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YIELD AND YIELD COMPONENTS OF RICE VARIETIES AS INFLUENCED BY STAND DENSITY AND NPK FERTILIZER

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ABSTRACT

Field trials were conducted in 2016 at Ahmadu Bello University, Zaria in Northern Guinea Savanna and Kadawa, in Sudan Savanna of Nigeria, to study yield and yield components of rice varieties as influenced by NPK fertilizer and stand densities. The treatments consisted of two lowland rice varieties (FARO 44 and FARO 52), three NPK fertilizer (40:20:20, 80:40:40, 120:60:60) kgha^{-1} and three level of plants/stand (2, 4 and 6). The treatments were factorially combined and laid out in a randomized complete block design and replicated three times. The result showed that yield parameters were enhanced with increased rate of NPK fertilizer with optimum grain yield obtained from the application of NPK 120:60:60 kgha^{-1}. Also 2 plants/stand densities gave the highest grain yield components which translated into higher grain yield. Among the two varieties evaluated, FARO 52 gave higher value for most yield components, however, FARO 44 gave higher harvest index and grain yield. The interaction between 2 plants/stand densities with the application of NPK 120:60:60 kgha^{-1} resulted in maximum yield of 6479.3 kgha^{-1} at Kadawa and 5762.5 kgha^{-1} at Samaru. The interaction between FARO 44 with the application of NPK 120:60:60 kgha^{-1} gave maximum yield of 5882 kgha^{-1}. It can be concluded that, sowing FARO 44 at 2 plants/stand with the application of NPK fertilizer at 120:60:60 kgha^{-1} gave optimum grain yield per ha.

Key words: FARO 44, FARO 52, NPK, Density, *Oryza sativa*, grain yield

1.0 INTRODUCTION

The earliest cultivation of rice in Nigeria was reported to be 1890 when rice varieties were introduced to the high forest zone in Western Nigeria [1]. Rice is widely distributed throughout the tropical, sub-tropical and temperate zones of all the continents. Among the cereals grains, rice is humanity‘s second crop after wheat in terms of area cultivated and production but it ranked first as far as human consumption is concerned [2]. Rice is a staple food for half of the world population and approximately three quarter of a billion of the world’s poorest people depend on the staple to survive. It is essentially used for human consumption either boiled and eaten as such or prepared into various liquid and solid drinks, depending on the qualities of the rice variety [3]. Although rice production has increased during the last two decades in Nigeria, the country’s production capacity is far below the national requirement. Nigeria’s inability to meet her rice consumption needs through local production has resulted in high cash outlays for importation [4]. Among the explanations for poor performance of rice has been its slow adoption and low usage rates of agricultural technologies such as inorganic fertilizers and improved seeds. Hence, the nation depends on the international markets to fill the demand-supply gap at a colossal amount of foreign exchange as a result of low productivity in the local production of rice. It is further projected that Nigeria’s rice consumption will rise to 35million metric tons by 2050, increasing at the rate of 7% per annum due to estimated population growth [5]. Not exclusive, rice farmers in Nigeria are not getting maximum returns from the resources committed to their enterprises leading to a decline in per capita food production [6] This is because farmers do not make use of high yielding varieties developed by research Institutes due to inaccessibility and poor knowledge on where to obtain the improved varieties. They usually buy seeds from market with low yield as such most seed are wasted during planting as farmer sowed as high as twenty seed per hill leading to high population density and unproductive tillers. The low fertility nature of the Nigerian Savanna Soil has made production of this important commodity impossible without input from fertilizers. Results of research have revealed significant improvement in rice output as a result of use of such fertilizer as NPK [7]. It is in light of the above observed constraints to rice production that this research was conceived with the objective to determine the effect of stands density on the yield attributes and yield of low land rice varieties

2.0 MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted at the farms of Institute for Agricultural Research (I.A.R), Ahmadu Bello University located at Samaru (Latitude 11^0N 39' Longitude 08^0 02' E), 686 m above sea level and Kadawa (Latitude 11^0 11' N Longitude 7^0 38' E), 500m above sea level in Northern Guinea and Sudan Savannah ecological zones of Nigeria, respectively, during the 2016/2017 dry season.

2.2 **Treatments and Experimental Design**

The treatments consisted of two lowland rice varieties (FARO44 and FARO52), three NPK fertilizer rates (40:20:20, 80:40:40, 120:60:60) and three level of plant/stand density (2, 4 and 6 plant/stand). The treatments were factorially combined and laid out in randomize complete Block design with three replicate. Gross and net plot size of 3.0m x 3.0m and 2m x 2m, respectively.

2.3 Varietal Description and Source

FARO 44 (Sipi) is an improved semi- dwarf cultivar with a maturity period of 90 -100 days with a potential yield of 4-6t/ha. FARO 52 (Wita 4), which has an outstanding characteristic of high yield and tolerance to African rice gall midge, matures between 100 - 120 days with a potential yield of 5 - 6t/ha. All were sourced from Premier Seed Company Nigeria limited in Zaria.

2.4 Cultural Practices

The field were harrowed to produce fine tilt before making out gross and net plot size of 3.0m x 3.0m and 2m x 2m, respectively. Sowing of seeds was carried out on the 21st of February, 2017 at Samaru and 28th February, 2017 at Kadawa by dibbling according to the treatment at a spacing of 20 x 20cm. The germinated rice was thinned to 2 weeks after sowing (WAS). NPK (15:15: 15) fertilizer was applied by deep placement (2-3cm) according to the treatment. Half dose of N and full dose of P and K were applied at sowing, while the remaining half dose of N was applied at 6 WAS using Urea (46 % N). Pre-emergence herbicide (Pendimethalin) was applied one day after sowing at 4 L/ha (455g ai/l) for weed control. Supplementary weeding were done at 3, 6 and 9 WAS. The fields were irrigated through controlled flooding of the plots (basins) at three days interval throughout the period of the experiment. The crop was harvested when mature rice panicle changed colour from green to a golden brown colour prior to grain shattering. It was done by cutting the stands with sickle close to the ground level. The harvest from each net plot was bundled into sheaves, weighed and threshed by beating with sticks for each net plot in a 100kg sag bag. The grain obtained was winnowed and grains cleaned, dried and used for the determination of yield parameters.

Data were collected from the following yield parameters:

Number of productive tillers per plant- Productive tillers bearing panicles from five sampled plants in each net plot was counted at harvest and the average was determined and recorded.

Panicle length (cm)

Length of the panicle was measured from the 5 sampled plants in cm from the basal node of the spike to the tip of the topmost spikelet within each net plot. The value was averaged and recorded for each treatment.

Number of spikelets per panicle-

Number of spikelet was determined by counting the spikelet from the five sampled plants from each net plot at harvest and average thereafter was taken and recorded.

Number of grain per panicle-

The number of grains per panicle was counted from five sampled plants from each net plot at harvest and average was recorded.

Weight of grain per panicle (g)

The weight of grains from the five sampled panicle from each net plot were measured with Metler electronic precision balance and average was recorded.

1000 grain weight (g)

Samples of 1000 grains were counted from each net plot and weigh separately using Metler electronic precision balance and values obtained was recorded.

Grain yield (kg/ha)

The harvested grains from each net plot were threshed; winnowed, cleaned and weighed and recorded. Thereafter the values obtained were converted to kgha^{-1} basis.

Harvest index-

The harvest index is the proportion of economic yield to biological yield [8]. This was determined by dividing the grain yield by the total biomass in each net plot. The value obtained was recorded for each -plot.

$$\text{Harvest index} = \frac{\text{Economic yield}}{\text{Biological yield}}$$

2.5 Statistical Analysis

Data collected were subjected to Statistical Analysis of Variance (ANOVA) as described by [9]. The differences between the treatments means were compared using Duncan Multiple Range Test (DMRT) [10].

3.0 RESULTS

3.1 Effects of NPK Fertilizer and Stand Density on Yield Parameters

3.1.1 Number of Productive Tillers

Effects of NPK fertilizer and stand density on the number of productive tillers of two lowland rice varieties at Kadawa and Samaru during 2016 dry season is presented in Table 1.

Application of NPK fertilizer significantly affected the number of productive tillers per plant. The number of productive tillers per plant increased with each increase in NPK rate from 40:20:20 to 120:60:60 kg ha-^{1} only in Samaru. In Kadawa, the NPK rate of 80:40:40 kgha^{-1} gave statistically

similar number of productive tillers per plant with that of NPK 40:20:20 kgha^{-1} even though the NPK 120:60:60 kgha^{-1} gave the highest number of productive tillers.
The effect of stand density on number of productive tillers was significant only at Samaru, increasing the number of stand from 2 to 4 and further to 6 plants per stand, led to a progressive decreased in the number of productive tillers. Variation in number of productive tillers between the two rice varieties was significant only at Samaru with FARO 52 recording significantly more productive tillers than FARO 44.

3.1.2 Panicle length

The effects of NPK fertilizer rate and stand density on panicle length of two lowland rice varieties at Kadawa and Samaru is presented in Table 1. The results indicated that the application of NPK on panicle length was significant in both Kadawa and Samaru. Panicle length increased from application of NPK 40:20:20 to 120:60:60 kg ha-^{1} in both locations.
The effect of stand density on panicle length was significant only in Kadawa. 4 plants per stand gave statistically similar panicle length to 6 plants per stand in Kadawa. In Samaru the mean value for panicle length are statistically the same.
There was significant variation in panicle length produced between the varieties of rice used in both locations, with FARO 52 recording significantly longer panicle length than FARO 44.

3.1.3 Number of spikelet per panicle

The effects of NPK fertilizer and stand density on number of Spikelet per panicle of two lowland rice varieties in Kadawa and Samaru during the 2016 dry season is shown in Table 1. Results indicated that NPK significantly influenced number of spikelet in both locations. Increasing NPK rate from 40:20:20 to 120:60:60 kgha-^{1} significantly increased number of spikelet per panicle in both locations. The effect of stand density on number of spikelet was significant in both locations. 2 plants/stand gave higher number of spikelet per panicle in both locations. Further increased in stand density from 4 to 6 plants per stand do not significantly increase number of spikelet per panicle in Kadawa.

Variation in number of spikelet per panicle of the two rice varieties was significant in both locations. FARO 52 gave higher number of spikelet per panicle in both locations than FARO 44.
Number of Grain per Panicle
The effect of NPK fertilizer rate and stand density on the number of grain per panicle of two low land rice varieties in Kadawa and Samaru during 2016 dry season is presented in Table 1. Results indicated that NPK rate significantly increased the number of grain per panicle. Increasing NPK rate from 40:20:20 to 80:40:40 kgha^{-1} significantly increases number of grain per panicle. Further increase in NPK rate to 120:60:60 kgha^{-1} increased number of grain per panicle in Samaru but was statistically at par with 80:40:40 kgha^{-1} in Kadawa. Stand density effect on number of grain per panicle was significant in both locations. Increasing stand density from 2 to 4 plants per stand gave statistically the same number of grain per panicle. Further increase from 4 to 6 plants per stand was significant on the number of grain per panicle in both locations.
Variation in number of grain per panicle of the two rice varieties was significant in both locations with FARO 52 giving higher number of grain per panicle than FARO 44.

3.1.4 Number of Grain per panicle

The effect of NPK fertilizer rate and stand density on the number of grain per panicle of two low land rice varieties in Kadawa and Samaru during 2016 dry season is presented in Table 38. Results indicated that NPK rate significantly increased the number of grain per panicle. Increasing NPK rate from 40:20:20 to 80:40:40kgha^{-1} significantly increases number of grain per panicle. Further increase in NPK rate to 120:60:60 kg ha-1 increased number of grain per panicle in Samaru but was statistically at par with 80:40:40kgha^{-1} in Kadawa.

Stand density effect on number of grain per panicle was significant in both locations. Increasing stand density from 2 to 4 plants per stand gave statistically the same number of grain per panicle. Further increase from 4 to 6 plants per stand was significant on the number of grain per panicle

Table 1: Effects of NPK and Stand density on number of productive tillers and panicle length (cm) per plant of rice varieties at Kadawa and Samaru 2016 dry season

	Number of Productive Tillers^{-1}		Panicle Length (cm) Plant^{-1}		Number of Spikelet Panicle^{-1}		Number of Grain Panicle^{-1}	
TREATMENT	**KADAWA**	**SAMARU**	**KADAWA**	**SAMARU**	**KADAWA**	**SAMARU**	**KADAWA**	**SAMARU**
NPK20:10:10 (kg ha^{-1})								
40:20:20	19.00b	19.333c	8.056c	8.167c	91.22b	80.056c	20.13c	20.13c
80:40:40	19.94b	26.778b	10.22b	9.556b	130.2a	118.944b	24.53b	23.785b
120:60:60	24.17a	29.667a	11.11a	11.222a	134.6a	135.167a	24.9a	26.778a
SE±	1.328	0.6261	0.0734	0.0968	2.136	1.655	0.1417	0.1495
Number of Plant per Stand								
2	20.17	30.833a	9.889a	10.167a	126.4a	119.44a	23.67a	22.639
4	21.05	25.111b	9.833ab	9.611b	118.6a	116.16a	22.78b	22.628
6	21.89	21. 833c	9.667b	9.167c	111.0b	98.556b	22.63b	22.356
SE±	1.328	0.6261	0.0734	0.0968	2.136	1.655	1.328	0.1495
Variety								
Faro 44	21.00	24.000b	9.370b	9.370b	110.36b	100.56b	22.29b	22.013b
Faro 52	21.07	26.	10.22a	9.926a	127.1a	122.22	24.10a	23.070

		519a				2a		a
SE±	1.085	0.5113	0.0599	0.0791	1.920	1.486	0.1157	0.1220
Interaction								
FX S	NS	NS	NS	NS	NS	NS	NS	NS
S X V	NS	NS	NS	NS	NS	NS	NS	NS
F X V	NS	NS	NS	NS	NS	NS	NS	NS
F X S X V	NS	NS	NS	NS	NS	NS	NS	NS

1. Mean in a column of any sets of treatment followed by unlike letter (s) is significantly different at 5% level of probability using DMRT
2. WAS = Week after sowing, **3.** NS= Not significant, *= significant, **= highly significant

3.1.4 Weight of grain per panicle

Table 2 show the effects of NPK fertilizer and stand density on the weight of grain per panicle of two lowland rice varieties in Kadawa and Samaru during 2016 dry season. The results indicated that application of NPK in both locations significantly affect weight of grain per panicle. Increase in NPK rate from 40:20:20 to 120:60:60 kgha^{-1} increased weight of grain per panicle.
Stand density effect on weight of grain per panicle was significant only Samaru but was not significant in Kadawa. Variation in weight of grain of the two rice varieties used was significant at both locations where FARO 52 gave higher grain weight per panicle than FARO 44 in both locations.

3.1.5 1000-grain weight

The effects of NPK fertilizer and stand density on 1000-grain weight of two lowland varieties of rice during the 2016 dry season at Kadawa and Samaru is shown on Table 2. The results indicated that application of NPK significantly affected 1000-grains weight of rice. Increasing NPK rate from 40:20:20 to 120:60:60kg NPK ha^{-1} significantly increased the 1000-grain weight. The effect of stand density and varietal response to 1000-grain weight in both Kadawa and Samaru were not significant.

3.1.6 Harvest index

Table 2 show the effects of NPK fertilizer rate and stand density on harvest index of two lowland rice varieties at Kadawa and Samaru during the 2016 dry season. Results indicated that NPK rate was significant in both locations. Increasing NPK rate from 40:20:20 to 120:60:60kg NPK ha^{-1} increased harvest index. The effect of stand density on harvest index was significant in both locations. 2 plants per stand gave the highest harvest index. This was followed by 4 plants/stand and 6 plants /stand, respectively. Variation in harvest index of the two rice varieties was significant in both locations. Faro 44 gave higher harvest index than Faro 52.

3.1.7 Grain yield

The response of grain yield of the two rice varieties to application of NPK fertilizer and stand density is shown on Table 2. Results indicated that each increase in NPK fertilizer rate from 40:20:20 to 80:40:40 and further to 120:60:60 kgha^{-1} had led to a corresponding increase in grain yield. Stand density effects on grain yield per plot was significant in both locations. Two plants per stand gave the higher grain yield at both Kadawa and Samaru than for 4 and 6 plants/stand that were statistically similar. The result also show that 2 plants/stand and 4 plants/stand gave statistically similar number of grain per panicle, while 2 plants/ stand gave highest grain yield per ha and harvest index. Significant variation in grain yield was observed between the two varieties evaluated only in Kadawa, where FARO 44 gave higher grain yield than FARO 52.

Table 2: Effects of NPK and Stand density on Weight of Grains Panicle^{-1}, 1000 Grains Weight (g), Harvest Index and Grain Yield (kg) of two lowland rice varieties at Kadawa and Samaru 2016 dry season

	Weight of Grains Panicle^{-1} (g)		1000 Grains Weight (g)		Harvest Index		Grain Yield (kg)	
TREATMENT	**KADAWA**	**SAMARU**	**KADAWA**	**SAMARU**	**KADAWA**	**SAMARU**	**KADAWA**	**SAMARU**
NPK20:10:10 (kg ha^{-1})								
40:20:20	1.394c	0.786c	21.67c	16.722c	0.2220c	0.1644c	1029.28c	822.1c
80:40:40	2.222b	1.511b	26.00b	23.444b	0.3009b	0.2547b	1940.04b	1723.5b
120:60:60	2.772a	2.011a	28.17a	26.444a	0.3362a	0.2688a	2268.84a	1981.0a
SE±	0.1197	0.0583	0.6834	0.7704	$4.3*10^{-5}$	$4.1*10^{-5}$	1.870	2.220
Number of Plant per Stand								
2	2.283	1.731a	25.67	22.444	0.3197a	0.2608a	1895.90a	1700.2a
4	2.156	1.450b	24.94	23.000	0.2844b	0.2168b	1670.78b	1394.9b
6	1.950	1.128c	25.22	21.167	0.2844b	0.2168b	1671.47b	1431.2b
SE±	0.1197	0.0583	0.6834	0.7704	0.2549c	0.2104c	1.870	2.220
Variety								
Faro 44	1.889b	1.361b	25.07	22.556	0.3162a	0.2500a	1769.74	1546.59a
Faro 52	2.370a	1.511a	25.48	21.852	0.2565b	0.2086b	1223.6	1471.17b
SE±	0.0977	0.0476	0.5581	0.6291	$4.2*10^{-5}$	$5.3*10^{-5}$	1.673	1.995
Interaction								
FX S	NS	NS	NS	NS	NS	NS	NS	NS
S X V	NS	NS	NS	NS	NS	NS	NS	NS

F X V	NS	NS	NS	NS	NS	NS	NS	NS
F X S X V	NS	NS	NS	NS	NS	NS	NS	NS

1. Mean in a column of any sets of treatment followed by unlike letter (s) is significantly different at 5% level of probability using DMRT
2. WAS= Week after sowing
3. NS= Not significant, *= significant, **= highly significant

3.2 Interaction

Table 3 shows the interaction between NPK fertilizer rates and stand density on grain yield in both location. Increasing stand density from 2 to 6 plants per stand significantly reduced grain yield. However, in Kadawa at fixed NPK rate of 40:20:20 kg ha^{-1} no significant different between 4 and 6 plants per stand.
At a fixed stand density of 2, 4 and 6 plants per stand, increasing NPK fertilizer rate from 40:20:20 to 120:60:60 kg NPK ha^{-1} significantly increased grain yield at both locations. Rice sown at 2 plant/stand and received 120:60:60 kg NPK ha^{-1} had the highest value of grain at both locations while the least grain yield were from rice sown with combination of 6 plants per stand and 40:20:20 kg NPK ha^{-1}.
Table 4 show the interaction between NPK fertilizer rate and variety on grain yield of rice at Kadawa. At a fixed variety of FARO 44 and FARO 52 increasing NPK fertilizer rate from 40:20:20 to 120:60:60 kg NPK ha^{-1} significantly increased grain yield. Both variety that received 120:60:60 kg NPK ha^{-1} had the highest value for grain yield while the least crop grain yield was from 40:20:20kg NPK ha^{-1} at a fixed NPK rate FARO 44 gave higher value for grain yield than FARO 52.

Table 3. Interaction between fertilizer rate and stand density on grain yield per plot (g) at Samaru and Kadawa

Treatment	**Stand Density KADAWA**			**SAMARU**		
	2	**4**	**6**	**2**	**4**	**6**
NPK (kgha^{-1})						
40:20:20	1038.2g	1002.3h	1002.0hi	881.3g	870.0h	714.9i
40:20:20	2057.7d	1722.1e	1700.0f	1914.0c	1342.7e	1113.7f
40:20:20	2591.7a	2287.9b	1926.8c	2305.4a	1971.0b	1665.8d
SE±		2.40			2.90	

Table 4. Interaction between Fertilizer rate and variety on grain yield per plot (g) at Kadawa

Treatment	**Variety**	
	Faro 44	**Faro 52**
NPK (kgha^{-1})		
40:20:20	1069.5e	988.9f
40:20:20	2054.7c	1825.3d

40:20:20	2352.8a	2184.8b
SE±	2.20	

4.0 DISCUSSION

4.1 Effects of NPK Fertilizer on Yield Components and Yield of Rice Varieties

The study revealed that increasing the application of NPK from 40:20:20 to 80:40:40 and further increased to 120:60:60 kg NPK ha^{-1} significantly increased the values for yield parameters which translated into optimum grain yield. This may be attributed to the fact that the application of 120:60:60 kg NPK ha^{-1} dose supplied sufficient nutrients for higher growth and development of the rice varieties which translated into superior expression of yield attributes and grain yield. The result is in conformity with the reports of several researchers; Judicious and proper use of fertilizers can markedly increase the yield and improve the quality of rice [11]. [12] reported that application of 120:60:60 NPK Kg ha^{-1} produced significantly higher number of grains per panicle, grain weight, 1000 grain weight and grain yield than 0:0:0 and 40:40:40 kgNPK ha^{-1}. [13] reported that application of different graded level of fertilizers had significant impact on yield and yield components. [14] reported that increasing rate of nitrate fertilizer considerably improves yield parameters such as; the number of panicle per plant, the number of panicle per m^2 and the weight of 1000 grains. Increased grain yield and straw yield with application of NPK has been previously reported by [15] Tunga and Nayak (2000) and [16], respectively. Also [17] and [18] observed that application of 150: 75: 50 Kg NPK and 120: 80: 40 Kg NPK ha^{-1} to rice gave maximum yield, net profit and benefit cost ratio. The influenced of higher yield attributes on yield in this study is in agreement with the findings of [19].

4.2 Effects of Stand Density on Yield Components and Yield of Rice Varieties

The result shows that 2 plants/stand produced higher values for yield parameters and grain yield recorded during the study than 4 and 6 stand/hill. This implies that 2 plants/stand had lower populations per unit area compared to 4 and 6 plants/stand. This indicates that the lower plant population per unit area had less intra-specific completion than the higher stands, which led to efficient utilisation of available plant nutrients, moisture and radiation for the synthesis of carbohydrate for higher vegetative growth, enhances yield characters and yield. The result is in consonant with [20] who reported that low plant population generally results in abundant vegetative growth due to less interplant competition for light, nutrients, water and other growth factors. Also [21] reported that plant density influenced solar radiation interception, nutrient uptake, rate of photosynthesis and yield of rice. [22] reported that number of tillers per stand was significantly affected by number of plant/stand. The result obtained also show that number of plant per stand had no significant on 1000-grain weight. This is in line with the finding of [23] who observed that 2 plants per hill gave highest paddy yield of rice while single plant per hill gave lowest paddy yield.

4.3 Varietal Response of Rice Varieties on Yield Components and Yield

It was evident from the study that yield attributes performed differently in response to the two rice varieties. This could be due to the variation in their genetic constituents. This is in agreement with the findings of [24] who reported significant differences in length of panicle and straw yield due to different cultivars. The grain yield of rice could be associated with the production of greater number of productive tillers, number of grains/panicle, length of panicle, panicle weight, test weight and low sterility percentage [25] and [26]. Association of 1000-grain weight and percent filled grain with

higher grain yield was also reported by [26] respectively. [27] reported that 1000 grain weight varied significantly with different cultivars in the range of 13.0 to 24.1 g.
In this study, FARO 52 recorded higher values for most yield attributes measured except harvest index but gave lower grain yield than FARO 44 which recorded higher value with only harvest index but translated into higher grain yield. This result contradict [28] Yoshida (1983) who observed that rice grain yield depend on number of grains per panicle, panicle length, panicle weight, number of filled grains, number of spikelet and 1000 seed weight. The superiority of FARO 44 in terms of harvest index and grain yield over FARO 52 could be attributed to its potential genetic makeup in efficient partitioning of assimilates into higher grain yield. This is in line with the finding of [29] who attributed variation in plant height and yield of rice to the differences in the genetic makeup of the varieties and their differences in response to the environment.

4.4 Interaction

The combination of 2 plants per stand and NPK 120:60:60 kgha^{-1} fertilizer produced significantly higher grain yield of rice. This could be due to the sufficient supplied of nutrient at the higher rate of NPK which enhanced grain yield of rice at the lowest number of plants/stand. Also, the application of 120:60:60 kg NPK ha^{-1} to FARO 44 gave higher grain yield. This could be attributed to the ability of FARO 44 to efficiently utilize the applied nutrient for optimum grain yield production. This concur with the findings of [30] who have showed that, genotypes with high yield potential accumulated more nutrients than genotypes with less yield potential.

5.0 CONCLUSIONS AND RECOMMENDATION

This study carried out on the effect of different rates of NPK fertilizer on the growth and yield of rice revealed that, sowing FARO 44 rice variety at 2 plants/stand with the application of NPK at 120:60:60 Kg NPKha^{-1} gave optimum grain yield of rice in both study areas.
It is therefore recommended that rice farmers in Southern Guinea Savanna and Sudan savanna in Nigeria should use FARO 44 sown at 2 plants per stand with the application of 120:60:60 Kg NPKha^{-1} for optimum grain yield.

CONFLICT OF INTERESTS
The authors have not declared any conflict of interests.

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