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Genetic Variability for Some Morphological Traits in Lowland Rice (*Oryza sativa* L.)

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ABSTRACT

The study on genetic variability for some morphological trait in rice enables breeders to be able to select the lines of rice that can be suitable for breeding programs. Different data was collected on growth parameter and yield components. The objective of this study was to determine the genetic variability for some morphological traits and their correlation with yield contributing factors. There are 10 entries that comprised 8 anther cultured derived lines from South Korea and 2 from University of Port Harcourt AGRA germplasm. Experimental design used was Randomized Complete Block Design (RCBD), in three replications. The rice seeds were directly seeded in a poly pot of three seeds per pot and thinned to two after 15 days of emergency, each variety has two poly pots per replication. Significant differences exist among the genotypes for all the morphological traits measured. Genotypes four are earlier than the mean value for days to 50% flowering and days to maturity. The earliest genotype was UPN 234 followed by UPN 268 and the late maturing genotype was UPN 276. Most of the traits measured were significant and positively correlated with other traits and correlation magnitudes ranging from 0.45 to 1.00. Dendrogram showed that WBK114 is different from other rice varieties evaluated, because it is interspecific hybrid (O. sativa and O. glaberrima). This information will assist the breeder in the selection of parent for crop improvement. The early maturing genotypes can be recommended to farmers to grow them because it is possible for the farmers to grow them in three cropping seasons in a year which is of economic importance and livelihood to farmers.

INTRODUCTION

Rice is considered as one of the most important cereal crop after corn and it is grown on over 161.1 million hectares of land, yielding 487.5 metric tons of milled rice worldwide (Statista, 2018). Exploring genetic diversity in available landrace and wild relatives is one of the most important ways to improve the germplasms (Thomson et al., 2007) used in breeding programs. For sustainable breeding programme, clear-cut knowledge on genetic diversity related to yield and yield contributing traits is a vital one. Through systematic test and evaluation of germplasms, plant breeders are trying to exploit superior genetic stock for selection and production of cultivars with high yield potentiality (Salim et al., 2021) as rice cultivation does not solely depends on cultural practices but also relies on inherent genetic variability among the germplasm (Augustina et al., 2013). For enhancement of rice production, determining the best breeding procedures is a must and in this aspect, it is crucial to have morpho-genetic diversity for different yield contributing traits in rice. Presence of wide genetic diversity for yield and its attributes in rice have been reported (Ahmed et al., 2016, Akter et al., 2016 and Akter et al., 2018a,b,c). To ascertain the polygenic relationships within and between species, agro-morphological traits have been widely used to study genetic variability and character association in rice (Akter et al., 2018 a,b,c). The genetics of morpho-physiological traits in segregating populations rice was reported (Efisue et al., 2009) to assist the breeders in crop improvement.

Therefore, it is necessary to determine the association between yield and some of the morphological components that have a great effect on yield. This information on the association is of great importance to breeders in selecting desirable genotypes (Özer et al., 1999; Fukai et al., 1991 and Weng et al., 1982). The objective of this study was to determine the genetic variability for some morphological traits and their correlation with yield contributing factors

MATERIALS AND METHODS

The research was carried out at the University of Port Harcourt Faculty of Agriculture's teaching and research farm in Choba, Rivers State. University of Port Harcourt is located in the southern part of the country along the Niger-Delta coast and lies on latitude 4°31 to 5°00N and longitude 6°45 to 7°00 E, has an estimated annual rainfall of 2000 – 2680 mm and an average temperature of 28 – 30℃ with an elevation of 20 metres above sea level. There are 10 entries that comprised 8 anther cultured derived lines from South Korea and 2 from University of Port Harcourt AGRA germplasm (Table 1). Experimental design used was Randomized Complete Block Design (RCBD), in three replications. The rice seeds were directly seeded in a poly pot of three seeds per pot and thinned to two after 15 days of emergency, each variety has two poly pots per replication. Manual irrigation was applied to maintain soil field capacity. Basal fertilizer was applied at 5g per poly pot of NPK 20:10:10 (200kg/ha) and top-dressed with urea (46% N) 65 kg /ha at 5g per poly pot. Weeds were controlled manually by hand picking throughout the duration of the experiment.

Table 1: Varieties used in this study

S/NO	Variety	Origin/Source
1	WBK 114	Uniport Agra germplasm
2	IR 64	Uniport Agra germplasm
3	UPN 276	Anther culture line (derived from South Korea)
4	UPN 228	Anther culture line (derived from South Korea)
5	UPN 254	Anther culture line (derived from South Korea)
6	UPN 266	Anther culture line (derived from South Korea)
7	UPN 347	Anther culture line (derived from South Korea)
8	UPN 234	Anther culture line (derived from South Korea)
9	UPN 236	Anther culture line (derived from South Korea)
10	UPN 268	Anther culture line (derived from South Korea)

Data Collection

Data was collected at the appropriate time of crop development. The following data were collected at the appropriate phenology. All data measurements were based on the standard evaluation system (SES) for rice reference manual (IRRI, 2013). Data was taken for four weeks after planting and was taken from two plants stand of each variety per pot. Plant height was measured in centimeter from the base to the tip of the highest leaf, leaf length was measured from below the flag leaf to the tip of the highest leaf, and leaf width was measured from the widest leaf. Effective tillers, which is the number of tiller harvested, the number of panicles in each plant. Panicle length of the central tiller of each plant was measured at maturity using a meter rule. The number of grains (seeds) per panicle was taken from the main tiller of each plant and was counted at maturity stage separately after harvesting. Plant biomass was taken, weight of panicle, weight of seeds per 1000g were all taken at maturity.

Data Analysis

The following analysis were carried out, Analysis of variance (ANOVA) using PROC GLM (SAS 2003) for mean separation, correlation analysis and cluster analysis using pair-wise distance matrixes between genotypes, and were again derived using the numerical taxonomy and multivariate analysis system (NTSYS-PC), Version 2.1 (Rohlf, 2000) and the Jaccard coefficient of similarity (Jaccard, 1908). Genetic diversity dendogram for the genotypes was created by unweighted pair group method with arithmetic mean (UPGMA) cluster analysis (Sneath and Sokal, 1973; Swofford and Olsen, 1990).

RESULTS

Evaluation of Growth and Yield Parameters of Selected Rice Genotypes

Table 2 below shows that significant differences exist in the growth parameters of the rice genotypes with exception of number of tillers, but the genotype with the highest number of tillers was UPN276 (14.17±2.05) followed by UPN228 (12.00±3.33), while WBK114 (2.07±0.07) had the least number of tillers. WBK114 produced the highest mean plant height of 93.83±2.17cm while plant height means were UPN228 (87.40±6.97cm), UPN347 (85.50±4.51cm). WBK also dominated leaf area (163.71±7.89cm^2) and leaf area index (8.48±0.41) measurement which was significantly different from other genotypes. UPN228 (109.24±10.47cm^2; 5.66±0.54), UPN276 (87.21±3.95cm^2; 4.52±0.20). Genotype UPN276 had the highest mean number of panicles per plant of 10.33±0.33 and followed by UPN228 (9.67±1.01) and UPN347 (8.50±2.57) (Table 2).

Table 2: Mean Comparison of Growth Parameters Amongst Selected Rice Genotypes

Genotype	No. of Tillers	Plant Height (cm)	Leaf Area (cm2)	Leaf Area Index	Number of Panicle Per Plant	Panicle Length (cm)
UPN254	9.67±1.09^{a}	61.17±8.41^{bc}	65.13±14.29^{cd}	3.37±0.74^{cd}	7.83±0.60^{ab}	21.15±3.38^{a}
UPN347	8.83±4.33^{a}	85.50±4.51^{a}	86.64±1.50^{bc}	4.49±0.08^{bc}	8.50±2.57^{ab}	25.58±1.66^{a}
WBK114	2.07±0.07^{a}	93.83±2.17^{a}	163.71±7.89^{a}	8.48±0.41^{a}	3.00±0.00^{c}	26.27±1.10^{a}
UPN234	7.33±2.33^{a}	47.33±2.67^{c}	29.96±4.28^{d}	1.55±0.22^{d}	6.67±1.67^{abc}	12.56±0.58^{c}
UPN228	12.00±3.33^{a}	87.40±6.97^{a}	109.24±10.47^{b}	5.66±0.54^{b}	9.67±1.01^{ab}	25.24±0.42^{a}
UPN276	14.17±2.05^{a}	78.50±2.47^{ab}	87.21±3.95^{bc}	4.52±0.20^{bc}	10.33±0.33^{a}	23.30±0.86^{a}
UPN268	10.50±0.58^{a}	47.83±1.09^{c}	30.15±3.86^{d}	1.56±0.20^{d}	7.17±1.17^{abc}	12.55±0.80^{c}
UPN236	8.33±3.11^{a}	62.67±12.67^{bc}	72.44±24.50^{c}	3.75±1.27^{c}	5.33±1.59^{bc}	19.74±4.20^{b}
Mean	9.11	70.53	80.56	4.17	7.31	20.8
CV (%)	24.77	27.84	37.41	35.4	30.04	29.38

Means with different alphabet are significantly different at $p \leq 0.05$

There were significant differences observed among the rice genotypes except in the biomass and weight of seed per plant. (Table 3). The UPN234 (83.99±0.74g) had the highest mean value for biomass followed by UPN347 (81.65±1.85g). The highest mean weight of seed per plant were UPN228 (15.97±1.62g) and UPN268 (15.45±4.48g). The highest value of weight of 1000 seeds was WBK114 (21.13±0.62g), followed by UPN 268 (19.70±0.30g). Four genotypes were earlier than the mean value for days to 50% flowering and days to maturity (Table 3). The earliest genotype was UPN 234, followed by UPN 268 and late maturing genotype was UPN 276 (Table 3).

Table 3: Mean Comparison of Yield Components and Flower Parameters Amongst Selected Rice Genotypes

Genotype	Biomass (g)	Weight of Seed Per Plant (g)	Weight of 1000 seeds (g)	Days to 50% flowering	Days to Maturity
UPN254	76.38±2.57^{a}	12.53±1.75^{a}	18.50±0.80^{bc}	45.67±6.71^{bc}	75.67±6.71^{bc}
UPN347	81.65±1.85^{a}	14.26±3.26^{a}	17.87±0.37^{bc}	57.17±10.04^{abc}	87.17±10.04^{abc}
WBK114	69.38±1.66^{a}	7.88±1.66^{a}	21.13±0.62^{a}	51.00±1.00^{abc}	81.00±1.00^{abc}
UPN234	83.99±0.74^{a}	12.25±5.55^{a}	17.97±0.99^{bc}	32.07±9.05^{c}	62.07±9.05^{c}
UPN228	79.80±1.23^{a}	15.97±1.62^{a}	17.87±0.35^{bc}	66.00±3.79^{ab}	96.00±3.79^{ab}
UPN276	77.93±2.91^{a}	14.47±3.00^{a}	18.00±0.25^{bc}	71.67±8.80^{a}	101.67±8.80^{a}
UPN268	73.37±9.16^{a}	15.45±4.48^{a}	19.70±0.30^{ab}	35.17±1.67b^{c}	65.17±1.67^{bc}
UPN236	79.23±3.19^{a}	9.08±2.34^{a}	17.80±0.26^{c}	59.67±13.35^{ab}	89.67±13.35^{ab}
Mean	77.72	12.74	18.6	52.3	82.3
CV (%)	9.14	42.94	7.53	33.77	21.46

Means with different alphabet are significantly different at $p \leq 0.05$

Relationship between Growth and Yield Parameters of Selected Rice Genotype

Most of the traits measured were significant and positively correlated with other traits and had correlation magnitudes ranging from 0.45 to 1.00. Number of tiller was significantly correlated with Weight of Seed per Plant, days to 50% flowering, days to maturity and Number of Panicles per Plant. Significant correlation was also observed between leaf area index and days to 50% flowering, days to maturity and panicle length (Table 4).

Table 4: Correlation Matrix of Relationship between Growth and Yield Parameters of Selected Rice Genotypes

	NT	HT	LA	LAI	BM	WS	DF	DM	NP	PL	WSP 1000
NT											
HT	-0.07										
LA	-0.21	0.86**									
LAI	-0.21	0.86**	1.00**								
BM	0.14	-0.12	-0.32	-0.32							
WS	0.52**	0.1	-0.12	-0.13	0.22						
DF	0.52**	0.50*	0.50*	0.50*	-0.02	0.17					
DM	0.52**	0.50*	0.50*	0.50*	-0.02	0.17	1.00**				
NP	0.88**	0.09	-0.15	-0.15	0.17	0.74**	0.45*	0.45*			
PL	0.07	0.83**	0.85**	0.85**	-0.099	-0.06	0.71**	0.71**	0.1		
WSP1000	-0.38	0.2	0.38	0.38	-0.396	0.05	-0.15	-0.149	-0.39	0.04	

**Correlation significant at 0.01 level, *Correlation significant at 0.05 level; NT = Number of tillers; HT = Plant height; LA = Leaf Area; LAI = Leaf Area Index; BM = Biomass, DF = Days to Flowering; DM = Days to Maturity; NP = Number of Panicles per Plant; PL = Panicle Length; WSP100g = Weight of 1000 Seeds, WS = Weight of Seed per Plant;

Cluster Analysis of Rice Genotypes

Cluster analysis showed three optimal clusters/groupings (A, B and C) of the selected rice genotypes based on the growth and yield parameters measured as shown (Figure 1). Cluster A had two genotypes while cluster B had only WBK 114, which is interspecific hybrid between (*O. sativa* and *O. glaberrima*). The cluster with the highest number of genotypes is cluster C with 7 genotypes, anther-culture derived lines (Figure 1).

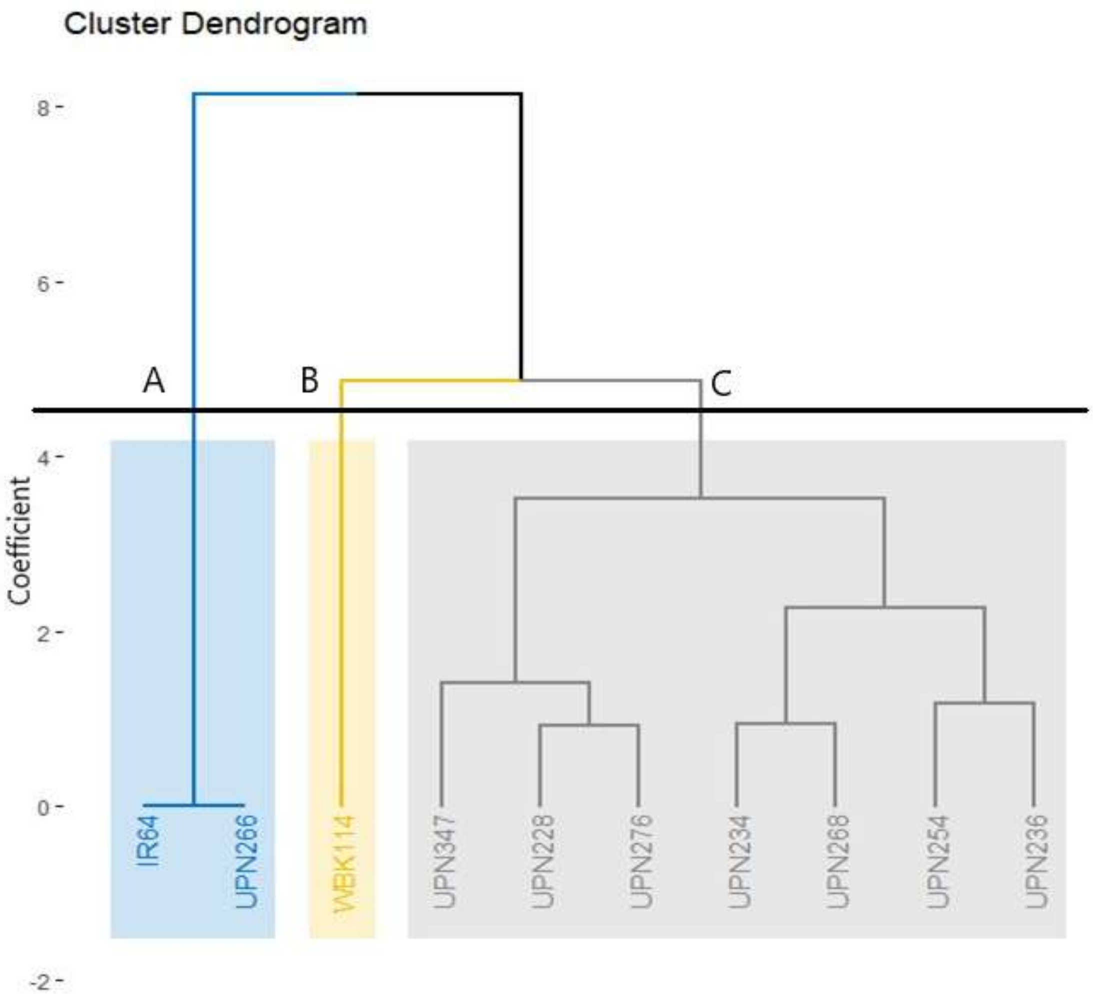

Figure 1: Dendrogram of Selected Rice Genotypes

DISCUSSION

Some of the characteristics that can help increase rice production potential are the number of tillers and plant height. Due to its large impact on panicle number and number of tiller, it is crucial in determining eventual grain production. Grain yield is hampered by insufficient tillers, while too many tillers result in excessive tiller abortion, small panicle size, poor grain filling, and even lower grain yield (Yang *et al*., 2006). Though not significant, result from this study showed a negative relationship between number of tillers and plant height which corroborates with reports (Yang *et al*. 2006).

Panicle number is a crucial factor in determining grain yield, and it was observed that crop management and environmental factors have a significant impact on this key yield component (Garris cia *et al*., 2005). Increasing the number of panicles is often how crop management improvements are realized, which increases yield (Wang *et al*., 2017). This study shows that the number of panicles is strongly and positively correlated with the number of tillers, weight of seeds produced, days to 50% flowering and days to maturity; this corroborate with earlier reports (Efisue et al.,2022). Thus, these lines could be promising based on panicle number per plant UPN276, UPN228, UPN347 and UPN254. Due to current erratic rainfall experienced over the globe, early maturing rice varieties such as UPN 234 and UPN 268 could be introduced to rice farmers, which can be cropped for two cropping seasons.

The leaf area and leaf area index could also determine the efficiency of photosynthetic rate in plant (Quan *et al*., 2017). It is an indication of the carbon dioxide absorption and light intercepting capacity as well as the release of oxygen. Leaf area and leaf area index in this study were significantly and positively correlated with plant height, days to 50% flowering, maturity and panicle length. Leaf area has been reported to increase from vegetative, reproductive to maturity phase of rice development, which accounts for the positive relationship in the growth variables measured in this study. Fagade and Datta (1971) reports the effect of leaf area index on yield components such as increasing spikelet number which is an important component of physical capacity for grain yield. WBK114 had the largest leaf area and leaf area index and could be a promising rice variety.

Dendrogram showed that WBK114 is different from other rice varieties evaluated because it is an interspecific hybrid (*O. sativa* and *O. glaberrima*); this information will assist the breeder in the selection of parent for crop improvement.

CONCLUSION

Rice is a major staple food for the world population and serves as a good source of energy for humans when consumed. The study showed significant difference in morphological traits among the varieties studied, while significant correlations were also observed among the measured traits. Using the traits data from the rice varieties studied, significant differences and correlations were observed between the agronomic traits and yield of the rice varieties. For yield improvement, number of tillers, and number of panicles which had more direct relationship with days to flowering, days to maturity and had indirect correlations with yield component, should be focused on by rice breeders. UPN234 and UPN268 are early maturing varieties and it can be recommended to farmers to grow them because it is possible for the farmers to grow them in three cropping season in a year which is of economic importance and value to the farmers.

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