeggi, Niger State. The Rice varieties used were FARO44, FARO52 and FARO62. The time of fertilizer application was in two weeks after transplanting (2WAT), four weeks after transplanting (4WAT) and six weeks after transplanting (6WAT) with no fertilizer application as untreated control.

2.2 Varieties

Faro44 (sippi) originated from Taiwan and was introduced to Nigeria in 1992. It is a lowland ecology variety belonging to the early maturity (100-110 days) class. Faro 44 has high tillering ability, long grain and average height ranging from 90-110cm. It is an all season variety (Rain fed and Dry season) with yield potential of up to 7 t ha^{-1}.

Faro52 originated from West African Rice Development Association (WARDA) and was introduce in 1997. This variety is suitable for lowland ecology with medium maturity of (120-130 days) class, has an average height of 100-120cm. It records height above 120cm in a more suitable ecology. It is a long grain variety with good milling quality suitable for both rain fed and dry season and has potential yield of about 8 t ha^{-1}.

Faro62 has the original name of NCRO 49 which originated from and developed in Nigeria, National Cereals Research Institute, Badeggi in the year 2011 with yield potential of about 4 t ha-1. One of the advantages of Faro62 is its ability to tolerate drought and a competitive height of 100-130cm. It is lowland ecology varieties that can be cultivated in both rain fed and dry season (Maji et al., 2017).

3.0 RESULTS AND DISCUSSION

3.1 Tiller count

Tiller ability in rice is an important agronomic trait for number of panicles per unit land area as well as grain production (Moldenhauer and Gibbons, 2013). The application of NPK enhances the number of tillers in rice. Table 3 showed the tiller count of rice varieties at 6, 9 and 12WAT, as influenced by fertilizer regime in 2022/23, 2023/24 and combined data. In 2022/23 trial, Faro52 produced more tillers compared to Faro44 and Faro62. At 6WAT, Faro52 has the highest number of tillers compared to Faro62 which was in turn higher than Faro44. Similarly, Faro52 was noted to tiller better than Faro62 and Faro44 which were statistically the same at 9WAT. At 12WAT the result also showed the same trend as observed in 6 and 9WAT. During 2023/24 trial period, all the three varieties showed no significant difference at 6, 9 and 12WAT. The combined result also showed no significant difference at 9 and 12WAT among all the three varieties. However, Faro52 and Faro62 were statistically the same having higher tiller number compared to Faro44 at 6WAT.

In terms of fertilizer regime, similar trend was observed across all the sampling periods during 2022/23 trial where fertilizer application at 2WAT resulted to higher number of tillers than other treatment at 6WAT. Fertilizer application at 4WAT gave more tillers than by application of fertilizer at 6WAT which was in turn was higher than the untreated control. In 2023/24 trial during 6 WAT, tiller count by the fertilizer regime of 2 and 4WAT were statistically the same and in turn higher compared to fertilizer regime of 6WAT the untreated control. During 9WAT, fertilizer regime of 2, 4 and 6WAT produced statistically similar and more tillers than the untreated control. Tiller count during 12WAT was higher by fertilizer regime of 2WAT than fertilizer regime of 6WAT. The fewest tillers were by the untreated. In the combined result, application of fertilizer at 2 and 4 WAT produced more tillers than application at 6WAT; and fewest tillers were by the untreated control, during both 6 and 9 WAT sampling periods. While during 12 WAT, tiller count consistently decreased with delaying fertilizer application from 2WAT to 6WAT. The least tiller count was by the untreated control. There was no significant interaction of variety and fertilizer regime at all sampling periods during in both trials and the combined results (Table 3). The possible reasons for having more tiller counts in nitrogen applied plots than the control could be attributed to the nitrogen ability in enhancing vegetative growth in plants. This result is in line with the findings of Yu, *et al.* 2021 who reported significant increased in tiller number in rice treated with nitrogen fertilizer.

3.2 Number of Filled Grains, 1000-grain weight and Grain yield

Table 2 shows response of rice varieties to time of fertilizer application on Number of Filled Grains, 1000-grain weight and Grain yield during 2022/23 and 2023/24 dry seasons; and the two trials combined. During 2022/23 trial, Faro52 recorded the highest value in terms of grain yield compared to Faro44 which was in turn higher than Far62. Faro65 and Faro52 were statistically similar and higher in number of filled than Faro44. Also, during 2022/23 trial, result for 1000 grain weight shows that Faro44 produced higher value than Faro62 which in turn produced higher weight of 1000 grains than Faro52 while the results of 2023/24 trial and combined were statistical similar in all varieties. Furthermore, result obtained during 2023/24 trial reveals that Faro44 and Faro52 were statistically similar and recorded the highest value of grain weight when compared to Faro62 which recorded the least. In terms of number of filled grain per panicle, Faro52 recorded the highest value when compared to Faro62 which in turn was greater than Faro44. The combined result showed that Faro52 recorded higher grain yield compared to Faro44 which was in turn higher than Faro62. The result obtained in terms number of filled grain per panicle in the combined showed that Faro52 and Faro62 were statistically similar and higher than Faro44. Results for the fertilizer regime showed that, number of filled grain per plant and grain yield fertilizer regime of 2WAT gave higher values compared to fertilizer regime of 4WAT; while the values recorded by 6WAT was in turn higher than by the untreated control. The overall performance of rice due to nitrogen application significantly gave more grain yield of rice than the control. This significant in grain yield difference can be attributed to the faster release of nutrients for plants use from the nitrogen fertilizer which gave higher grain yield of rice. This finding is in line with that of Yu *et al.* (2021) who reported that higher rice grain yield was obtained from plants that received nitrogen fertilizer over the plants due to its faster rate of mineral fertilizer and release of nutrient for the plant used.

Table1: Tiller Count of Rice varieties as influenced by fertilizer regime during 2022/23, 2023/24 dry seasons and combined at Birnin Kebbi

Treatments	Tiller count								
	6WAT	9WAT	12WAT	6WAT	9WAT	12WAT	6WAT	9WAT	12WAT
	2022/2023			2023/2024			Combined		
Variety									
Faro44	278.16c	471.42b	475.66b	466.25	587.83	587.08	372.21b	542.83	544.88
Faro52	387.75a	497.83a	502.66a	537.83	546.83	586.25	462.79a	509.13	530.96
Faro62	325.00b	452.42b	458.00b	541.25	588.25	577.58	433.13a	520.33	517.79
SE±	**3.285**	**7.080**	**7.051**	**30.898**	**40.220**	**24.431**	**19.956**	**22.847**	**15.023**
Fertilizer Regime (FR)									
2WAT	450.22a	638.11a	642.00a	590.89a	629.00a	687.56a	520.56a	633.56a	664.78a
4WAT	369.44b	584.89b	589.00b	627.78a	637.67a	639.22ab	498.61a	611.28a	614.11b
6WAT	304.33c	459.11c	462.67c	447.67b	585.00a	575.00b	376.00b	522.06b	518.18c
Control	197.22d	213.44d	221.44d	394.11b	446.56b	432.78c	296.67c	329.50c	327.11
SE±	**3.937**	**8.175**	**8.142**	**35.676**	**46.440**	**28.210**	**19.578**	**26.380**	**17.346**
Interaction									
V x FR	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in a treatment group are not significantly different at 5% using DMRT

Table 2: Yield ha^{-1}, 1000 grain weight and Number of filled grain per panicle of Rice varieties as influenced by fertilizer regime during 2022/23, 2023/24 dry seasons and combined at Birnin Kebbi

Treatments	Yield (t ha^{-1})	1000-grain weight (g)	Filled grain/ panicle	Yield (t ha^{-1})	1000 grain weight (g)	Filled grain/ panicle	Yield (t ha^{-1})	1000 grain weight (g)	Filled grain/ panicle
	2022/2023			2023/2024			Combined		
Variety									
Faro44	5.17b	23.42a	315.50b	5.66a	23.58	335.50c	4.87b	23.50	325.50b
Faro52	6.20a	21.18c	351.25a	5.82a	21.64	368.66a	5.41a	21.41	359.95a
Faro62	4.31c	22.15b	351.50a	4.73b	39.75	354.41b	4.07c	30.95	352.95a
SE±	**0.120**	**0.148**	**1.575**	**0.085**	**10.186**	**3.733**	**0.112**	**5.105**	**6.084**
Fertilizer Regime (FR)									
2WAT	7.30a	23.00a	405.33a	7.68a	47.19	430.11a	6.75a	35.09	417.72a
4WAT	5.81b	22.66a	342.11b	6.03b	23.29	378.22b	5.33b	22.97	360.16b
6WAT	5.04c	22.00b	317.22c	4.85c	22.58	348.77c	4.46c	22.28	333.00c
Control	2.46d	21.34c	293.00d	2.74d	20.23	254.33d	2.60d	20.78	273.66d
SE±	**0.139**	**0.171**	**1.819**	**0.098**	**11.761**	**4.311**	**0.130**	**5.865**	**7.025**
Interaction									
V x FR	*	NS	NS	*	NS	NS	*	NS	NS

Means followed by the same letter(s) in a treatment group are not significantly different at 5% using DMRT

Table 3: Interaction of Variety and Fertilizer Regime on Weight per plot in Combine

	Fertilizer Regime			
Variety	2WAT	4WAT	6WAT	CONTROL
FARO44	7.13a	5.58cd	4.66e	2.11h
FARO52	7.13a	6.11b	5.41d	2.98fg
FARO62	5.98bc	4.30e	3.30f	2.71g
SE±	**0.041**			

Means followed by the same letter (s) across rows and columns are not significantly different at 5% using DMRT

4.0 CONCLUSION

Considering the outcome of this study, it can be concluded that application of fertilizer as earlier as 2 weeks after transplanting resulted to higher yield of rice, irrespective of the variety used. Also, variety Faro52 proved to be better in term of yield compared to Faro44. The least variety in term of yield was Faro62.

5.0 RECOMMENDATIONS

From the findings of this study, the following recommendation could be made:

1. Fertilizer regime at 2 weeks after transplanting is recommended better rice growth, development and yield in the study area.
2. Faro52 is recommended due to its outstanding agronomic performance compared to Faro44 and Faro62

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