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AGRONOMIC PERFORMANCE AND ESTIMATE OF GENETIC VARIABILITY OF UPLAND RICE GENOTYPES ON ACID SOIL OF CROSS RIVER STATE

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ABSTRACT

Studies on the performance and genetic variability of five upland rice genotypes which included FARO 43, FARO 46, FARO 49 and NERICA-1 was carried out on acid soil of Calabar, Cross River State. FARO 43 was found to give the highest yield of 4.75 t/ha followed by FARO 49 with 4.69 t/ha, indicating that the two genotypes are tolerant to acid soil condition. The genetic variability estimates revealed low values of genotypic coefficient of variability (GCV) and corresponding high values of phenotypic coefficient of variability (PCV) for all the characters investigated with exception of plant height. High heritability (h^2) and high genetic advance (GA) were observed for number of tillers and productive tillers. Number of days to 50% flowering, number of grains/panicle and rain yield had high heritability (h^2) values with corresponding low genetic advance (GA). These two characteristics are considered as selection indices for further improvement.

KEYWORDS: Acid soil, coefficient of variability, genetic advance, genetic variability, upland rice.

INTRODUCTION

The rice plant has been growing in the wild prior its domestication; today most countries cultivate varieties belonging to the genus,*Oryza* with well over twenty different species (RRI, 2001). This crop today is central to the lives of billions of people around the globe and it is the most important staple food in the developing world with other cereals like maize and wheat. Nutritionally, rice is a good source of magnesium, thiamine, niacin, phosphorus, vitamin B6, zinc and copper and, it contributes 50-80% of daily caloric intake (Grist, 1986). Some varieties have iron, potassium and folic acid. The protein content ranges from 6.4 to 8.5% (Udoh *et al.,* 2005). Apart from the primary (culinary) importance of rice, it has many industrial uses. For example starch, alcoholic beverages, rice wine and flour for the confectionary industry are made from rice.

Phytin and vitamin B production for the pharmaceutical industry and rice oil for the manufacturing of soap and candle, all come from rice (Udo and Ittah, 2006).

In spite of the abundant potentials of rice, its production still faces numerous climatic, edaphic and environmental constraints. Particularly, soil acidity is one of the prevailing conditions in both the rice and swamp rice ecologies in the world today; rice is grown under different conditions and production systems based on water supply and topography (Windmeijer *et al.,* 1994). Though swamp rice cultivation has a primeval Institution, the upland system has gained importance over the decades as reported by Chopra and Prakash (2002).

However, acid soil related problems are more critical to the upland rice system of cultivation and, these greatly affect optimum cultivation (Singh *et al*). Soil acidity has been associated with high level of soil weathering as reported by Fageria *et al*. (2004) and WARDA (1999). Tisdale *et al*. (2003) explain the mechanism of soil acidity to be the resultant of aluminum toxicity. Aluminum toxicity is probably the most important growth limiting factor in many acid soils, particularly with pH less than 5.0. This also increases the concentration of micronutrients up to toxic levels, thus, interfering with the uptake, transport and of water and nutrients by plants. Sarkarung (1989) reported that yield losses on acid soils could be very high, up to 50%.

In Cross River State, rice is mostly cultivated under hydromorphic condition. Cultivation of rice on upland condition is not common and this might be due to inadequate knowledge of available and adoptable upland rice varieties. The upland varieties required for this ecology have not been adequately studied in the past. Lack of suitable varieties and the effect of soil acidity limit the yield to 1.5 – 2.0 t/ha. The soils of Calabar, Cross River State, Nigeria are mostly Oxisols and these are typical acid soils (Ibanga, 2002).

Given the potentials of upland rice production that abound in the state, there is a need to identify acid soil tolerant upland rice genotypes for adaptation in this area. Consequently, though liming is a soil management practice for acid soils, but this only decreases aluminum toxicity according to Tisdale *et al.* (2003). And Okada and Wissuwa (2003.) The use of acid soil tolerant crop species or cultivars would be a complementary solution

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for the improvement of crop production on such soils. According to Iwo *et al.* (2006), one of the approaches to bring about improvement of crops is to understand the genetic variability of the yield related traits and the agronomic performance.

Therefore, the purpose of this study was to assess the performance of upland rice genotypes on acid soil condition and also to estimate the genetic variability among the evaluated genotypes.

MATERIALS AND METHOD

The five upland rice genotypes used for the study were obtained from National Cereals Research Institute (NCRI), Badeggi, Niger State, Nigeria. These were grown in May 2006 and August 2007 cropping seasons at the University of Calabar Teaching and Research Farm, Calabar, Cross River State, Nigeria. The representative soil samples of the area were randomly taken at a depth of 15cm with a standard core sampler for the determination of the relevant physio-chemical soil properties (Table 1). Randomized Complete Block design with three replications was used for the study. Each of the experimental plot measured 5m by 1m. The inter-row spacing was 0.25m and 0.25m, respectively. The seeds were planted by dibbling. Thinning was done at two weeks after planting; maintaining a maximum of two stands of plant per hill. The first weeding was carried out at three weeks after emergence followed by the first split fertilizer (NPK 15:15:15) application, at a rate of 100kg/ha. The second weeding took place four after weeks the first weeding; followed with the second split of fertilizer (Urea 46%) application, at the rate of 50kg/ha. For each of the characters, five plants were randomly sampled from the inner row of the experimental plots per replication. The means of the three replicates were subjected to Analysis of Variance (ANOVA) according to Gomez and Gomez (1984) and the estimates of genetic variability determined as suggested by Johnson *et al.* (1955), Hanson *et al.* (1956) and Singh and Chaudhary (1995).

The characters investigated were: number of days to 50% flowering, number of tillers at maturity, number of productive tillers, plant height (cm), panicle weight (g), number of grains/pinnacle, grain weight/pinnacle (g), 1000-grain weight (g) grain yield (t/ha).

Table1: Physico-chemical properties of the soil in the study area

Sand	Silt	Clay	Textural Class	pH	Organic Carbon	Total Nitrogen	Available Phosphorus	Ca^{+2}	Mg^{+2}	K^{+}	Na^{+}	H^{+}	Al^{+3}	ECEC	BS
	(%)				(%)	(%)	(ppm)				(cmol(+)/kg)				(%)
81.7	6.7	11.6	SL	4.8	1.18	0.09	57.3	1.0	0.6	0.08	0.05	4.64	2.16	8.53	20.3

SL: Sandy Loam, ECEC: Effective Cation Exchange Capacity, BS: Base Saturation.

RESULTS AND DISCUSSION

Agronomic performance

The agronomic performance of the rice genotypes evaluated in field (table 2) showed that there was no significant difference ($p> 0.05$) in plant height, panicle length, panicle weight grain weight /panicle and 1000-grain weight for all the genotypes. There was significant difference in the number of days to 50% flowering, number of tillers at maturity, productive tillers, grains/panicle and grain yield. FARO 43, FARO 49 and NERICA-1 had 50% flowering at the same period differing significantly (PL.05) from FARO 46, which was an early maturing genotype, and FARO 48, the late maturing genotype. This was in consonance with the findings of Imolehin and Wada (2000). As reported by Kamura (1956), apart from early maturity, tillering ability and productivity in rice are good parameters that do affect grain yield positively. FARO 48 had the highest number of tiller counts and NERICA-1 has the least of this and productive tillers.

In terms of number of grains /panicle, FARO 43, FARO 48 and FARO 49 were not significantly different from NERICA-1 and FARO 46 which gave the lowest number of grain panicle (147.83). However, FARO 43 and FARO 49 had the highest number of grains/panicle of 261.83 and 261.00, respectively. The number of grains/panicle has been reported by Honya (1961) to have a positive correlation with grain yield in rice; with some implications for selection of genotypes for increased grain yield.

For grain yield, though an average yield of 3.82 t/ha was obtained for the five investigated genotypes, FARO 43 gave the highest yield of 4.75 t/ha followed by FARO 49, with 4.69 t/ha. The lowest yield was obtained from NERICA-1 (2.56 t/ha) which differed significantly ($p<0.05$) from the other genotypes. This further conformed to the average yield estimate of 5.30 t/ha for twenty different upland rice genotypes worked on by Masajo et al (1986).

It has also been ascertained by IRRI (1994), that good morphogical attributes in rice are possible markers for high yield. These attributes: Robust, heavy grains, thick and sturdy stems as well as erect leaves, were observed on FARO 43 and FARO 49. Thus, these two genotypes were considered to be very promising and tolerant to acid soil conditions of Calabar and its environs.

Table 2: Mean values for the yield and other agronomic traits of five upland rice genotype evaluated in 2006/2007 cropping season

Genotype	Days to 50% flowering	Tillers at maturity(no)	Productive tillers (no)	Plant height (cm)	Panicle length (g)	Panicle weight (g)	Grains/panicle (no)	Grains weight/panicle (g)	1000-grain weight (g)	Yield (t/ha)
FARO 43	83.67	13.67	11.83	115.67	27.03	9.13	261.83	8.12	31.43	4.75
FARO 46	66.33	12.67	11.33	126.67	30.10	5.88	147.83	5.88	36.76	3.95
FARO 48	88.00	19.33	14.00	114.00	28.77	7.40	248.67	5.52	26.09	3.16
FARO 49	82.33	14.17	12.33	117.00	27.10	8.55	261.00	7.65	28.98	4.69
NERICA -1	81.67	7.17	6.17	112.67	30.32	6.18	209.50	5.10	24.19	2.56
Mean	80.40	13.43	11.13	117.20	28.66	7.34	225.77	6.55	29.49	3.82
SEM	2.02	1.79	0.96	8.17	1.51	1.04	17.80	1.05	4.55	7.83
CV (%)	3.08	16.36	10.59	8.54	6.46	17.18	9.66	19.55	18.88	21.07
LSD05	4.66	4.14	2.22	NS	NS	NS	41.06	NS	NS	1.91

Ns: not significant at 5% level.

genotypic coefficient of variability (GCV). Highest genotypic coefficient of variability was observed in the number of tillers at maturity, followed by grain yield, number of productive tillers and number of grains/panicle. These characters had corresponding high phenotypic coefficient of variability. A combination of these proffers a considerable condition for improvement.

Iwo et al, (2006) noted that the genotypic coefficient of variability and the phenotypic coefficient of variability are not reliable measures for heritable variations. Thus heritability (h2) estimates and genetic advance (GA) were considered. The heritability estimates of these characters; panicle length, 1000-grain weight, grains /panicle weight revealed that they were greatly influenced by the environment. Very high heritability values were observed in number of days to 50% flowering (91.46%, number of productive tillers (86.00%), number of grains/panicle (82.18%), number of tillers at maturity (78.56%) and grain yield (67.73%).

number of tillers at maturity, number of productive tillers, grains weight/panicle and panicle weight. Selection for these characters will genetically proved to be very effective and promising. Characters with high heritability and very low genetic advance are less likely to facilitate an effective selection due to the resultant influence of non additive gene action i.e dominance and epitasis (Liang and Walter, 1968). This was observed in the number of grains/panicle, number of days to 50% flowering and grain yield. Similar observations of these were made by Mehetre et al., (1984) and Vange et al, 1999).

In conclusion, the results of this study have shown that these promising genotypes, FARO 43 and FARO 49 were exceptionally tolerant to acid soil condition and performed agronomically well. The genetic variability estimates showed that the existence of agronomical related characters such as tillering and grain yield could be harnessed in these genotypes for further improvements.

Table 3: Estimates of genetic variability in five upland genotypes

Character	Range	Mean	GCV	PCV	H^2 (%)	GA AS % of mean
Days to 50% flowering	81.67-88.00	80.40	10.08	10.55	91.46	1.14
Tillers at maturity (no)	7.17-19.33	13.43	31.33	35.34	78.56	5.83
Productive tillers (no)	6.17-14.00	11.13	25.81	27.90	86.00	7.73
Plant height (cm)	112.67-	117.20	0.00	8.42	-2.74	-0.02
Panicle length (cm)	126.67	28.66	4.02	7.61	27.94	0.98
Panicle weight (g)	27.03-30.33	7.43	16.37	23.74	47.59	6.41
Grains/panicle (no)	5.88-9.13	225.77	20.74	22.88	82.18	0.36
Grains weight/panicle	147.83-	6.55	13.00	25.91	43.06	6.57
(g)	261.83	29.49	12.60	22.70	30.80	1.04
1000-grain weight (g)	5.10-8.12	4.83	30.35	37.10	67.73	0.01
Yield (t/ha)	24.19-36.76					
	2.56-6.75					

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