Biometrical Studies On Genetic Diversity Of Some Upland Rice (*Oryza Sativa* L.) Accessions

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ABSTRACT: Field experiments were conducted in 2005 in the Experimental Farm Station of the University of Agriculture. Makurdi, Nigeria to evaluate the performance and genetic diversity of some upland rice accessions. Preliminary results indicates highly significant ($P<0.01$) differences on all traits studied except for grain length, grain width, grain length/width ratio and 1000 grain weight, indicating genetic diversity among these accessions. Grain yield ranged between 0.54 t/ha (TOX 1870-30-102) and 3.7 t/ha (TOX 1010-21-5-124). Genotypic coefficient of variability (GCV) was generally lower than phenotypic coefficient of variability (PCV). Days to 50% heading, days to maturity, flag leaf area, panicle weight, panicle length, number of branches/panicle, number of seeds/panicle, grain weight/panicle and seed yield showed very low differences between their PVC and GCV values. Also these traits had high estimates for heritability and genetic advance. Genotypic correlation analysis of yield with other traits revealed that yield had a significantly positive correlation with flag leaf area, number of tillers, number of panicles, panicle weight, panicle length, number of branches/panicle, number of seeds/panicle and seed weigh/panicle, grain length and 1000 seed weight. The direct and indirect effect of the rice traits on yield was assessed. The implications of these results for varietal recommendations and crop improvement are highlighted. [Nature and Science. 2009;7(1):21-27]. (ISSN: 1545-0740).

Keywords: Diversity; Coefficient of variability; Heritability; Genetic advance; Correlation; Path coefficient

INTRODUCTION

Rice in Nigeria is the sixth major crop in area cultivated after sorghum, millet, cowpea, cassava and yam (FAO, 1994). It is grown in four major rice growing environment: Upland, rainfed lowland, irrigated lowlands, and deep water. Singh *et al*., 1997. Rainfed upland is the major rice growing ecology in West Africa, accounting for nearly 60% of the total regional rice area. In Nigeria, upland rice comprises around 32% of the total rice area (Singh *et al*. 1997).

Chaudhary and Nanda (1986) estimated 4.6 million ha as potential areas for rice cultivation in Nigeria. The rice area has increased tremendously since 1989. The average annual growth rate from 1983 to 1992 was 14.2% (WARDA 1996) due to ban on importation in 1986. There is still vast potential for increasing the rice area; especially for upland ecologies.

Rice production increased from 0.94 million tonnes to 2.54 million tonnes in 1994 (Singh *et al*., 1997). This increase is however due to mark expansion and not increased productivity per unit area, which remain around 1.5 t/ha.

Rice consumption is on increase, the annual growth rate in rice consumption average 7.7% from 1983 to 1992 (Singh *et al*., 1997). To meet up with this about 0.35 million tonnes valued at 91 million US dollars was imported in 1993 (Singh *et al*, 1997). Local production has not met the demand due to lack of adequate suitable flood plains and unavailability or affordable irrigation facilities to the local farmers, hence limiting lowland rice area expansion in addition to other bio physical constraints. Also human health risk poses important constraints to rapid development of the lowland areas.

Increase in rice production can only be achieved through area expansion and increase yield per unit area by employing high yielding varieties. To sustain local production and rice area expansion the potential of upland rice varieties to fit into the length of growing period, and it's cultivation ease (requiring less land clearance) has to be utilized.

Rice varieties had been evaluated in the country across rainforest and the Sudan Savanna agro-ecological zone (Kehinde *et al*., 1989). Vange *et al*., 1999; 2000, studied lowland rice genotypes in the Southern Guinea Savanna zone. Such evaluation Offers Scientist opportunity to select varieties/lines that are promising for breeding purpose or for on-farm farmers participatory varietal selection (a dual mechanism for obtaining feed back on farmers preferences in new rice varieties) and for technological transfer. These form the objective of this present study.

MATERIALS AND METHODS

Field experiments were conducted during 2005 cropping seasons at the Experimental Farm of the University of Agriculture, Makurdi (7.40^{o}N, 8.37^{o}E, altitude 106.m) Nigeria. Prior to the experimentation, soil analysis of the site was done (83.5% sand, 8.6% silt, 7.7% Clay and Bulk density 1.40 with pH (H_20) 6.19, 13.12% organic matter and 0.09% total N). Total rainfall data during the crop season June, to November, 2005 was 872.70 mm.

Upland rice varieties obtained from International Network for Germplasm Evaluation (INGER) Africa, West Africa Rice Development Association (WARDA) and National Cereal Research Institute (NCRI) Badeggi-Nigeria were laid in a Randomised Complete Block Design in 4 replications with plot size of 12m^2/plot.

The experimental site was ploughed and harrowed twice before seeding. The seeds were broadcasted (farmers most adopted seeding method) at 50kg/ha (60g/plot). Fertilizer was applied at 75Kg N, 60 Kg P and 60 kg K in 3 split doses at 2nd harrowing, 5th week after planting and at panicle initiation with NPK 15:15:15 for the first 2 doses and Urea (46N:0:0) at top dressing. Weeds were controlled manually by weeding at 4 weeks after planting and subsequently as the weeds appear.

The observations were recorded from 5 random plants from each plot. The characters studied were grain yield, panicles/m^2, 1000-grain weight, grain weight/panicle, Total number of panicles branches (both primary and secondary branches), production tillers (%), plant height, days to 50% heading and days to maturity.

All data were subjected to analysis using relevant analysis of variance according to Steel and Torrie (1980), means were separated with List significant Difference (LSD) at P≤0.05.

Genotypic and phenotypic variance was estimated by the formulae suggested by Singh and Chandhary (1977), while broad since heritability was estimated on a replicated plot mean basis according Burton and De Vane (1953). Also genetic and phenotypic coefficient of variability was estimated according to Burton and De Vane (1953). The estimated genetic Advance was estimated using the formula given by Allard (1960) at 50% selection intensity. Path coefficient analysis and genotypic correlation between yield and yield components was computed.

RESULTS AND DISCUSSION

The genotypes showed significant genotypic variation for all traits studied except for grain length, grain width, grain length/width ratio and 1000-grain weight (Table 1). This indicates wide variability among genotypes especially for the traits that are significant thus genetic improvement through selection could be promising. Singh *et al.,* 1986, reported genetic variability in 98 upland rice cultivars they studied with respect to seedling height, days to 50% flowering, culm angle, leaf angle, leaf length, plant height (cm), panicle length (cm), shealth length (cm), tillers/plant, grains/panicle and grain yield (g). Mehetre *et al.*, 1994, reported similar findings on upland rice they studied.

The mean values are presented in Table 2. TOX 1010-21-5-12-4 (TOX 1010) had the highest yield of 3.70t/ha. TOX 1010 also had the highest panicle length, number of panicles/m^2 seed weight/panicle, grain length and grain width with high 1,000-grain weight, and number of seeds/panicle, and panicle weight. Similar trend were obtained for ITA 315, WAB 36-34-FX, ITA 150, and WAB 96-1-1 that had grain yield of 2.67, 2.63, 2.09, 2.08 t/ha respectively.

TOX 1870-30-102 gave the lowest yield of 0.54t/ha, the lowest 1000 grain weight, and generally low seed weight per panicle, panicle weight and panicle length. WARDA (1990) reported avenge yield of 2211kg/ha and 1738kg/ha for WAB-56-104 and WAB 6-125 in their replicated on Station yield trials.

The results of the phenotypic coefficient of variability (PVC) and genotypic coefficient of variability (GCV) revealed that PCV was generally higher than the GCV in the genotypes studied (Table 3). The difference was low for Days to 50% heading, panicle length, no of Branches/Panicle, No of seeds/panicle, and weight of seeds per panicle. Seed yield had a moderate amount of difference between PCV and GCV, while plant height had a considerable high difference between PCV and GCV. These results implies that traits with low difference in PCV and GCV shows that variability is due more to genetic cause. Heritability and Genetic advance estimates was observed to be high for Days to 50% heading, Days to maturity, flag leaf area. Panicle weight, panicle length, No of branches per panicle, no of seeds/panicle, seed weight/panicle at seed yield (Table 3). High heritability coupled with high Genetic

advance observed for these traits indicates a predominance of additive gene effects. Vange and Ojo 1997 reported similar results in lowland rice genotypes.

The results of the path coefficient analysis and genotypic correlation of yield with other traits revealed generally that, the genotypic correlation estimates was positive and significantly correlated with flag leaf area, number of tillers, number of panicles, panicle weight, panicles length number of branches/panicle, number of seeds/panicle, seeds weight/panicle, grain length and 1000 seed weight. Number of tillers (0.30174), number of panicles (0.28615), panicle weight (0.27933), and seed weight per panicle (0.2294) had positive high direct effect on yield while Flag leaf area (0.17938), grain length (0.16251) and 1000 seed weight had direct effect on yield. Number of tillers had high positive indirect effect via number of panicles while panicle weight had indirect effect on yield via panicle length, number of panicle branches, number of seeds per panicle and seed weight per panicle. These traits can serve as indicators in selecting for high yield in the material studied. Ramalingam *et al.* (1993) assert that traits that have high positive correlations, very high direct effects and positive indirect effects on yield through many traits should be emphasised for selecting yield. Panicle length, number of panicle branches, number of seeds per panicle hand negative direct effect on yield. While days to 50% heading, Days to maturity, and productive tillers seem to have limited practical usefulness as indicators for selecting high yield in these genotypes. Chauhan *et al.* (1986), Suarez *et al*. (1989), Vange *et al.* (1999; 2000) reported similar results.

In conclusion: TOX 1010, WAB 36-34-Fx, and WAB 96-1-1 appear promising while Number of tillers, number of panicles, panicle weight, seeds weight/panicle, number of seeds/panicle could be use for indirect selection criteria for grain yield improvement.

Table 1: MEANSQUARES FROM ANALYSIS OF VARIANCE FOR AGRONOMIC TRAITS, YEILD AND YIELD COMPONENTS OF 19 UPLAND RICE GENOTYPES

Sources of Variation	Replications	Genotypes	Error	F pr.
Df	3	18	54	
Days to 50% Heading	45.14	298.79**	8.94	< 0.001
Days to Maturity	47.63	295.87**	9.05	< 0.001
Plant Height (cm)	475.8	219.20**	101.90	< 0.016
Flag Leaf Area (cm^3)	66.64	741.83**	97.10	< 0.001
No. of Tillers/M^2	427.2	1429.6**	357.8	< 0.001
No. of Panicles/M^2	508.3	883.1**	308.5	< 0.001
Productive Tillers (%)	149.09	280.12**	46.28	< 0.001
Panicle Weight (g)	0.715	2.685**	0.424	< 0.001
Panicles Length (cm)	2.74	41.528**	4.235	< 0.001
No. of Branches/Panicle	1.93	38.00**	6.672	< 0.001
No. of Seeds/Panicle	296.7	5623.5**	541.5	< 0.001
Seeds Weight /Panicle (g)	0.497	1.8819**	0.345	< 0.001
Grain Length (mm)	0.27	0.484	0.287	0.072
Grain Width (mm)	0.0695	0.0771	0.107	0.777
Grain Length/Width ratio	0.154	0.1299	0.1932	0.822
1000 Grain Weight (g)	44.11	45.86	31.81	0.150
Seed Yield (t/ha)	0.285	2.903**	0.788	< 0.001

** = significant at P = 0.01

TRAITS, YIELD AND YIELD COMPONENTS

Genotypes	Source	Days to 50% Heading	Days to Maturity	Plant Height (cm)	Flag Leaf Area (cm^2)	No. of Tillers/M^2	No. of Panicles/M^2	Productive Tillers (%)	Panicle Weight (g)	Panicles Length (cm)	No. of Branches/ Panicle	No. of Seeds/Panicle	Seeds Weight /Panicle (g)	Grain Length (mm)	Grain Width (mm)	Grain Length / Width Ratio	1000 Grain Weight (g)	Seed Yield (t/ha)
WAB 96-1-1	NCRI	83	118	89.8	107.6	97.2	88	98	3.4	23.85	13	159	2.45	9.55	3.00	3.18	23.3	2.08
WAB 99-1-1	NCRI	65	100	79.7	60.2	113.6	91	81	2.1	20.35	10	65	1.38	9.05	3.00	3.03	28.0	1.24
WAB 181-11	NCRI	64	99	83.2	51.2	97.2	64	72	2.5	23.28	11	70	1.35	9.40	2.95	3.20	26.4	0.67
WAB 36-34-Fx	NCRI	69	104	102.2	62.3	116.0	104	90	2.9	23.85	14	94	1.70	10.25	3.15	3.53	34.5	2.63
WAB 56-128-Fx	NCRI	66	102	92.4	80.3	109.6	93	86	3.4	27.90	17	148	2.40	9.85	3.00	3.25	25.4	2.22
WAB 56-144-Fx	NCRI	66	100	89.2	59.1	103.6	73	78	2.1	20.00	11	81	1.33	9.45	3.00	3.08	26.3	0.97
WAB 56-21-Fx	NCRI	71	106	87.4	55.7	111.2	91	83	2.6	20.85	12	113	2.03	9.45	3.00	3.15	29.6	1.85
TOX 1010-21-5-12-4	IITA/WARDA	85	120	85.6	81.7	140.0	124	99	3.9	25.95	12	135	2.90	10.10	3.05	3.30	32.3	3.70
ITA 150	IITA/WARDA	65	100	97.9	60.6	124.0	102	83	3.0	24.35	11	120	2.03	9.90	3.00	3.28	29.8	2.09
ITA 315	IITA/WARDA	80	115	76.2	74.1	111.2	96	87	4.2	24.80	18	162	3.00	9.00	3.00	3.05	27.0	2.67
WAB 18-844	NCRI	83	118	76.0	74.5	67.2	65	97	3.4	24.60	14	124	2.53	9.35	3.15	3.08	25.0	1.02
WAB 35-1-Fx2	NCRI	72	107	83.9	48.0	92.2	86	93	1.3	15.55	7	35	0.68	9.55	3.05	3.05	25.3	1.23
WAB 56-1-Fx2	NCRI	70	105	96.8	55.5	90.5	89	98	1.6	15.50	8	53	1.15	9.30	2.90	3.13	28.9	0.63
ITA 337	IITA/WARDA	87	122	86.3	69.0	85.5	80	93	4.0	24.45	18	159	2.86	9.50	3.05	3.10	24.7	1.45
TOX 1870-30-102	IITA/WARDA	76	111	88.9	63.4	96.7	91	96	1.6	20.85	9	74	0.95	9.55	2.85	3.45	19.3	0.54
ITA 343	IITA/WARDA	83	118	89.4	58.3	89.5	90	100	3.1	23.05	12	122	2.43	9.00	3.05	2.95	29.9	1.37
WABIS 675	INGER	81	116	85.2	60.8	82.2	79	96	3.1	24.10	12	127	2.33	9.15	3.50	2.70	26.4	1.12
ITA 143	INGER	85	120	75.8	66.5	66.5	66	98	2.3	19.60	11	95	1.65	9.40	2.90	3.25	27.1	0.65
FARO 43	NCRI	88	123	80.5	59.9	77.7	76	98	2.4	22.40	13	115	1.95	9.25	2.90	3.15	24.7	0.89
$LSD_{(0.05)}$		4.3	4.3	14.4	14.09	27.0	25.1	9.7	0.9	2.94	3.69	33.2	0.84	0.77	0.47	0.63	8.06	1.27
C.V (%)		3.95	2.72	11.66	15.00	19.20	20.3	7.50	23.6	9.20	21.1	21.6	30.18	5.66	10.8	13.9	20.87	58.0

Table 3: GENETIC PARAMETERS FOR 13 TRAITS IN UPLAND RICE GENOTYPES

Traits	Means	Standard Error	Broad Sense Heritability (h^2)	Genotypic Coefficient of Variability	Phenotypic Coefficient of Variability	Genetic Advance as % of mean
Days to 50% Heading	75.61	2.11	0.89	11.26	11.93	21.88
Days to Maturity	110.64	2.13	0.89	7.654	8.122	14.86
Plant Height (cm)	86.63	7.14	0.22	6.251	13.22	6.087
Flag Leaf Area (cm^3)	65.72	6.97	0.62	19.32	24.45	31.44
No. of Tillers/M^2	98.52	13.38	0.43	16.62	25.39	22.4
No. of Panicles/M^2	86.58	12.42	0.32	13.84	24.56	16.07
Productive Tillers (%)	90.74	4.81	0.56	8.426	11.28	12.97
Panicle Weight (g)	2.76	0.46	0.57	27.24	36.04	42.42
Panicles Length (cm)	22.38	1.46	0.69	13.64	16.45	23.31
No. of Branches/Panicle	12.22	1.83	0.54	22.9	31.16	34.67
No. of Seeds/Panicle	107.9	16.45	0.70	33.03	39.45	56.98
Weight of Seeds/Panicle (g)	1.95	0.42	0.53	31.79	43.79	47.54
1000 Grain Weight (g)	27.03	3.99	0.10	6.934	21.99	4.504
Seed Yield (t/ha)	1.53	0.63	0.40	47.53	74.99	62.06

TABLE 4: A PATH COEFFICIENT ANALYSIS† AND GENOTYPIC CORRELATION OF YIELD WITH 10 YIELD RELATED TRAITS

	Flag Leaf Area (cm^3)	No. of Tillers/M^2	No. of Panicles/M^2	Panicle Weight (g)	Panicles Length (cm)	No. of Branches/Panicle	No. of Seeds/Panicle	Seeds Weight /Panicle (g)	Grain Length (mm)	1000 Grain Weight (g)
Flag Leaf Area (cm^3)	**0.17938**	0.022602	0.042513	0.110139	0.099556	0.087896	0.126642	0.109242	0.04054	-0.03319
No. of Tillers/M^2	0.038019	**0.30174**	0.25316	0.067288	0.085091	0.013277	0.028364	0.038924	0.15962	0.153284
No. of Panicles/M^2	0.067818	0.24008	**0.28615**	0.078691	0.070393	0.015452	0.057802	0.072682	0.150229	0.146509
Panicle Weight (g)	0.171509	0.062291	0.076816	**0.27933**	0.238827	0.239386	0.257822	0.270112	0.034637	0.057821
Panicles Length (cm)	-0.08881	-0.04513	-0.03936	-0.13682	**-0.16002**	-0.1245	-0.13106	-0.12706	-0.04609	-0.01472
No. of Branches/Panicle	0.071075	0.006382	0.007833	0.124308	0.112849	**0.14505**	0.123147	0.117926	0.007833	0.002611
No. of Seeds/Panicle	-0.09479	-0.01262	-0.02712	-0.12392	-0.10996	-0.11399	**-0.13426**	-0.12701	-0.00765	0.001477
Seeds Weight /Panicle (g)	0.139759	0.029604	0.05829	0.221917	0.182215	0.186575	0.217098	**0.22949**	0.001836	0.040849
Grain Length (mm)	0.036727	0.085968	0.085318	0.020151	0.046803	0.008776	0.009263	0.0013	**0.16251**	0.057529
1000 Grain Weight (g)	-0.025	0.068661	0.069202	0.027978	0.012435	0.002433	-0.00149	0.024058	0.047847	**0.13516**
Genotypic Correlation with Yield (t/ha)	0.49568*	0.7596**	0.8128**	0.6690*	0.5782**	0.460*	0.5533*	0.6097**	0.55131*	0.54733*

† = Direct (underlined) and indirect effect of rice traits on rice yield.

*, ** = Significant at P = 0.05 and P = 0.01 respectively.

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