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SELECTED RICE YIELD PARAMETERS AS INFLUENCED BY VARIETY, SEEDLING TRANSPLANTING AGE AND NITROGEN FERTILIZER RATES IN SOUTHERN GUINEA SAVANNAH, NIGERIA

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ABSTRACT:
The study determined the effects of seedling transplanting age and nitrogen fertilizer rates on selected yield components of two rice varieties. Treatments consisted of two locations (Edozhigi and Badegi), two rice varieties (FARO 44 and FARO 52), four seedling transplanting ages (7, 14, 21 and 28 days after planting) and five inorganic N fertilizer rates (0, 60, 120, 180 and 240 kg N/ha), were laid out as split–split plot arrangement fitted into Randomized Complete Block Design (RCBD) with three replications. Data were collected on the following parameters: panicle length (PL), spikelets per panicle (SP), grains per panicle (GP) and number of unfilled grains per panicle (NUGP). The harvest data revealed that location had significant effect on PL, GP and NUGP in 2015 and 2016 planting seasons at Edozhigi. Location only had significant effect on SP in 2015 and 2016 planting seasons. Nitrogen fertilizer rates significantly affected PL and SP. The result of the study showed that seedling transplanting age significantly affected PL and SP with 28 days old planted seedlings producing the highest values of these parameters.Number of grains per paniclewas highest with 21 days old transplanted seedling, while NUGP was highest with 7 days old transplanted seedling. Variety had significant effect on PL and SP. Overall, the application of 120-240 kg N/ha to 28 days old seedlings of FARO 52 rice variety gave the best response in increasing the PL, SP, GP and NUGP of rice.

Keywords: Nitrogen fertilizer, grains per panicle, lowland rice and panicle length,

INTRODUCTION
Rice (*Oryza sativa* L) a cereal crop, is an important staple food for more than half of the world's human population (Ohen and Ajah 2015). Rice is one of the major food crops produced in Nigeria. It is a popular grain with high nutritional gain and is grown and consumed in all the ecological zones of Nigeria (Ohaka*et al*, 2013; Rufun, 2014; Ajah and Ajah 2014; Abdulahi ,2012). Before the discovery of crude oil, Ohaka*et al*, 2013 reported that Nigeria produced almost enough rice for local consumption. Paddy production increased from an average of 0.4 million metric tons in 1960-69 periods to an average of 4.5 million metric tons per annum in 2012(Iwuchukwu and Igbokwe, 2012). Variety is an important factor to be considered for increased rice yield parameters. The selection of high yielding varieties, transplanting seedlings at the appropriate age and application of optimum amount of rate of nitrogen fertilizer can play important role in increasing rice yield parameters. Variety has variable effect on number of grains per panicle, panicle length, number of spikelets per panicle and number of unfilled grains per panicle (Kakar, *et al*, 2016; Kiniry*et al*, 2001). Seedling transplanting age influence rice yield parameters tremendously as it affects plant height, tiller production, panicle length, grain formation and other yield attributes (Ram *et al*, 2015). Too young seedlings may die as a result of transplanting shock while too old seedlings may not produce its yield attribute potentials to the peak (Ranjan *et al*, 2015). Ranjan *et al*, (2015) also reported that tiller death could be reduced by transplanting seedlings in appropriate age and time as it provides proper ground for achieving higher yield parameters. Farmers transplant older seedlings up to 50 days old in lowland rice production (Singh *et al*, 2013)

. However, Petras and Haque (2011) reported that grain yield increased by transplanting younger seedlings of 10 days old. Optimum application of fertilizer is required to realize the yield potential of crops. Yoseftabar (2013) reported that the profitability of intensive rice production depends on N fertilizer application. Nitrogen, among the nutrients is required in large amounts than other essential nutrients obtained from the soil. Nitrogen plays an important role in the yield attributes of rice. Qiaog-gang *et al* (2013) reported that soils deficient in N limit high rice yields. Nitrogen increased number of grains per panicle and number of panicles per plant (Kiniry*et al*, 2001). Late transplanting significantly affects yield attributes of rice and has detrimental effects on grain yield parameters (Lin *et al*, 2015). Besides, age of seedling at the time of transplanting is directly related with the stand and establishment of rice (Brar *et al*, 2012). Earlier researchers focused on rice seedling age with different transplanting date (Adhikari *et al*, 2013; Sarwar *et al*, 2014 Fan *et al*, 2012; Guo *et al*, 2010). The rate farmers apply N fertilizer is higher than the recommended rate for maximum rice yield components (Fan *et al*, 2012). Excessive N fertilizer application could cause ground water pollution, increase cost of production, enhance global warming and reduce the yield attributes of rice (Fan *et al*, 2012; Guo *et al*, 2010). To increase rice yield parameters, proper agronomic practices such as transplanting seedlings at the appropriate time and the application of optimum rate of N fertilizer should be in place. The objective of this study was to determine selected yield components of rain fed rice as influenced by variety, seedling transplanting age and N fertilizer rates under two different locations.

MATERIALS AND METHODS

Description of study area

A 2-year agronomic field experiment was planted at two locations Edozhigi (9˚ 05^1 N; 5˚ 57^1 E) and Badeggi (9˚ 45^1 N; 6˚ 07^1 E) under lowland ecology at the National Cereals Research Institute (NCRI) Farms during 2015 and 2016 planting seasons. The soil at Edozhigi is silt-loam, iron-toxic and classified as dystricgleysol (Narteh and Sahrawat 1999). On the other hand, soils at Badeggi site are sandy loam with bulk density of 1.489 g m^{-3} and classified as ultisol(Ayotade and Fagade 1993). Both sites are located in the Southern Guinea Savannah zone of Nigeria where climate is characterized by a distinct wet season from April to November and dry season from November to March. The relative humidity at dry and raining season ranges between 75 – 85%. Annual rainfall at the sites ranges between 1,200 – 1,400 mm and mean temperature of between 23˚ C – 33˚ C.

Experimental design and field layout:

The experiment was designed as a split–split plot arrangement fitted into Randomized Complete Block Design (RCBD); and replicated three times. Treatments consisted of two locations (Fdozhigi and Badeggi) two rice varieties (FARO 44 and FARO 52) as main plots and four seedling transplanting ages (7, 14, 21 and 28 days after sowing) as sub plots and five inorganic N fertilizer rates (0, 60, 120, 180 and 240 kg N/ha) as sub-sub plots. The size of each main plot was 193.8 m^2 while the sub plot and sub-sub plot were 34.2 m^2 and 5.4 m^2, respectively. Each sub-sub plot had a dimension of 3 m x 1.8 m with alley way of 2.0 m between the main plots, 1.0 m between sub plot, and 1 m between replications. Hence, there were a total of 20 sub-sub plots per replication which gave a total of 60 plots per variety and a total of 120 plots for each site. Two rice seedlings were transplanted per hill at a spacing of 20 cm x 20 cm between and within rows with 16 rows in a plot.

Agronomic practices

Two Nursery beds (2 x 2 m^2) were prepared by manually pudding, raising and levelling the soil with hoe at weekly intervals for four weeks at the two sites near the main field. Healthy seeds of the two FARO rice varieties were obtained from (NCRI) Badeggi. The seeds were soaked in water for 24 hours and were drained using a muslin cloth to remove the excess water from the seeds. The moist seeds were then sown by broadcast method in the wet beds. The sowing was done weekly for four weeks to cater for the different sowing age. The nursery bed was managed till transplanting age per treatment. Prior to the field layout, the experimental plot (2,184 m^2) was ploughed and harrowed, followed by the preparation of bounds. The main field was laid out into sub plots (19 m x 1.8 m) with a spacing of 1.0 m alley way and sub-sub plots that were well leveled using spade before transplanting. Basal application of inorganic P and K fertilizers using single super phosphate (SSP) and murate of potash (MOP), respectively were both applied at 40 kg/ha. Nitrogen fertilizer (urea) was split applied to the experimental plots based on each treatment with half of the various inorganic N fertilizer (urea) rates applied together with the P (single super phosphate SSP) and K (murate of potash) prior to transplanting and manually worked into the soil using hoe while the remaining half was broadcasted at panicle initiation. Regular weeding was undertaken in the experimental plot using hoe. The experiments were conducted in Edozhigi and Badeggi

Data collection

The following data were collected during harvesting from the sampled area of 5.4m^2 for each treatment combination. Five plants were randomly selected and taggedfrom the middle rows for data collection. However, maturity of the crop was determined when 90% of grains become golden yellow in colour. Length of panicle was measured for each tagged plant from the node to the tip of the panicle and the average recorded. The total spikelets were counted from each panicle and average of the five samples taken. Five panicles were randomly selected from each sample. The number of grains from each panicle were counted and recorded as well as number of unfilled grains per panicle (spikelets having no food materials inside).**The** experiments were conducted in Edozhigi and Badeggi and a combined analysis of variance was carried out to determine the statistical difference between the performance of the two locations.

Data analysis
The yield components data generated was subjected to analysis of variance (ANOVA) using GenSTAT and the difference between treatments mean tested using least significant difference (LSD) at 5% probability level. Correlation analysis was carried out to determine the relationship between the measured yield parameters.

RESULTS

The effect of location, nitrogen fertilizer rates, seedling transplanting age and variety on rice panicle length
Location had highly significant effect ($p< 0.001$) on rice panicle length as indicated in Table 1. Rice planted at Edozhigi had significantly longer panicle length of 26.28 cm and 30.09 cm during 2015 and 2016 planting seasons respectively. Nitrogen fertilizer rates revealed significant effect ($p< 0.05$) on rice panicle length during 2016 planting season. Rice fertilized with 240 kg N/ha had significantly the longer panicle length of 27.07 cm. Seedling transplanting age had significant effect ($p< 0.001$) on rice panicle length during 2016 planting season. Rice seedling transplanted at 28 days after planting had the longest panicle length of 28.82 cm than other seedling transplanting age. Rice variety had significant effect ($p< 0.05$) on rice panicle length. Rice variety Faro 52 recorded longer panicle length of 24.30 cm and 28.14 cm during 2015 and 2016 planting seasons respectively.

The effect of location, nitrogen fertilizer rates, seedling transplanting age and variety on rice number of spikelets per panicle: Location had significant effect ($p< 0.001$) on rice number of spikelet per panicle during 2015 and 2016 planting seasons as shown in Table 1. Rice planted at Badeggi had significantly higher number of spikelets per panicle of 15.02 and 16.38 during 2015 and 2016 planting seasons respectively.Nitrogen fertilizer rates had significant effect ($p< 0.013$) on rice number of spikelets per panicle. Rice fertilized with 240 kg N/ha showed the highest number of spikelets per panicle of 14.39 during 2016 planting season.Seedling transplanting age had significant effect ($p< 0.034$) on number of spikelets per panicle in 2015 planting season. Rice seedling transplanted at 28 days after planting had the highest number of spikelets per panicle of 14.12 during 2015 planting season. In 2016, seedling transplanting age had very highly significant effect ($p< 0.001$) on number of spikelets per panicle. Rice seedling transplanted at 21 days after planting gave the highest number of spikelets per panicle of 15.36 during 2016 planting season.Rice variety had very highly significant effect ($p< 0.001$) on number of spikelets per panicle in 2015 planting season. Rice variety Faro 52 had a greater number of spikelets per panicle of 14.11 during 2015 planting season. Rice varietyrevealed significant effect ($p< 0.019$) on number of spikelets per panicle in 2016 season. Faro 44 produced a greater number of spikelets per panicle of 13.81 during 2016 planting season.

The effect of location, nitrogen fertilizer rates, seedling transplanting age and variety on number of grains per panicle: Location had significant effect ($p< 0.05$) on number of grains per panicle as revealed in Table 2. Rice planted at Edozhigi had more grain per panicle of 173.83 and 108.55 during 2015 and 2016 respectively. Nitrogen fertilizer rates had no significant effect ($p > 0.05$) on number of grains per panicle during 2015 and 2016 planting seasons. Seedling transplanting age revealed significant effect ($p< 0.05$) on number of grains per panicle. Rice seedling transplanted at 21 days after planting had significantly the highest number of grains per panicle of 109.28 during 2016 planting season. Variety had no significant effect ($p> 0.05$) on number of grains per panicle during 2015 and 2016 planting seasons.

The effect of location, nitrogen fertilizer rates, seedling transplanting age and variety on number of unfilled grains per panicle:
Location had very highly significant effect ($p< 0.001$) on number of unfilled grains per panicle as indicated in Table 2. Rice planted at Edozhigi revealed a greater number of unfilled grains per panicle of 16.53 and 14.29 during 2015 and 2016 planting seasons respectively.Nitrogen fertilizer rates had no significant effect ($p>0.05$) on number of unfilled grains per panicle during 2015 and 2016 planting seasons. During 2015 and 2016 planting seasons, Seedling transplanting age had very highly significant effect ($p< 0.001$) on rice number of unfilled grains per panicle? Rice seedling transplanted at 7 days after planting had the highest number of unfilled grains per panicle of 15.14 and 10.40 during 2015 and 2016 planting seasons respectively.Variety had no significant effect ($p> 0.05$) on number of unfilled grains per panicle during 2015 and 2016 planting seasons.

Table 1. The effect of location, nitrogen fertilizer rates, seedling transplanting age and variety on rice panicle Length (cm) and spikelet per panicle during 2015 and 2016 planting seasons

Treatment factors	Panicle length		Spikelets/Panicle	
	2015	2016	2015	2016
Location				
Badeggi	20.61	22.08	15.02	16.38
Edozhigi	26.28	30.09	12.19	10.48
LSD $_{(0.05)}$	1.17	0.71	0.79	0.62
Nitrogen rates				
0 kg	23.26	25.77	13.25	13.57
60 kg	23.16	25.02	13.47	13.51
120 kg	23.91	25.94	13.73	12.77
180 kg	23.18	26.62	13.62	12.91
240 kg	23.70	27.07	13.94	14.39
LSD $_{(0.05)}$	1.85	1.13	1.24	0.99
Seedling trans. Age				
7 days	23.20	22.27	12.65	10.72
14 days	23.61	25.74	13.57	12.99
21 days	24.03	27.51	14.07	14.66
28 days	22.95	28.82	14.12	15.36
LSD $_{(0.05)}$	1.66	1.01	1.11	0.88
Variety				
Faro 52	24.30	28.14	14.11	13.06
Faro 44	22.59	24.03	13.09	13.81
LSD $_{(0.05)}$	1.17	0.71	0.79	0.62

Seedling trans. age = seedling transplanting age

Table 2. The effect of location, nitrogen fertilizer rate, seedling transplanting age and variety on rice grain per panicle and number of unfilled grains per panicle during 2015 and 2016 planting seasons

Treatment factors	Grains/panicle		Number of unfilled grain/ panicles	
	2015	2016	2015	2016
Location				
Badeggi	142.30	103.00	8.36	4.28
Edozhigi	173.83	108.55	16.53	14.29
LSD $_{(0.05)}$	7.51	3.45	0.75	0.66
Nitrogen rates				
0 kg	161.17	106.74	13.23	9.91
60 kg	157.17	105.34	12.33	8.52
120 kg	154.90	105.50	12.45	9.11
180 kg	158.52	105.94	11.77	9.00
240 kg	158.57	105.80	12.45	9.66
LSD $_{(0.05)}$	11.88	5.45	1.18	1.04
Seedling trans. age				
7 days	150.87	102.04	15.14	10.40
14 days	159.70	104.65	13.29	9.20
21 days	160.73	109.28	11.43	10.14
28 days	160.95	107.12	9.91	7.23
LSD $_{(0.05)}$	10.62	4.88	1.06	0.93
Variety				
Faro 52	156.38	106.18	13.69	9.40
Faro 44	159.75	105.36	11.21	9.08
LSD $_{(0.05)}$	7.51	3.45	0.75	0.66

Seedling trans. age = seedling transplanting age

Correlation analysis on yield parameters of rice during 2015 planting season at Badeggi

Significantly positive correlation was observed between number of spikelets per panicle and grains per panicle (r= 0.224**) and panicle length (r= 0.134*) but was negatively associated with number of grains per panicle Table 3. Grain per panicle showed a positive correlation ($p < 0.01$) with panicle length (r= 0.664**), Number of unfilled grains per panicle exhibited a significantly positive correlation ($p < 0.01$) with panicle length (r= 0.500**) and grain per panicle (r= 0.344**) but

showed a negative correlation with spikelet per panicle.

Correlation analysis on yield parameters of rice during 2015 planting season at Edozhigi

Number of spikelets per panicle was positively correlated ($p < 0.01$) to panicle length (r= 0.481**) and grain per panicle (r= 0.583**) Table 4. Grain per panicle was positively correlated (r= 0.614**) to panicle length and number of spikelets per

panicle (r=
correlation (p < 0.01) was observed between number of unfilled grains per panicle and panicle length (r= 0.295**)

Correlation analysis on yield parameters of rice during 2016 planting season at Badeggi:

There was a positive association (p < 0.01) of grain per panicle on panicle length and spikelet per panicle Table 5. Spikelet per panicle revealed a positive correlation (r= 0.674**) with panicle length and grain per panicle (r= 0.668**), grain yield (r= .386**). Significantly positive (p < 0.01) correlation was shown between panicle length and spikelet per panicle (r= 0.674**) and grain per panicle (r= 0.527**).

Correlation analysis on yield parameters of rice during 2016 planting season at Edozhigi:

Grain per panicle revealed a positive correlation with spikelet per panicle (r= .359**). Spikelet per panicle showed a positive correlation with grain per panicle (r= .359**) but had a negative correlation with other yield parameters. Panicle length showed non- significant positive correlation with grains per panicle (r= .166 and number of grains per panicle (r= .089) and non -significant negative correlation with spikelet per panicle (Table 6).

Table 3. Correlation analysis of rice yield parameters during 2015 planting season at Badeggi

	PL	SP	GP	NUGP
PL	1	.134*	.664**	.500**
SP	134*	1	.224**	-.263**
GP	54**	.224**	1	.344**
NUGP	00**	-.263**	.344**	1

*, **; Significant at 0.05 and 0.01 probability levels, respectively. PL= Panicle length. SP= Spikelet per panicle. GP= Grain per panicle. NUGP= Number of unfilled grains per panicle.

Table 4. Correlation analysis on growth parameters of rice yield parameters during 2015 planting season at Edozhigi

	HL	SP	GP	NUGP
PL	1	.481**	.614**	.295**
SP	.481**	1	.583**	.040
GP	.614**	.583**	1	.026
NUGP	.295**	.040	.026	1

*, **; Significant at 0.05 and 0.01 probability levels, respectively .PL= Panicle length. SP= Spikelet per panicle. GP= Grain per panicle. NUGP= Number of unfilled grain per panicle.

Table 5. Correlation analysis on growth parameters of rice yield parameters during 2016 planting season at Badeggi

	PL	SP	GP	NUGP
PL	1	.674**	.527**	-.069
SP	.674**	1	.668**	-.160
GP	.527**	.668**	1	-.136
NUGP	-.069	-.160	-.136	1

*, **; Significant at 0.05 and 0.01 probability levels, respectively.PL= Panicle length. SP= Spikelet per panicle. GP= Grain per panicle. NUGP= Number of unfilled grain per panicle.

Table 6. Correlation analysis on growth parameters of rice yield parameters during 2016 planting season at Edozhigi

	PL	SP	GP	NUGP
PL	1	-.099	.116	.089
SP	-.099	1	.359**	-.319**
GP	.166	.359**	1	-.092
NUGP	.089	-.319**	-.092	1

*, **; Significant at 0.05 and 0.01 probability levels, respectively. PL= Panicle length. SP= Spikelet per panicle. GP= Grain per panicle. NUGP= Number of unfilled grain per panicle.

DISCUSSION

Panicle length and spikelets per panicle:

The longer panicle length revealed in Edozhigi and higher number of spikelets per panicle observed at Badeggi during both planting seasons respectively might be as a result of environmental factors. Choi *et al*, (2013) reported that panicle length and spikelets per panicle depends on environmental factors such as sunshine during the growth of rice plant. Among the nutrients, nitrogen is important in rice production as it is required in large quantity. Thelonger panicle length and higher number of spikelet per panicle under 240 kg/N ha in this study revealed significant effect of nitrogen. This was probably due to higher uptake of applied nitrogen and greater availability of soil nutrients. This is supported byYoseftabar (2013) who reported that panicle length increased with an increase in nitrogen fertilization. Abou-Khalifa (2012) also experimented on some rice varieties under different levels of nitrogen and reported the significant effect of nitrogen on panicle length. It was further reported that nitrogen fertilization at higher rate gave rise to increased panicle length (20.81 cm) while control plots having no nitrogen application revealed low panicle length (18.23 cm). Nitrogen fertilizer increases spikelets production during the early panicle formation period and enhances sink size by decreasing the number of degenerated spikelets and contributes to hull size during the late panicle formation stage. Nitrogen fertilizer application showed significant influence on spikelets per panicle. In conformity with the findings of the present study, Zhu *et al*, (2017) reported a positive correlation of yield with the total number of spikelets. They reported that total spikelet first increased and then decreased with increasing nitrogen rates, revealing that nitrogen rates influenced yield primarily by affecting the total amount of spikelet.

Longer panicle length and higher number of spikelets per panicle under 28 days seedling transplanting age might be due to the influential role age of seedling played in regulating the grain development process in rice. This is in conformity with Sarkar *et al* (2011) who reported significant influence of seedling age on panicle length; they recorded longer panicle (27.98 cm) from 25 days old seedlings. Although Ali *et al* (2013); Nwokwu (2015) reported that seedling transplanting age had non-significant influence on panicle length. Pramanik and Bera (2013) reported that the number of filled grains per panicle decreased greatly due to increase in age of seedlings.

The longer panicle length and higher number of spikelets per panicle observed in FARO 52 variety in this study might be due to differences in inherent traits of genotypes and genetic characters of the varieties, primarily affected by heredity (Ranawake*et al*, 2013; Mohammed *et al*, 2014). Variety contributed variable effect on yield contributing components of rice (Tyeb*et al*, 2013; Islam *et al*, 2012)

Grain per panicle and number of unfilled grains per panicle:

higher grains per panicle and higher number of unfilled grains per panicle as observed at Edozhigi might be due to variation in environmental conditions. Jiang *et al* (2016) reported that grain per panicle depends on external environmental factors.Grain per panicle was significantly influenced by seedling age at transplanting as observed at 21 days seedling transplanting age. This is in line with the findings of Rahimpour*et al*, (2013) who reported significant influence of seedling age on grain per panicle of rice cultivars. This result is against the findings of Brar *et al*, (2012) who reported that seedling age had no significant effect on number of grains per panicle. Number of unfilled grains per panicle was higher under 7 days seedling transplanting age. This is not in conformity with Ranjan *et al*, (2015) who reported that planting 25 days old seedling produced the highest number of unfilled grains per panicle.

CONCLUSION

From the study it can be concluded that the application of 120 – 240 kg N/ha to 28 days old seedlings of Faro 52 rice variety revealed the best response in panicle length, spikelet per panicle, number of grains per panicle and number of unfilled grains per panicle in 2015 and 2016 planting seasons at both sites.

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