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Research Paper

Performance index, genetic variability for yield and yield components in some rice varieties (*Oryza sativa* L.) in southern guinea ecological zone of Nigeria

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Abstract
A field experiment was conducted at the Teaching and Research Farm of Joseph Sarwuan Tarka University Makurdi (Latitude 07°41′01"N Longitude 08°37'17"E) to study performance index, genetic variability for yield and yield components in some rice varieties (Oryza sativa L.) in southern guinea ecological zone of Nigeria. The materials used for the study comprises of thirty six (36) varieties of rice obtained from National Cereal Research Institute (NCRI) Badeggi, Niger State Nigeria. A randomized complete block design with three replications was used. Parameters assessed include: plant heights, days to 50% heading, panicle lengths, panicle weights, number of productive tillers per hole, number of seeds per panicle, number of panicle branches and yield in tonne per hectare. Data obtained were subjected to analysis of variance and means were compared using cultivar performance index. Results obtained shows significant difference for all traits evaluated. Heritability, genetic advance, genotypic coefficient of variation, phenotypic coefficient of variation, environmental coefficient of variation were computed. From the cultivar performance index, it shows that FARO 30, FARO 57, FARO 8, FARO 51, FARO 16, FARO 41, FARO 47, FARO 33, FARO 32, FARO 50, FARO 45, FARO 60, FARO 44 and FARO 49 showed superior performance.
Keywords: *Yield, Performance index, Genetic variability*

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I. INTRODUCTION

Rice is considered the most important staple crop in the world with Africa accounting for one-third of global rice imports due to high population growth rate and rapid urbanization (Macauley and Ramadjita, 2015). Rice production in the world has witnessed considerable increase in the last two decades due mainly to improved technology such as high yielding varieties and better crop management practices (Seck *et al*., 2012). Rice consumption is growing faster than that of any other major staple on the continent with demand expected to continue in the foreseeable future (Seck *et al*., 2013). The need to increase yield hastherefore become a top priority with potential for sustainable development in terms of ensuring food security and social stability in sub-Saharan Africa. Development of high yielding varieties depends upon the amount of genetic variability inherent in the cultivars which is an essential component for breeding and in selecting desirable genetic material (Atlin, 2003). Genetic variability provides an array of genotypes that can be selected to develop new varieties,which depends on the amount and direction of genetic association of the traits in the base population. The presence of genetic variabilityin crops provides better options for breeders to develop new varieties, in other words, the genetic improvement of any breeding population mainly depends upon the amount of genetic variability present (Govindaraj *et al*., 2015).

Cultivar performance is a significant test that is used to distinguish the performance of varieties (Luo*et al*., 2014). In the process, the variety means are usually arranged in a descending or ascending order. In LSD or NDMRT, any pair of mean that do not differ significantly between themselves, either assigned the same letter(s) or alphabet or are underscored by the same line otherwise significant different means are assigned different alphabets/letter(s) or underscored by different line (Gomez and Gomez, 1984). Although, it tends to be cumbersome especially if the number of varieties are many. Thereby, making visual discrimination difficult.

However, with cultivar performance index, the means "M" from which a particular variety differs significantly is used to arrange the varieties in order of superiority. For a variety under study, the maximum M values corresponding to the best variety yield is n – 1, indicating that it exceeds other varieties yields and the minimum is zero "M". Therefore, Performance index, $P = \frac{100M}{n-1}$,giving the percentage of which a particular yield exceeds significantly. Rating varietal yield according to P gives overall picture of the relative superiority of the entries (Fasoulas, 1983). Therefore, this research has been initiated to determine the extent of variability among yield selection from rice varieties evaluated

II. MATERIALS AND METHOD

A field experiment was conducted at the Teaching and Research Farm of Joseph Sarwuan Tarka University Makurdi during the 2020 cropping season (Latitude 07°41´01´´N Longitude 08°37´17´´E). The planting materials for the study comprises of thirty-six (36) varieties of rice obtained from National Cereals Research Institute (NCRI) Badegi. A Randomized Complete Block Design with three replications was used. Plot sizes of 2 x 2m = 4m^2 was used with 0.5m separating between plots and 0.5m separating between blocks. The land was cleared, ploughed, and harrowed. 3 – 7 seeds were planted per hole which were later thinned to two (2) seedlings per hole at spacing of 20cm x 20cm. Manual weed control with hoe was carried out periodically. Fertilizer was applied at rate of 200kg/ha N, 60kg/ha P_2O_5 and 60kg/ha K_2O. Parameters assessed include plant heights, days to 50% heading, panicle lengths, panicle weights, number of seeds per panicle, number of tillers per hole, number of panicle branches and seed yields. Data obtained were subjected to Analysis of Variance, cultivar performance index was computed as outlined by Fasoulas (1983)

$$P = \frac{M}{n-1} \times 100$$

Where M = Number of significantly inferior varieties
n = Number of varieties tested

III. RESULTS AND DISCUSSION

Mean squares from Analysis of various Table 1 shows that there were significant difference in all traits studied plant heights (950.19 cm), days to 50% heading (670.48), panicle lengths (23.21 cm), panicle weights (1.94 g), number of seeds per panicle branches (2.75) and yields (3.16 tonnes/ha) respectively. Table 2 shows mean performance of different traits used on the study.

Table 1: Mean square from Analysis of Variance for Agronomic traits studied

		Mean Squares							
SOV	**DF**	**HT**	**DTF**	**PANL**	**PANWT**	**NSEED**	**PTILLER**	**PANB**	**YLD**
TRT	35	950.19**	670.48**	23.21**	1.94**	3610.92**	8.44**	2.75**	3.16**
REP	2	10.53ns	3.82ns	0.48ns	0.02ns	296.12ns	0.70ns	0.12ns	0.05ns
Error	70	16.09	21.77	0.51	0.01	179.59	1.92	0.83	0.16
Total	107	321.54	233.63	7.94	0.64	1304.17	4.03	1.44	1.04

Where SOV = Source of variation; DF = degree of freedom; HT = Plant Height (cm); DTF – Days to flowering; PANL – Panicle Length (cm); NSEED – Number of seeds per panicle; PANWT – Panicle weight (g); PTILLER – Number of tillers per hole; PANB = Panicle branches; YLD –Yield (tonne/ha); TRT = treatments; REP = Replication

Table 2: Mean yield and agronomic performance of different varieties studied

TRT	HT	DTF	PANL	PANWT	NSEED	PTILLER	PANB	YLD
1	86.33	121.33	26	2.97	94	9.67	9	2.03
2	80.67	95	27.33	3.13	147.33	11	8.67	3.99
3	89	97.67	27.67	3.3	158.33	11	11.67	4.24
4	166.33	163	33	5.17	118	10.67	12	1.4
5	88	102.67	27.33	2.93	125.67	9	9	5.15
6	99	89	25.67	2.6	130.33	10.33	12	1.8

7	90.67	97	27.33	2.7	132	14	9	4.11
8	89	99.67	26.33	3	140.67	12.67	10.67	4.02
9	89	106.33	24.67	2.53	109	11.33	10	4.22
10	105.67	90.33	31	4.47	239	9.33	11.33	1.72
11	75	97.33	25.33	2.77	98	14	10.67	3.19
12	96.33	93.33	28.33	3.33	184	10.67	9.67	3.59
13	80.67	101	27	3.03	122	9	10	4.16
14	106.67	108	29.67	4.13	179	10.67	9	4.46
15	118.67	120	35	5.37	181	9.33	10.33	2.32
16	82.67	112	26	2.9	167.33	10.67	11.33	3.98
17	100.33	94	26.67	2.97	117	9.67	11	4.01
18	105.67	112.33	28.67	3	122.33	10.67	8.67	3.04
19	78.33	110.67	25.33	2.53	129	10.33	10	3.4
20	89.33	94.67	26.67	2.67	159.33	10.33	10.33	4.07
21	90.67	107.67	27.33	3.03	223	11.67	10.33	3.53
22	72	95.33	23.67	2.27	119.33	11	9.67	1.35
23	74.33	93.67	24.67	2.47	100.33	13.67	9.67	4.02
24	86.33	100.67	26.67	2.77	129.67	11.67	10	4.36
25	120.33	120.33	35.33	4.7	93	11.67	9.67	2.01
26	87	96.33	26	2.87	151	8.33	11.67	1.89
27	72	98.33	23.67	2.77	160	12	11.33	1.85
28	82.33	112.33	25.67	2.43	131	12.33	9.67	2.87
29	97.33	124.67	27.67	2.87	120.33	11.33	9	2.99
30	120.33	105.67	30.67	4.4	151	12	10.67	3.61
31	93.33	109.67	27.33	3.07	194.33	10	10.67	3.65
32	80.33	135.33	25	2.7	118.67	10.67	11.33	3.39
33	86.67	98.33	26.67	2.47	136.33	11.33	10.33	4.12
34	86.33	80	26	2.77	155	7	11	1.94
35	104.67	104.33	31	4.57	197	8	11	3.28
36	99.67	102.33	28	3	145	14.67	10	2.19
MEAN	93.64	105.29	27.51	3.18	143.84	10.88	10.29	3.22
SE	2.32	2.69	0.41	0.06	7.74	0.8	0.52	0.07
5%LSD	6.53	7.6	1.16	0.17	21.82	2.26	1.48	0.21
CV%	4.3	4.4	2.6	3.3	9.3	12.7	8.8	3.9

Where SOV = Source of variation; HT = Plant Height (cm); DTF – Days to flowering; PANL – Panicle Length (cm); NSEED – Number of seeds per panicle; PANWT – Panicle weight (g); PTILLER – Number of tillers per hole; PANB = Panicle branches; YLD –Yield (tonne/ha); TRT = treatments; REP = Replication; CV – coefficient of variation, LSD = Least significant difference; SE = Standard error

Cultivar performance index: The first superior variety mean is compared by subtracting the LSD value from the mean and then compared with other varieties means. Hence, FARO 30 is the most superior with seed yield of 5.15 tonnes/ha and LSD = 0.21, therefore, 5.15 – 0.21 = 4.94 tonnes/ha. Comparing 4.94 with other varieties mean shows that FARO 30 is superior to 35 other varieties (Table3). Similarly, the next higher yield is FARO 57. Hence, subtracting the LSD value from seed yield of FARO 57 = 4.46 – 0.21 = 4.25 tonnes/ha which is superior to 33 other varietal means. All other varietal values are compared in that order. For P values,

$$P = \frac{100M}{n-1}$$

$$FARO\ 30 = \frac{100\ \times 35}{35} = 100$$

$FARO\ 57 = \frac{100\ \times 33}{35} = 94.29$
$FARO\ 8 = \frac{100\ \times 30}{35} = 85.71$
$FARO\ 51 = \frac{100\ \times 27}{35} = 77.4$
In that order. That means FARO 8 = 4.36 – 0.21 = 4.15 is superior to 30 other varieties when compared with other mean.
FARO 51 = 4.24 – 0.21 = 4.03tonnes/ha which is superior to 27 other varietal means; in that order.

Table 3: Cultivar performance index of different varieties studied

Var	TRT	YLD	LSD	M	P
FARO 30	5	5.15	0.21	35	100.00
FARO 57	14	4.46	0.21	33	94.29
FARO 8	24	4.36	0.21	30	85.71
FARO 51	3	4.24	0.21	27	77.14
FARO 16	9	4.22	0.21	24	68.57
FARO 41	13	4.16	0.21	22	62.86
FARO 47	33	4.12	0.21	22	62.86
FARO 33	7	4.11	0.21	22	62.86
FARO 32	20	4.07	0.21	22	62.86
FARO 50	8	4.02	0.21	22	62.86
FARO 45	23	4.02	0.21	22	62.86
FARO 60	17	4.01	0.21	22	62.86
FARO 44	2	3.99	0.21	22	62.86
FARO 49	16	3.98	0.21	22	62.86
FARO 52	31	3.65	0.21	18	51.43
FARO 66	30	3.61	0.21	17	48.57
FARO 31	12	3.59	0.21	16	45.71
FARO 62	21	3.53	0.21	15	42.86
FARO 38	19	3.40	0.21	14	40.00
FARO 15	32	3.39	0.21	14	40.00
FARO 37	35	3.28	0.21	14	40.00
FARO 26	11	3.19	0.21	12	34.29
FARO 20	18	3.04	0.21	11	31.43
FARO 58	29	2.99	0.21	11	31.43
FARO 17	28	2.87	0.21	11	31.43
FARO 19	15	2.32	0.21	9	25.71
FARO 67	36	2.19	0.21	7	20.00
FARO 22	1	2.03	0.21	4	11.43
FARO 21	25	2.01	0.21	3	8.57
FARO 63	34	1.94	0.21	3	8.57
FARO 56	26	1.89	0.21	2	5.71
FARO 61	27	1.85	0.21	2	5.71
FARO 64	6	1.80	0.21	2	5.71
FARO 65	10	1.72	0.21	2	5.71

FARO 4	4	1.40	0.21	0	0.00
FARO 27	22	1.35	0.21	0	0.00

Where P – Performance index; M – Means for which a particular variety differs significantly with others; CV – coefficient of variation; TRT = Treatments; LSD = Least significant difference; YLD = Yield (tonne/ha)

Genetic Variability Parameters: Greater variability in initial breeding material ensures better chances of breeding desired forms of crop plants. The study carried out indicated low, moderate and high PCV and GCV values among yield characters (Table 4). Highest PCV and GCV values were recorded for yield, panicle weights and number of seeds per panicle while lowest PCV and GCV were recorded for panicle branches and panicle lengths. Hence, high phenotypic variations indicated high genotypic variation and less environmental variations for different traits. Similar results were observed by Ravindra *et al.* (2012), Shivani and Ready (2001), Rita *et al.* (2009).

Table 4: Genetic variability parameters on agronomic traits studied

Traits	Means	$G\sigma^2$	$P\sigma^2$	$E\sigma^2$	h^2	GCV (%)	PCV (%)	GA (%)
HT	93.64	311.37	327.47	16.1	0.95	18.84	19.33	37.85
DTF	105.29	216.24	238	21.77	0.91	13.97	14.65	27.42
PANL	27.509	7.57	8.08	0.51	0.94	10	10.33	19.94
PANWT	3.184	0.64	0.65	0.01	0.98	25.18	25.39	51.43
NSEED	143.84	1143.77	1323.37	179.6	0.86	23.51	25.29	45.03
PTILLER	10.88	2.17	4.1	1.92	0.53	13.55	18.6	20.33
PANB	10.287	0.64	1.47	0.83	0.44	7.78	11.77	10.59
YLD	3.221	1.05	1.06	0.02	0.98	31.77	32.01	64.96

Where SOV = Source of variation; DF = degree of freedom; HT = Plant Height (cm); DTF – Days to flowering; PANL – Panicle Length (cm); NSEED – Number of seeds per panicle; PANWT – Panicle weight (g); PTILLER – Number of tillers per hole; PANB = Panicle branches; YLD –Yield (tonne/ha); TRT = treatments; REP = Replication; GCV = Genotypic Coefficient of Variability; PCV = Phenotypc coefficient of variation GA – Genetic advance (%); $E\sigma^2$= Environmental variance; $P\sigma^2$= Phenotypic variance; $G\sigma^2$= Genotype variance; h^2 = Broad-sense Heritability

Heritability estimates is used as a predictive way in expressing the reliability of phenotypic value. Therefore, high heritability helps in effective selection for a particular character. Heritability is classified as low when it is blow 30% medium when it is 31 – 60% and high when it is above 60% (Revindra *et al.*, 2012). The traits studied shows medium heritability for number of tillers per hill (53%) and number of panicle branches (44%)respectively. High heritability were observed for plant heights, number of seeds per panicle and seed yield respectively.

Genetic advance is a useful tool that indicate the progress that can be expected as a result of exercising selection on a particular population (Islam*et al.*, 2015). Heritability in conjunction with genetic advance would give more reliable index of selection value (Johnson*et al.*, 1955). Genetic advance was highest for yield, panicle weights, number of seeds per panicle and plant heights respectively. Low genetic advance was recorded for panicle branches, number of tillers per hill and panicle branches. High heritability and genetic advance indicates the scope of genetic improvement for these characters through selection.

IV. CONCLUSION AND RECOMMENDATION

Cultivar performance index (PI) gives a quick, easy visual information and discrimination compared to other conventional used methods (DMRT and LSD) in selecting the best lines. FARO 30, FARO 57, FARO 8, FARO 51, FARO 16, FARO 41, FARO 47, FARO 33, FARO 32, FARO 50,L FARO 45, FARO 60, FARRO 44 and FARO 49 shows superior performance. Therefore, can be recommended for further evaluation or breeding procedures for high yields.

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