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Evaluation of Qualitative and Quantitative Traits and Correlation Coefficient Analysis of Six Upland Rice Varieties

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ABSTRACT

Field experiments were conducted in 2014 and 2015 seasons at the Teaching and Research Farm, Federal University Oye, (Ikole campus) Ekiti State, Nigeria, to determine genetic variability for phenotypic traits (qualitative and quantitative) among six upland rice varieties through estimating heritability of yield and yield components, genetic advance, correlation coefficients of grain yield and yield contributing traits. The experiments were laid out in a Randomized Complete Block Design (RCBD) with three replications. Slight differences were observed between the Phenotypic Coefficient of Variation (PCV) and Genotypic Coefficient of Variation (GCV). Phenotypic variances for the traits under study were higher than genotypic variances in the seasons suggesting that the traits were more responsive to environmental influence. Heritability estimate varied from 9.15% for panicle length to 99% grain yield. In the two years, correlation coefficients showed that number of grains per panicle (r = 0.95, 0.59), panicle weight (r = 0.57, 0.97) had positive and significant correlation with grain yield, while in 2014, grain yield was positive and significantly correlated with number of panicles/plant (r = 0.99) and grain yield was also positive and significantly correlated with 1000-grain weight (r = 0.77) in 2014 respectively. The present study revealed that varieties (NERICA 1, 4 and 8) with the highest number of grains per panicle, highest grain weight, more number of panicles per plant and large panicle size, increase rice yield in upland ecology. The study further revealed that the varieties selected are adaptable and can thrive well in the study area.

Keywords: *Genetic variability, correlation coefficients, upland rice and varieties;*

INTRODUCTION

Rice production in Nigeria ranges from 332, 800 tons to 3,189, 833 from 1975 to 2000 (Akande, 2000). This production level was harvested from 670, 000 to 2, 061, 000 hectares of land from 1985 to 2000 with an average yield (t/ha) of 1.6 tons/ha. (FAO, 2011) and consumption rate keep increasing from 833, 640 tons to 2, 248, 113 tons within 1985 to 2000 (Akande, 2000). Of all the staple crops, rice has risen to a position of preeminence. Since the mid-1970s, rice consumption in Nigeria has risen tremendously, at about 10% per annum due to changing consumer preferences. Domestic production has never been able to meet the demand, leading to considerable import which today stands at about 1,000,000 metric tons yearly. The imports are procured on the world market with Nigeria spending annually over US$300 million on rice imports alone (African Rice, 2013). The demand for rice has been increasing at a much faster rate in Nigeria than in other West African countries since the mid 1970's. For example, during the 1960's Nigeria had the lowest per-capita annual consumption of rice in the sub-region (average of 3 kg). Since then, Nigerian per-capita consumption levels have grown significantly at 7.3% per annum (Akande, 2000). Consequently, per-capita consumption during the 1980's averaged 18kg and reached 22 kg in 1995-1999 (African Rice, 2013). Despite the catching up of per-capita consumption with the rest of West Africa, Nigerian consumption levels still lag the rest of the sub region (34 kg in 1995-1999). Consequently, above average growth rates in

Nigerian per capita rice consumption are likely to continue for some time.

The world food crisis is rising astronomically and various countries, international organizations and development stakeholders globally have responded with pragmatic approaches aimed at curbing the global food imbalance (FAO, 2011). According to Aye and Mungatana (2010), the current food crisis is caused by a web of interconnected forces which involves agriculture. This food imbalance has threatening implications on economic growth and development, social security and cohesion of global food production. Rice is one of the most viable food crops that could stimulate growth in the economy, achieve food sovereignty and redirect agricultural production.

Nigeria is the 17th largest producer of rice in the world, and the second largest producer of rice in Africa, after Egypt (FAO, 2001). Nigeria produces about 0.5% of world rice production on 2,016,000 rice area (ha) of 28,200,000 (ha) arable lands (FAO, 2001; Rice Almanac, 2013). Rice has varied uses with wide genetic variability and able to grow successfully throughout Nigeria (AfricaRice, 2013). The savanna agro-ecology of Nigeria has a great potential for food production because of its average rainfall and high solar radiation that favours rice production. Rice is the only crop that can be grown in any part, from Northern, Western, and Eastern to Southern parts of Nigeria (IRRI, 2012).

Accelerating loss of productive rice land to rising sea levels, salinization, erosion, and human settlements, then these problems become ever more trying circumstances. From 1965-67 through 1989-91, the improvements in productivity spawned by the Green Revolution spread rapidly (Akande, 2000). During those years, total rice production almost doubled. Most of this increase came from increased yields and increased cropping intensity, although some resulted from new land brought under cultivation or shifted into rice from other crops. Much of the yield increase could be traced to the introduction of the dwarfing gene and to the increased use of fertilizer, irrigation water, and other inputs. Further yield increases have been constrained by diminishing returns and have been increasingly difficult to achieve (GRiSP, 2013).

Rice (*Oryza sativa* L.) is one of the most important cereal crops in sub-Sahara Africa and it is one of the world's most widely grown cereal as well as essential food source for millions of the world population.

The savanna agro-ecology of Nigeria has a great potential for food production because of its average rainfall and high solar radiation that favours rice production. Rice species are vast but only *Oryza sativa* and *Oryza glaberrima*, which were originated from Southeast Asia and Niger basin in Africa, respectively, are cultivated. *O. sativa* is extensively cultivated due to its better adaptation to local growing conditions and produces better yield.

Success of crop improvement programme depends on the definition and assembly of the required genetic variations and selection for yield through high heritable traits, excluding the environmental components (Mruthunjaya *et al.*, 1995). The most important traits in rice include plant height, number of tillers/plant, number of days to 50% flowering/heading, number of panicles/plant, number of grains per panicle, panicle length, panicle weight, number of days to maturity, 1000-grain weight and grain yield (t/ha). Various morphological and physiological characters contribute to yield, which is a major objective in breeding. Large amount of genetic variability has been observed to occur in the original accessions and races among sampled population representing different climatic and geographic regions. Different hybrids and inbred lines have also been evaluated for morphological and agronomic traits, showing significant amount of variation among the traits (Roohi, 2002; Usha *et al.*, 2011; Ricepedia, 2014). Each of these component characters has its own genetic systems. Further, these variabilities for yield and yield components are influenced by environmental fluctuations. Therefore, it is necessary to separate the total variations into heritable and non-heritable components with the help of genetic parameters such as genotypic and phenotypic coefficients of variation, heritability and genetic gain.

Correlation measures the degree to which characters vary together or measures the intensity of association within and between them. Improvement in yield as a quantitative trait often requires the improvement of a secondary trait that is positively correlated with yield (Smith *et al.*, 1978). Knowledge of correlation is important in identifying important parameters in any selection programme. Genotypic and phenotypic correlation coefficients tell us the association between and among two or more characters. A significant association suggests that such characters could be improved simultaneously; however, such an improvement depends on phenotypic correlation, additive genetic variance and heritability (Ojo *et al*., 2006). Furthermore, knowledge of the association between yield and its components can improve the efficiency of selection in plant breeding (Izge *et al*., 2006). Traits that are specifically associated with yield may be used as indirect selection criteria to improve yield (Adeyemo and Ojo, 1991).

The objectives of this study are to evaluate the extent of genetic variability for phenotypic traits among six upland rice varieties and determine the character association among yield and its components in the rice varieties.

MATERIALS AND METHODS

Study Area

This experiment was conducted at the Teaching and Research Farm, Federal University Oye, Ekiti State, Nigeria. The place is characterized by tropical climate with an average of eight raining months in a year and atmospheric temperature of 27^0c. It has a gentle undulating elevation of about 1150m -1250m above sea level. The land has long been subjected to cultivation of arable crops such as maize, cassava and cowpea. Total manual clearing of the experimental plot was done followed by minimum soil tillage of the plots. A total of six upland rice varieties including five upland NERICAs (*O. glaberrima x O. sativa*) and one WAB (*O. sativa*) as control variety were collected from AfricaRice Centre, Ibadan, Oyo State, Nigeria. The varieties were (New Rice for Africa (NERICA) - NERICA-U-1, NERICA-U-2, NERICA-U-4, NERICA-U-7, NERICA-U-8 and WAB 56-104.

Experimental Design and Field Layout

The experiment was laid out in a randomized complete block design (RCBD) with three replications in 2014 and 2015 seasons at the Teaching and Research Farm, Federal University Oye, Ekiti state, Nigeria. The experimental area (9.5m × 7m) was measured and marked out. Each plot size was 1m × 1m.

Planting

Two seeds were planted per hill at a spacing of 20 cm within hills and inter row spacing of 20cm, replicated three times. The planting was carried out in the raining season (April) of the two years (2014 and 2015).

Weeding

Pre and early post-emergence herbicide ($\text{Xtra}_{\text{force}}$) with *Atrazine and Metlolachlor* (*a/i*) was used to control weed-seeds and newly germinated weeds two weeks before planting. After planting, manual weeding was carried out at two weekly intervals.

Fertilizer Application

Inorganic fertilizer (Urea) was applied in two split applications, at four weeks (200 kg/ha) to boost tillering and NPK 20:10:10 top dressed at the booting stage (Ten weeks) to enhance grain formation.

Data Collection

Representative plants were tagged in middle rows out of the 30 plants in each plot for the purpose of data collection. Data were collected on each variety for agronomic and yield characters such as:

Number of days to 50% flowering, number of days to maturity, plant height, number of tillers per hill, number of panicles per plant at harvest, panicle length, 1000-grain weight, panicle weight, number of grains per panicle and grain yield (t/ha).

Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) using Minitab (version 17) and significant means were compared by Tukey test at 5% level of probability. Phenotypic and genotypic coefficients of correlation were determined using PB tools.

Component of Variance

Genotypic and phenotypic coefficients of variation were computed according to Singh and Chaudhury (1985) as follows;

Genotypic coefficients of variation (GCV)

$$= \frac{\sqrt{\sigma_g^2}}{\bar{x}} \text{ X } 100$$

Phenotypic coefficient of variation (PCV)

$$= \frac{\sqrt{\sigma_p^2}}{\bar{x}} \text{ X } 100$$

Where: $\sigma^2 g$ = Genotypic variation

$\sigma^2 p$ = Phenotypic variation

$\bar{x}$ = Population mean of the character

Heritability

Broad-sense heritability (H) was calculated as the ratio of the genotypic variance to the phenotypic variance using the formula ccording to Singh and Chaudhury (1985) as follows:

Heritability (H) = $\sigma^2 g / \sigma^2 g + \sigma^2 e X 100$

Where;

C = $\sigma^2 p$ (phenotypic variance), $\sigma^2 p$ = Phenotypic variance, $\sigma^2 g$ = Genotypic variance,

$\sigma^2 e$ = Environmental variation.

Heritability values were categorized as low, moderate and high as indicated by Elrod and Stranfield (2002) as follows; High heritability estimate (≥50%), Moderate heritability estimate (21 – 50%) and Low heritability estimate (0 - 20%).

Genetic Advance (GA) and Expected Genetic Gain (EGG)

Genetic advance was calculated at 5% selection differential (K=2.06) and Expected Genetic gain using the formula given by Singh (1990).

GA = $h^2 x\, k\, x \sqrt{Vp}$

Where:

K = 2.06 (Selection differential at 5%); $\sqrt{Vp}$= square root of phenotypic variance

Expected Genetic Gain was determined from genetic advance (GA) expressed as a percentage of the population mean (µ).

Expected Genetic Gain (G_s) = GA/$\bar{x}$ x100

Where:

$\bar{x}$ = sample mean of the character

Correlation was done according to the formula given by Sharma (1985).

$$r\,(xy) = \frac{Cov\,(x,y)}{\sqrt{\sigma_p^2 x . \sigma_p^2 y}}$$

Where: $r_{(xy)}$ = correlation coefficient between characters x and y; $Cov_{(xy)}$ = Covariance of characters x and y; Var_x = Variance of character x and Var_y = Variance of character y

Test of significance of correlation was done by comparing the computed values against table 'r' values given by Fisher and Yates (1967).

Results and Discussion

The mean squares from analysis of variance for ten observed traits of six upland rice varieties for each year and across the years are presented in Tables 1. It was observed that the rice varieties varied significantly for some traits in the two years. Such traits that varied significantly among varieties include; plant height (66.16), number of days to 50% flowering (75.09), number of days to maturity (44.09), 1000-grain weight (1.58), panicle weight (0.01), number of grains per panicle (278.55), and grain yield (0.02). The highest variation was observed in number of grains/panicle (278.55), which showed that this trait had the highest significant contribution to yield. In the two years, number of grains per panicle and grain yield was also significant in year x variety interaction. The variations in the characters measured on the rice varieties are indicative of the wealth of the population as a source of genes for varietal improvement.

Table1. *Mean squares from analysis of variance (ANOVA) for ten traits of six upland rice varieties evaluated in two years*

Source	DF	Plant Height (cm)	Number of Tiller	Number of Days to 50% flowering	Number of Days to maturity	Number of panicles/plant	Panicles Length (cm)	1000-grain Weight (g)	Panicles Weight(g)	Number of grains/panicle	Grain Yield t/ha
Replicate	2	10.66	0.56**	0.77	4.11	0.11	8.69	0.55	0.00	11.85**	0.00
Year	1	2.40	0.96**	2.25	8.02	0.25	28.44**	3.89**	0.05**	470.89**	0.03**
Variety	5	66.16**	0.10	75.09**	44.09**	0.69	3.71	1.58**	0.01**	278.55**	0.02**
Replicate × Year	2	13.69	0.87**	1.33	2.77	0.00	0.86	0.53	0.01**	10.62*	0.00*
Year × variety	5	0.45	0.04	3.98	4.22	0.25	1.04	0.47	0.00	25.16**	0.00**
Error	20	7.82	0.04	5.08	3.14	0.45	2.71	0.22	0.00	2.34	0.00

**Significant at P≤0.05, **significant at P≤0.01 respectively.*

The ranges, means and standard deviation of the characters of each year are presented in Tables 2. In the two years, plant height ranged from 39 to 111cm, having a mean of 98.73cm. Number of tillers/plant ranged from 0-6 having a mean of 5.67. Plant height and number of tillers/plant had standard deviation of 3.87 and 0.15 respectively. Among the varieties evaluated, the mean number of days to 50% flowering was 92 days. It took about 88 days for minimum number of days to 50% flowering to be achieved while late flowering was achieved 101 days, number of days to maturity also ranged from 125-138 days, having a mean of 129.33 days. Number of days to 50%flowering and number of days to maturity had standard deviation of 4.17 and 3.54 respectively.

Table2. *Ranges, means and standard deviation of ten characters in six upland rice varieties evaluated in two years*

Characters	Ranges	Mean	Standard deviation
Plant height (cm)	39.00 -111.00	98.73	3.87
Number of tillers	0.00-6.00	5.67	0.15
Number of days to 50%flowering	88.00-101.00	92.05	4.17
Number of days to Maturity	125.00-138.00	129.33	3.54
Number of panicles/plant	1.00-5.00	4.44	0.51
Panicle length(cm)	25.27-30.60	27.00	1.41
1000-grain weight (g)	31.70-33.00	32.72	0.47
Panicle weight (g)	2.24-2.48	2.36	0.06
Number of grains/panicle	190.00-208.00	199.84	6.33
Grain yield (t/ha)	1.50-1.70	1.61	0.06

The existence of genetic variation can be employed as the basis for improving yield and other potentials of crop plant (Morakinyo and Makinde, 1991). It is clear from the current study that variations occur among the rice varieties. Unpredictable changes in weather conditions experienced from one year to another necessitates the need to conduct the research in two years to be able to arrive at a logical conclusion with regards to rice varieties selection, especially when experiments are conducted within the same geographical location or site (George Acquaah, 2007).

Table3. *Performances of six upland rice varieties evaluated for ten characters across the two cropping seasons*

Varieties				Characters						
	PH(cm)	NT	ND to50%F	ND to M	NP/P	PL(cm)	1000GW(g)	PaniWT(g)	NG/P	GY(t/ha)
NERICA 1	97.66b	5.37a	89.83c	127.83b	4.50a	25.50a	32.85a	2.43a	201.36a	1.70a
NERICA 2	99.62ab	5.56a	88.83c	127.50b	4.33a	27.00a	33.10a	2.41a	193.86b	1.62b
NERICA 4	99.76ab	5.69a	92.16b	127.67b	4.83a	25.16ab	33.34a	2.34b	202.69a	1.72a
NERICA 7	96.22b	5.58a	91.16b	127.33b	3.83ab	26.33a	33.37a	2.44a	191.38b	1.60b
NERICA 8	95.83b	5.45a	93.00b	128.50b	4.50a	25.66a	33.52a	2.41a	201.93a	1.67b
WAB 56-104	104.88a	5.38a	98.83a	134.33a	4.16a	27.00a	32.11b	2.31b	186.11c	1.54c

**Mean in a column with the same letter(s) are not significantly different according to Tukey test (P=0.05)*

LEGEND: PH = PLANT HEIGHT; NT = NUMBER OF TILLERS; NDto50%F = NUMBER OF DAYS TO 50%FLOWERING; NDtoM = NUMBER OF DAYS TO MATURITY; NP/P = NUMBER OF PANICLES PER PLANT; PL = PANICLE LENGTH; 1000GW = A THOUSAND GRAIN WEIGHT; PaniWT = PANICLE WEIGHT; NG/P = NUMBER OF GRAINS PER PANICLE; GY = GRAIN YIELD (t/ha).

Mean performance of six upland rice varieties in respect of observed traits across years are presented in Table 3. WAB 56-104 had the highest mean plant height in the two years, which significantly had the highest height than other varieties. NERICA-2 and NERICA-4 had higher plant height, significantly higher than NERICA-1, NERICA-7 and NERICA-8 across the years. There were no significant differences between the number of tillers emerged among varieties. NERICA-2 had the earliest day to 50%flowering (88 days); there were no significant differences between the number of days to maturity among the NERICA varieties (127-128 days) while WAB 56-104 had later days of maturity (134.33 days). There were no significant differences between number of panicles/plant. For panicle length, highest panicle length was observed for NERICA-U-2 and WAB 56-104 (27.00) and there were no significant differences. For 1000-grain weight, there were no significant differences among the NERICA-1, NERICA-2, NERICA-7 and NERICA-8 (2.43g, 2.41g, 2.44g and 2.41g) varieties but significantly different from NERICA-4 and the control variety (WAB 56-104). NERICA-1, NERICA-7 and NERICA-8 had the highest panicle weight (2.43g, 2.44g, and 2.41 g) respectively. In the two years, NERICA-1, NERICA-4 and NERICA-8 had the highest number of grain per panicle (201.36, 202.69 and 201.93) respectively, early number of days to maturity (127days) were observed on NERICA varieties used in this experiment and was significantly different from control. Grain yield (t/ha) was highest for NERICA-4 (1.72 t/ha) and higher for NERICA-1 (1.70 t/ha) were significantly different from other NERICA varieties, while WAB 56-104 had the lowest grain yield (1.5 t/ha).

Tables 4 showed estimates of components of variance, heritability, estimates of genetic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), genotypic variance, phenotypic variance and expected genetic gain for ten agronomic characters in six upland rice varieties. In the two cropping years, the GCV ranged from 1.28 for panicle weight, 5.22 for number of tillers per plant, 1.50% for 1000-grain weight and 6.17% for grain yield while PCV ranged from 1.07% for panicle weight to 15.50% for number of panicles per plant. Genotypic variances varied from 0.00 for panicle weight to 49.34 for number of grains per panicle while phenotypic variances varied from 0.00 for panicles weight to 53.16 for number of grains per panicle. Phenotypic variances for the characters under study were more than genotypic variances. The extent of the environment influence on traits is explained by the magnitude of the difference between the values of PCV and GCV. These differences between the PCV and GCV values reflect environmental influence on the expression of traits (Jena, 2010). A similar observation was also made by Kole *et al*. (2008).

Table4. *Estimates of broad sense heritability, genetic advance, genetic gain, genotypic and phenotypic variation across the two years*

S/N	Characters	Variance		GCV (%)	PCV (%)	H (bs) (%)	GA	Gs (%)
		Vg	Vp					
1	Plant height (cm)	8.25	16.80	2.89	4.13	48.90	4.14	4.18
2	Number of tillers	0.04	0.19	5.22	8.00	53.40	0.45	8.04
3	Number of days to 50%flowering	11.63	16.27	3.58	4.34	67.50	5.74	6.23
4	Number of days to maturity	7.12	9.92	1.94	2.40	63.25	4.33	3.35
5	Number of panicles/plant	0.05	0.46	5.04	15.50	10.10	0.14	3.35
6	Panicles length (cm)	0.28	3.37	1.77	6.80	9.15	0.33	1.22
7	1000-grain weight (g)	0.25	0.53	1.50	2.11	62.65	0.78	2.36
8	Panicles weight (g)	0.00	0.00	1.28	1.07	0.00	0.00	0.63
9	Number of grains/panicle	49.34	53.16	3.57	3.71	93.20	13.97	7.12
10	Grain Yield t/ha	0.01	0.01	6.17	6.17	99.99	0.21	12.96

**Vg = genotypic variance, Vp = phenotypic variance, GCV = Genotypic Coefficient of Variability, PCV = Phenotypic Coefficient of Variability, H (bs) = Broad sense heritability, GA = Genetic Advance, Gs = Genetic gain.*

Heritability estimate varied from 9.15% for panicle length to 99.99% for grain yield. However, there were no differences between genotypic variance, phenotypic variances, heritability and genetic advance for panicle weight. There were no differences between genotypic variance, phenotypic variance, GCV, PCV and heritability (H) for grain yield. High heritability estimate (≥50%) were observed for nearly all the characters studied, except for number of panicles per plant (10.10%), panicle weight (0.00%) and panicles length (9.15%). High heritability estimates were accompanied by relatively high genetic advances which were observed in plant height, number of days to flowering, number of day to maturity and number of grains per panicle. These traits reiterate the results of Yadav, 2000; Zahid *et al*., 2006; Kole *et al*., 2008; Khan *et al*., 2009; Akinwale *et al*. 2011 and Sadeghi, 2011, where high to moderate heritability estimates were recorded in different quantitative characters studied in rice for the traits which may facilitate selection.

Genetic advance was relatively high for plant height (4.14), number of days to flowering (5.74), number of days to maturity (4.33) and number of grains per panicle (13.97) while other traits had comparably low values. The highest expected genetic gain (G_s) was 12.96% for grain yield while number of tillers per plant (8.04), number of days to flowering (6.23) and number of grains per panicle (7.12) had higher values. Akinwale *et al*., (2011) suggested that selection for these traits may be under genetic control and selection for them may be achieved through phenotypic appearance. High heritability with low genetic advance observed for number of tillers per plant, 1000-grain weight and grain yield in this experiment indicates non-additive gene effects (Garris *et al*., 2005). Therefore, there seems a limited scope for improvement in this trait. Although, grain yield is a complex trait which is influenced by various environmental factors, biotic or abiotic. It is also interplay of various morphological characters which either favours or worsens the final yield. Since high heritability does not always indicate high genetic gain, heritability with genetic advance considered together should be used in predicting the ultimate effect for selecting superior varieties (Ali *et al*., 2002). These findings are in accordance with the findings of Das *et al*. (2005), Singh *et al*. (2006), Dutt *et al*., (2007) who also observed significant variability for yield and its components in rice.

Phenotypic and genotypic correlation coefficient for the ten characters studied in six upland rice varieties in the two years are presented in Table 5 and 6. Genotypic correlation for the two years showed that, plant height had positive and significant correlation with number of days to flowering and number of days to maturity (r = 0.74, 0.88 and 0.94, 1.00), but was positively and significantly correlated with number of panicles per plant and 1000-grain weight in 2015 only while plant height had negative and significant correlation with number of tillers, number of grains per panicle, panicle weight and grain yield. In comparing table 5 and 6, Close values of genotypic and phenotypic correlations observed between some character combinations in the two cropping years, such as panicle weight (r = 0.57, 0.97 and 0.57, 0.95), number of grains per panicle (r = 0.95, 0.59 and 0.95, 0.49) with grain yield might be due to reduction in error (environmental) variance to minor proportions as reported by Dewey and Lu (1959). Thus selection for higher yield on the basis of the characters would be reliable. Similar findings of close genotypic and phenotypic correlations values were also reported by Rao *et al.* (1997), Prasad *et al.* (2001), Surek and Beser (2003) and Yogamenakshi *et al.* (2004).

Number of tillers had positive and significant correlation with number of grains per panicle in both years (2014 and 2015) and was positively and significantly correlated with grain yield in 2014 only while number of tillers had negative and significant correlation with number of days to 50% flowering and number of days to maturity. Number of days to 50% flowering had positive and significant correlation with number of days to maturity in both years and was positively correlated with 1000-grain weight in 2015 only while number of days to 50% flowering had negative and significant correlation with panicle weight, panicle length, number of grains per panicle and grain yield (r = -0.71).

Number of panicles per plant had positive and significant correlation with number of grains per panicle in both years and significantly correlated with grain yield in 2015 only while number of panicles per plant had negative and significant correlation with panicle length in both years (r = -1.00, -1.00). Number of grains per panicle had positive and significant correlation with grain yield (r = 0.95, 0.59 and 0.95, 0.49) in both years while Panicle weight also had positive and significant correlation with grain yield in both years (r = 0.57, 0.97 and 0.57, 0.95), number of grains per panicle had negative and significant correlation with number of days to maturity, number of panicles per plant, panicle weight and grain yield (r = -0.73, -0.66) and 1000-grain weight had negative and significant correlation with panicle length in both years (r = -1.00, -1.00).

Phenotypic correlation coefficients showed that plant height had positive and significant correlation with number of days to 50% flowering and number of days to maturity in both years (2014 and 2015) while plant height had negative and significant correlation with number of tillers, number of grains per panicle,

panicle weight, and grain yield. Number of days to 50% flowering had positive and significant correlation with number of days to maturity. Number of days to maturity had positive and significant correlation with 1000-grain weight in 2015 only while number of days to 50% flowering had negative and significant correlation with number of panicles per plant, number of grains per panicle, panicle length, panicle weight and grain yield in both years (r = -0.70, -0.35). The result revealed that grain yield showed negative correlation with number of days to 50% flowering and number of days to maturity at both genotypic and phenotypic levels. Similar negative correlation was also reported by Chaudhary and Das (1998) and Shanthi and Singh (2001). The genetic reasons for this type of negative association may be linkage or pleiotropy (one gene influencing two or more seemingly unrelated phenotypic traits). According to Newall and Eberhart (1961) when two characters show negative phenotypic and genotypic correlation it would be difficult to exercise simultaneous selection for these characters in the development of a variety. Hence, under such situations, judicious selection programme might be formulated for simultaneous improvement of such important developmental and component characters.

Table5. *Genotypic correlation (rg) coefficients of ten agronomic traits evaluated in six selected varieties of rice in 2014 and 2015 cropping seasons*

Character	Year(s)	Plant height(cm)	Number of Tillers	Number of Days to 50%flowering	Number of Days to Maturity	Number of panicles per plant	1000-grain weight(g)	Number of grain/panicle	Panicle Length (cm)	Panicle weight (g)	Grain Yield(t/ha)
Plant height (cm)	2014	1									
	2015	1									
Number of Tillers	2014	-1.00	1								
	2015	-0.02	1								
Number of Days to 50% flower	2014	0.74**	-1.00	1							
	2015	0.88**	-1.00	1							
Number of Days to Maturity	2014	0.94**	-1.00	0.92**		1					
	2015	1.00**	-0.81	1.00**		1					
Number of panicles/plant	2014	1.00**	0.00	-1.00	-1.00	1					
	2015	-0.75	0.04	-0.24	-0.77	1					
1000-grain weight (g)	2014	-0.96	1.00	-0.96	-1.00	1.00**	1				
	2015	1.00**	-0.20	0.73**	1.00**	-1.00	1				
Number of grains/panicle	2014	-0.47	1.00**	-0.60	-0.65	1.00**	0.71**	1			
	2015	-0.94	0.94**	-0.43	-0.88	0.53*	-0.90	1			
Panicle length (cm)	2014	1.00	-1.00	-1.00	1.00**	-1.00	-1.00	1.00**	1		
	2015	-1.00	-0.34	-1.00	-1.00	-1.00	-1.00	0.70**	1		
Panicle weight (g)	2014	-0.96	-1.00	-0.71	-0.82	-1.00	0.77**	0.39	-1.00	1	
	2015	-0.79	0.06	-0.47	-0.74	1.00**	-1.00	0.67**	0.74**	1	
Grain Yield (t/ha)	2014	-0.54	1.00**	-0.71	-0.73	-1.00	0.77**	0.95**	-1.00	0.57*	1
	2015	-0.65	0.31	-0.40	-0.66	0.99**	-1.00	0.59**	0.44	0.97**	1

**Significant at P=0.05, **significant at P=0.01*

Table6. *Phenotypic correlation (rp) coefficients of ten agronomic traits evaluated in six selected varieties of rice in 2014 and 2015 cropping seasons*

Character	Year(s)	Plant height(cm)	Number of Tillers	Number of Days to 50%flowering	Number of Days to Maturity	Number of panicles per plant	1000-grain weight(g)	Number of grain/panicle	Panicle Length (cm)	Panicle weight (g)	Grain Yield(t/ha)
Plant height (cm)	2014	1									
	2015	1									
Number of Tillers	2014	-0.31	1								
	2015	-0.06	1								
Number of Days to 50% flower	2014	0.64**	-0.24	1							
	2015	0.71**	-0.42	1							
Number of Days to Maturity	2014	0.78**	-0.43	0.91**	1						
	2015	0.87**	-0.36	0.90**	1						
Number of panicles/plant	2014	0.11	0.16	-0.13	-0.17	1					
	2015	-0.08	0.09	-0.05	-0.22	1					
1000-grain weight (g)	2014	-0.81	0.32	-0.92	-0.98	0.16	1				
	2015	0.57*	-0.05	0.37	0.66**	-0.44	1				
Number of grains/panicle	2014	-0.41	0.38	-0.59	-0.64	0.42	-0.49	1			
	2015	-0.70	0.56*	-0.40	-0.60	0.05	0.27	1			
Panicle length (cm)	2014	0.13	0.54*	-0.10	0.04	0.26	0.38	1.00**	1		
	2015	-0.75	-0.05	-0.80	-0.68	-0.12	0.58*	0.70**	1		
Panicle weight (g)	2014	-0.88	0.14	-0.68	-0.76	-0.16	0.77**	0.39	0.00	1	
	2015	-0.71	0.05	-0.39	-0.61	0.67**	-1.00	0.67**	0.45	1	
Grain Yield (t/ha)	2014	-0.48	0.19	-0.70	-0.71	-0.02	0.77**	0.95**	-0.07	0.57*	1
	2015	-0.53	0.19	-0.35	-0.55	0.84**	-1.00	0.59**	0.28	0.95**	1

**Significant at P=0.05, **significant at P=0.01*

Number of panicles per plant (r = 0.99, 0.84) had positive and significant correlation with grain yield in 2015. 1000-grain weight had positive and significant correlation with number of grains per panicle, panicle weight and grain yield in 2014 only. Number of grains per panicle had positive and significant correlation with panicle weight in 2015 only but had positive and significant correlation with grain yield in both years while panicle weight also had positive and significant correlation with grain yield in both years, meaning that different varieties may respond differently to a specific environment and might be due to high genetic variability for these traits existing in different rice varieties. These findings were in agreement with Yolanda and Das (1995) and Ashvani *et al*. (1997). This result is also supported by George (2007) that number of grains per panicle and grain weight is effective in selecting for yield potentials. Rokonuzzman *et al*. (2008) and Khan *et al*. (2009) also reiterate positive and significant values for number of grains per panicle and grain yield. This indicated that as number of grains per panicle increases, grain yield (t/ha) also increases.

Number of tillers had negative and significant correlation with number of days to 50% flowering and number of days to maturity. Number of days to maturity had negative and significant correlation with number of panicles per plant, number of grains per panicle, panicle weight and grain yield (r = -0.71, -0.55) while 1000-grain weight also had negative and significant correlation with panicle length in 2015 (r = -1.00). Negative correlation among traits indicate retrogressive association between the traits, i.e. increase in a particular trait may lead to a decrease in the other, simultaneous selection may be considered in this case for variety improvement.

Conclusion

It should be noted in the experiments that variation identified between the varieties are important steps in improving rice yield in upland ecology, which was achieved through the expression of the phenotypic traits with the use of broad sense heritability, GCV, PCV, Genetic advance (G_A) and Genetic gain (Gs). Number of grains per panicle had the highest positive and significant correlation coefficients, grain weight also had positive and significant correlation with grain yield, therefore, are the most important traits that should be given attention in making effective selection for high yielding varieties in upland rice breeding programme. The study further revealed that the varieties selected are adaptable and can thrive well in the study area.

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