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AGRONOMIC EVALUATION OF SOME RICE GENOTYPES IN NSUKKA

Agbo, C. U. and Obi, I. U.
Department of Crop Science, University of Nigeria, Nsukka

Corresponding Author: Agbo, C. U. Department of Crop Science, University of Nigeria, Nsukka

ABSTRACT

The performance of eleven rice genotypes obtained from National Cereals Research Institute, Badeggi, Nigeria and a local check were evaluated in Nsukka for two cropping seasons. Statistical analyses were performed on the agronomic and yield related traits and biotic stresses measured on the rice genotypes. Combined analysis of variance was estimated using mixed models of random years and fixed treatment on the genotypes' traits measured. There was significant (p = 0.05) genotypic differences in all the traits and biotic stresses measured in both years. The genotype ITA 324 gave the highest yield of 3.9 t/ha in both years. There was significant genotype by year interaction (G x Y) with most of the traits indicating differential genotypic expressions. The highly significant differences in the agronomic characters and biotic stresses measured gives room for further selection. Thus, genotypes that showed higher resistance to the stresses and had higher yields will be favoured in selection.

Keywords: Biotic stresses, G x Y interaction, Selection

INTRODUCTION

Rice (*Oryza sativa L.*) is well adapted to a wide range of ecosystem especially regarding its moisture needs (Courtois, 1988). It is an important staple food crop in West Africa. International Rice Research Institute (IRRI) (1981) reported that there was progressive replacement of other cereals and traditional food crops by rice in West Africa due to increased urbanization, taste, ease of cooking and storage. Abba and Mohammed (2000) stressed that the demand for rice in Nigeria has increased (without a proportional increase in local rice production) due to general shift of consumer preferences away from traditional foods.

Genotype by environment (G x E) interaction in crops expresses the relative reaction of a genotype to the environment over others to increase or decrease yield in such a genotype (Kang and Gauch, 1996; Kang, 1998). Kang (1998) showed that G x E interaction could be useful in selecting genotypes in breeding programmes for specific sites or years.

Nigeria is not self-sufficient in rice production because of low yields (0.5 to 1.5 t/ha) due to use of unimproved varieties, stress conditions and poor agricultural practices (Anon. 1989). The frequent ban on rice importation by successive governments in Nigeria always encourages smuggling of rice from neighbouring countries like Benin (Anon. 2005). It also results in demand deficit and thus scarcity of the product. There is then need for concerted efforts to improve on the level of rice production and yield in Nigeria. Improvement of rice yields in Nigeria demands an approach that will involve selection of rice genotypes from breeding programmes to replace the existing ones after passing through the necessary tests. Our objective was to evaluate eleven rice genotypes and assess their reaction to field stresses under natural conditions and make selection based on their performance.

MATERIALS AND METHODS

The experiment was carried out in the experimental field of Department of Crop Science, Faculty of Agriculture, University of Nigeria, Nsukka. Nsukka lies within latitude 06°51'N, longitude 07°29'E, altitude 400 m above sea level. The experiment was carried out for a period of two cropping seasons.

Eleven rice genotypes obtained from National Cereals Research Institute, Badaggi, Nigeria and a local check, faro 16 were used for the study. The genotypes include: Tox 3154-17-1-3-2-2, Tox 3084-136-1-3-2-2, Tox 3440-132-3-3-1, ITA 324, Tox 3499-84-2-1-3, BR57-282-8-HC-83, Tox 4008-34-1-1-1-2, De Priuni (Naputo), Farox 317-1-1-1-1, SPT 7106-2-3-3-1 and ITA 368.

The experimental design was a randomized complete block (RCB) with three replications. Plot size measured 4m x 3m. Seeds were sown 20 cm apart between rows and 15 cm apart within rows. Three seeds were sown per hill and later thinned to two stands per hill. Straight fertilizers were applied three weeks after planting at the rate of 30 kg N, P and K/ha each. Nitrogen was re-applied at the same rate as top dressing at the onset of booting. All cultural practices employed in rice production which include weeding, bird scaring, threshing and winnowing were done when necessary.

Measurements were based on standard evaluation system for rice (SES) (IRRI, 1988). Data collected on agronomic characters included: days to 50% flowering, plant height, number of tillers/plant, number of panicles/m^2, number of spikelets/panicle, percentage fertile spikelets, days to maturity and 1000-grain weight. The biological stresses measured under natural infestation include: African rice gall midge symptoms (ARGM), dead heart and white head symptoms of stem borer and brown leaf spots. Data on the agronomic characters and biotic stresses were collected from twenty randomly selected hills of middle rows in each plot. Grain yield (t/ha) was estimated from harvests made from 5m^2 within the middle rows in each plot. Combined analysis of variance for agronomic characters and biotic stresses of the two years was performed using mixed models of random years and fixed treatment as was described by McIntosh (1983). This was to derive the effects of year, genotype and G x Y interaction.

RESULTS AND DISCUSSION

The results of the soil analysis before planting and after second harvest of the rice genotypes were shown in (Table 1).

Table 1: Soil analysis of experimental site (Before planting and after harvesting)

Soil property	(Before planting)	(After harvest)
Mechanical analysis		
Clay	21%	20%
Silt	8%	8%
Sand	71%	72%
Textural class	Scl	Scl
Chemical Analysis		
pH in H_2O	4.83	4.6
KCl	4.4	4.27
Organic matter		
Carbon	2.10%	1.11%
Nitrogen	0.058%	0.053%
Exchangeable Bases (Meq/100g)		
Na	0.84	0.78
K	0.56	0.35
Ca	0.80	0.58
Mg	0.38	0.58
CEC	1.57	1.66

Scl = Sandy clay loam

Table 2: Meteorological data collected during the study at Department of Crop Science, University of Nigeria, Nsukka Metrological Station

Months	Rainfall (mm)		Relative humidity (%)				Temperature				T°max.	T°Cmean
			1998		*1999*		*1998*			*1999*		
	1998	1999	6 am	6 pm	6 am	6 pm	T°min	T°max	T°C mean	T°min		
May	128.4	126.5	80.3	74.0	80.0	72.0	20	30	25	22	28	25
June	273.7	275.0	81.0	75.0	81.0	74.0	21	31	26	22	30	26
July	135.2	230.6	80.0	72.0	80.5	74.0	21	31	26	21	30	25.5
Aug.	217.0	73.9	82.0	73.0	80.7	75.0	22	31	26.5	21	30	25.5
Sept.	269.0	331.2	81.0	74.0	80.6	68.9	20	30	25	21	31	26
Oct.	288.5	161.0	81.5	74.0	80.5	71.8	19	29	24	21	31	26
Nov.	54.9	14.0	80.0	73.0	80.6	64.6	21	31	26	22	31	26.5

Table 3: Mean squares for rice agronomic characters and stresses measured for the two years

Sources of Variation	d.f	D50	PLHT	DMT	TNP	NSP	NPM	GWT	PFS	GY	ARGM	DH	WH	BLS
Year (Y)	1	703.13**	1369.4**	2837.6**	304.2**	7.3	26068.1**	9.43	2156.1**	24**	78.8*	74**	189.7*	1488.3**
Genotypes	11	62.86**	1029.3**	34.4**	3.0**	2808.6**	1150.6**	96.2**	416.7**	1.4**	21.7**	4.3**	5.3*	262.7**
G x Y	11	22.65**	130**	7.4*	5.4**	2.8	894.6**	2.7	25.5	0.3**	25.5**	0.9**	1.2**	103.2**
Error	44	2.47	10.58	1.2	0.7	4.4	87.4	1.8	11.6	0.02	0.6	0.5	0.6	4

Where: D50 is days to 5% flowering, PLHT is plant height (cm), DMT is days to maturity, TNP is number of tillers/plant, NSP is number of spikelets/panicle, NPM is number of panicles/m^2, GWT is 1000-grain weight, GY is grain yield (t/ha), ARGM is African rice gall midge symptoms, BLS is brown leaf spots symptom, DH and WH are dead heart and white head symptom of stem borer, respectively.

Table 4: Main effects and genotype X year (G x Y) interactions on the agronomic characters of the genotypes in both seasons

Genotypes	Days to 50% flowering			Plant height (cm) at maturity			Days to maturity			Tiller number per plant			Number of spikelets per panicle			Number of panicle per/ m^2		
	1998	1999	Mean	1998	1999	Mean	1998	1999	Mean	1998	1999	Mean	1998	1999	Mean	1998	1989	Mean
Tox 3154-17-1-3-2-2	109.0	117.0	113.2	87.0	87.0	87.0	139.0	147.0	143.0	8.0	7.0	7.5	136.0	135.0	135.5	152.0	123.0	137.5
Tox 3084-136-1-3-2-2	111.0	119.0	115.0	85.0	77.0	81.0	141.0	149.0	145.0	6.0	5.0	5.5	139.0	137.0	138.0	128.0	87.0	107.5
Tox 3440-132-3-3-1	117.0	120.0	118.3	92.0	89.0	90.5	147.0	150.0	148.5	5.0	4.0	4.5	131.0	130.0	130.5	142.0	80.0	111.0
ITA 324	110.0	121.0	115.5	81.0	81.0	81.0	140.0	151.0	145.5	7.0	6.0	6.5	148.0	143.0	145.5	148.0	92.0	120.0
Tox 3499-84-2-1-3	120.0	125.0	122.5	124.0	96.0	110.0	150.0	155.0	152.5	5.0	5.0	5.0	121.0	120.0	120.5	133.0	125.0	129.0
BR 57-282-8-HC-83	114.0	124.0	118.7	87.0	80.0	83.5	144.0	154.0	149.0	7.0	6.0	6.5	133.0	132.0	132.5	142.0	102.0	120.0
Tox 4008-34-1-1-1-2	108.0	119.0	113.2	99.0	90.0	94.5	138.0	149.0	143.5	9.0	8.0	8.5	176.0	177.0	176.5	150.0	142.0	142.0
De Priuni (Naputo)	108.0	116.0	111.8	122.0	103.0	112.5	138.0	146.0	142.0	6.0	6.0	6.0	134.0	131.0	132.5	107.0	98.0	124.0
Farox 317-1-1-1	120.0	120.0	120.0	86.0	84.0	85.0	150.0	150.0	150.0	5.0	5.0	5.0	145.0	148.0	146.5	155.0	77.0	92.0
SPT 7106-2-3-3-1	114.0	121.0	117.2	88.0	83.0	85.5	144.0	151.0	147.5	5.0	4.0	4.5	96.0	96.0	96.0	130.0	65.0	110.0
ITA 368	116.0	120.0	118.0	81	80	80.5	146.0	150.0	148.0	6.0	5.0	5.5	113.0	115.0	114.0	125.0	95.0	112.5
Farox 16	120.0	119.0	119.5	128.0	104.0	116.0	150.0	149.0	149.5	4.0	4.0	4.0	100.0	100.0	100.0	137.5	108.0	116.5
Mean	**113.8**	**120.1**		**96.5**	**87.9**		**136.9**	**149.5**		**6.1**	**5.5**		**131.0**	**126.8**		**10.44**	**95.3**	
F-LSD$_{(p = 0.05)}$ for comparing genotype	=	1.68		3.73			1.26			0.90			17.94				10.44	
F-LSD$_{(p = 0..05)}$ for comparing years	=	0.69		1.52			0.51			0.37			NS				4.26	
F-LSD$_{(p = 0.05)}$ for comparing G x Y interaction	=	2.38		5.28			1.78			1.27			NS				14.77	

Table 4 continues

Genotypes	1000-grain weight (g)		Mean	Percentage of fertile spikelets per panicle		Mean	Grain yield (t/ha)		Mean
	1998	1999		1998	1999		1998	1999	
Tox 3154-17-1-3-2-2	24.6	23.1	23.7	66.0	56.0	61.0	3.3	2.1	2.7
Tox 3084-136-1-3-2-2	23.5	23.1	23.3	66.0	54.0	60.0	2.8	1.8	2.3
Tox 3440-132-3-3-1	21.6	21.0	21.3	64.0	45.0	54.5	2.9	1.7	2.3
ITA 324	25.0	24.5	24.8	67.0	58.0	62.5	5.1	2.6	3.6
Tox 3499-84-2-1-3	20.5	19.8	20.2	55.0	41.0	48.0	2.7	1.7	2.2
BR 57-282-8-HC-83	16.6	16.2	16.4	54.0	42.0	48.0	2.7	1.8	2.2
Tox 4008-34-1-1-1-2	26.0	25.7	25.8	68.0	59.0	63.5	3.4	2.4	2.9
De Priuni (Naputo)	32.5	30.6	31.5	65.0	58.0	61.5	3.0	2.0	2.5
Farox 317-1-1-1	18.1	18.2	18.2	49.0	39.0	44.0	2.6	1.7	2.1
SPT 7106-2-3-3-1	19.0	18.9	18.9	49.0	39.0	44.0	2.7	1.8	2.3
ITA 368	23.5	22.1	22.9	49.0	40.0	44.5	3.0	1.8	2.4
Farox 16	20.6	20.0	20.3	47.0	37.0	42.0	2.6	1.6	2.1
Mean	**22.2**	**21.9**		**58.4**	**47.4**		**3.08**	**1.90**	
F-LSD$_{(p = 0.05)}$ for comparing genotype	2.92		3.87		0.25				
F-LSD$_{(p = 0..05)}$ for comparing years	NS		1.58		0.10				
F-LSD$_{(p = 0.05)}$ for comparing G x Y interaction	NS		5.48		0.35				

Table 5: Main effects and genotype x year (G x Y) interaction on biotic stress of the genotypes in both seasons

Genotypes	**Percentage of tillers with African rice gall midge symptoms**			**Percentage of brown leaf spots symptoms**			**Percentage of tillers with dead heart symptoms of stem borer**			**Percentage of tillers with white head symptoms of stem borer**		
	1998	**1999**	**Mean**	**1998**	**1999**	**Mean**	**1998**	**1999**	**Mean**	**1998**	**1999**	**Mean**
Tox 3154-17-1-3-2-2	3.0	2.0	2.5	6.0	2.0	4.0	2	3	2.5	1.0	4.0	2.5
Tox 3084-136-1-3-2-2	4.0	3.0	3.5	14.0	4.0	9.0	2	3	2.5	2.0	4.0	3.0
Tox 3440-132-3-3-1	4.0	3.0	3.5	14.0	6.0	10.0	1	4	2.5	2.0	5.0	3.5
ITA 324	3.0	1.0	2.0	3.0	3.0	3.0	2	3	2.5	1.0	4.0	2.5
Tox 3499-84-2-1-3	7.0	6.0	6.5	13.0	16.0	14.5	1	5	3.0	2.0	5.0	3.5
BR 57-282-8-HC-83	7.0	4.0	5.5	13.0	7.0	10.0	2	2	2.0	2.0	5.0	3.5
Tox 4008-34-1-1-1-2	3.0	3.0	3.0	5.0	3.0	4.0	1	4	2.5	1.0	4.0	2.5
De Priuni (Naputo)	3.0	2.0	2.5	13.0	7.0	10.0	2	3	2.5	1.0	4.0	2.5
Farox 317-1-1-1	8.0	5.0	6.5	30.0	3.0	16.5	3	5	4.0	2.0	6.0	4.0
SPT 7106-2-3-3-1	7.0	2.0	4.5	26.0	4.0	15.5	3	3	3.0	3.0	4.0	3.5
ITA 368	3.0	2.0	2.5	14.0	5.0	9.5	2	4	3.0	2.0	5.0	3.5
Farox 16	5.0	7.0	6.0	30.0	16.0	23.0	3	6	4.5	3.0	8.0	5.5
Mean	**5.0**	**3.0**		**15.0**	**6.0**		**1.9**	**3.7**		**1.7**	**4.9**	
F-LSD$_{(p = 0.05)}$ for comparing genotype		0.31			0.45			0.33			0.25	
F-LSD$_{(p = 0..05)}$ for comparing years		0.77			0.19			0.13			0.10	
F-LSD$_{(p = 0.05)}$ for comparing G x Y interaction		1.09			0.64			0.46			0.35	

It shows that the textural class of the soil is sandy clay loam with pH in water and KCL of 4.83 and 4.4, respectively. The organic matter content in terms of percent organic carbon was high before planting and was moderate after harvest but total nitrogen was low before planting. Sodium and potassium were moderate before planting. Calcium and magnesium had very low values respectively before planting. These ratings were adjudged according to Black (1975) on the methods of soil analysis. The low level of available nitrogen and other macro-elements showed that the soil needed adequate fertilization before and after the harvests to increase the availability of such nutrients to the crops. The soil should be allowed to rest after the second harvest and be amended before profitable cropping of rice could be achieved on it. This agrees with the recommendation of Courtois (1988) that rice should not be cropped three times consecutively on the same piece of land.

The agro-meteorological data in Table 2 showed that there was no remarkable difference in the temperature and relative humidity values of the study site for the two years. There were 66% and 44% drops in rainfall in the months of August and October in the second year and a 12.3% reduction in the total rainfall relative to the first year. The reduction in rainfall in the second year might be the cause of the observed reduction in the expression of the agronomic traits and biotic stresses measured on the rice genotypes in that year relative to the former year. This is in agreement with IRRI's report of (1975).

There was significant ($p = 0.05$) genotypic differences in all the agronomic and biological stresses measured in both years (Table 3). This shows that there was variable genotypic behaviours among the genotypes in the expression of their characters. The genotypes Farox 317-1-1-1 and Spt 7106-2-3-3-1 with statistical similar values in both years for plant heights and tiller number per plant indicates that they may have similar gene(s) expression for such traits (Table 4). The general increase in days to flowering and maturity and reduction in values of other traits and yield in the latter year relative to the first year could be attributed to vagaries of the environment. As an instance, the drop in rainfall in the latter year could have adversely affected other environmental factors that influence rice growth and yield. The genotype ITA 324 gave the highest yield of 3.9 (t/ha) in both years. The higher yield of the genotype over others may be attributed to its high resistance to biological stresses measured (Table 5) coupled with the expression of some of its yield traits above others in both years. ITA 324 demonstrated adaptation and could become commercial material in Nsukka if further trails are imposed on it.

There was significant genotype by year interaction on most of the traits evaluated except number of spikelets/panicle and 1000-grain weight (Table 4). The levels of interaction between the yield of the different genotypes and the years varied considerably, thus, some genotypes reacted less while others reacted largely to the years. The relative importance of each source of variation in the interaction was determined from the combined analysis table and it showed that the effect of years caused 53.2% of the variation observed in their yields. Furthermore, the genotypic differences caused 35.2% whereas, genotype by year (g x y) interaction caused 6.5% of the total variation observed. The rest of the variation was attributed to error and blocking effects. Thus, the effect of the differences genotypes more than any other source in both years. The significant G x Y interaction on most of the traits with the exception of number of spikelets/panicle and grain weight showed differential genotypic responses to the different years (Kang and Gauch, 1996; Kang, 1998). The presence of G x Y interaction gives room for selection of superior genotypes (Francis and Kannenberg, 1978; Kang, 1998). Thus, selection of superior genotypes can be made on the basis of yields and yield traits expression. On the basis of superior performance, ITA 324 and Tox 4008-34-1-1-1-2 could be selected for further trials.

Most of the introduced genotypes performed better than the local check. The check had an average yield of 2.1 (t/ha) which is more than low yields of 1.5 (t/ha) reported for Nigerian farmers (Anon., 1989) probably because it was under intensive care. It follows that continuous selections from bred genotypes at advanced stages for superior performance of yield and yield traits will help to improve rice yields in Nigeria when such selected genotypes are confirmed varieties for production.

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