Genetic Diversity In Yield And Quality Attributes Of Ten Genotypes Of Rice In Nigeria

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Abstract: Ten genotypes of rice (*Oryza sativa* L.) including some lines collected from the farmers fields in Abia, Ebonyi and Imo States of South Eastern, Nigeria, were used for the experiment. The seeds were grown in the early seasons of 2006 and 2007 at the Teaching and Research farms of the Federal University of Technology, Owerri and used for assessing their yield and Physicochemical characteristics. Moderate to high variation was observed for all the characters studied. Number of tillers per stand varied most having a coefficient of variation of 20% followed by percentage fibre (18. 7%) indicating a scope for selection of these traits among the lines evaluated. Conversely, percentage amylose (1.9%), grain length (4. 4%) and percentage protein (5 .4 %), had lower values for coefficient of variation suggesting that the variation were more genetically similar in these attributes. Heritability in the broad sense estimates revealed that grain length had the highest heritability (93. 2%) followed by number of days to anthesis (90 .7%) while number of spikelets/ panicle (32.3%) and number of tillers / stand (49.03%) were the least. The physical characteristics of the grains divided the lines investigated into long slender, long bold and medium bold sizes and shapes. Among the lines however, Mass and Wita 4 combined high numbers of tillers/ stand, high percentage fertile spikelets and high number of seeds per secondary branch of panicle and long slender grains. On the other hand, Sipi 692033 and NERICA 1 had higher percentage protein and amylose with long grains. [Researcher. 2010;2(9):85-90]. (ISSN: 1553-9865).

KEYWORDS: Attributes, Physicochemical traits, Variation, Heritability.

INTRODUCTION:

Rice *(Oryza sativa* L.) is a staple food for billions of people. Muller (1984) reported that one – third of the world population depend on rice for over half their caloric and protein requirements. As the world's population continues to increase unabatedly, malnutrition still poses a serious threat to the survival of the poor in many countries of the world. In sub-Saharan Africa , rice has become the most rapidly growing food source leading to the emergence of Africa as a big rice importer accounting for 32% of global rice imports in 2005 Currently rice production in Africa has been relatively low when compared to its demand. Oryza Market report (2005) indicated that rice production in Nigeria for 2004-2005 farming seasons were 2.3 million metric tones. Increased grain yield with improved seed qualities are criteria for meeting the demand for rice which has been on the increase since the last decade. Diversity in rice varieties will be essential for improvement, poverty alleviation and economic growth. Selection for better seed quality becoming an utmost priority to plant breeders owing to current awareness of nutritional quality of food crops.

Rice quality may be considered from the size, shape and appearance of milling and cooking properties. Khush (1979) indicated that preference for grain size and shape vary from one group of consumers to another. On the other hand, the cooking and eating quality of rice has been reported to be dependent on the amylose content (Juliana, 1972) while protein content is the determinent property for rice nutritional quality. Selection for good seed quality should therefore, be combined with high yield and good eating characteristics. This study was therefore undertaken to evaluate the yield and physicochemical attributes of ten genotypes of rice grown and consumed in Nigeria.

MATERIALS AND METHODS

Rice lines.

The rice lines used for the study were collected as shown in Table 1. They were grown at the Teaching and Research farm of the Federal University of Technology, Owerri at the growing seasons of 2006 and 2007 respectively. The site is located on latitude 5^0 27^1 N and longitude 7^0 02^1 E on an elevation of 55.0m above sea level in the humid tropics of South Eastern Nigeria. The temperature was moderate with high relative humidity and rainfall pattern that is consistent with that in humid tropical zones. The soil is classified as ultisol.

In 2006 planting season, the rice seeds were planted on the 25^{th} June, 2006, in plots of IM X IM within rows. in 3 replications. Fertilizers were applied manually in split - application and at planting as boost application and at booting stage between rows of seedlings at the rate of 80kg N, 40kg P and 30kg K ha $^{-1}$. Furadan granules were applied three weeks after planting (WAP) to check insect and nematode infestations. Weeding was done at 4 weeks intervals and scare-scrows and baits were kept to ward off birds and rodents. Harvesting was done at dough stage when the spikelets had turned golden and the experiment was terminated on 30th November 2006.

The saved seeds of 2006 harvests served as planting materials for 2007 plantings which was done on the 5th of June, 2007. The agronomic practices for 2006 planting were repeated and the experiment was terminated on the 12th of November, 2007.

Ten representative plants of each line were sampled and observations recorded according to Standard Evaluation Systems for measuring rice (1988) for: tillers per stand (T Std^{-1}), days to anthesis (DA), plant height at flowering (Ht at flowering), percentage fertile spikelets (% FS), number of seeds per secondary branch of panicle (Sds Brch^{-1}), number of spikelets per panicle (Spkt pan $^{-1}$) and the weight of 1000 seeds (1000 sd wt).

Table 1: Entry code, Source and habitat of the ten rice lines used for study.

Genotype	Source	Ecological adaptation
Canada	Abakiliki (Ebonyi State)	Upland
Mass	Alayi (Abia State)	Lowland
Sipi 692033	National Cereal Research Institute (NCRI, Umuahia)	Lowland
ITA321	Ihitte Uboma (Imo State)	Upland
Wita 4	“ ”	Lowland
WAB99-1-1	West African Rice Development Association (WARDA, Ibadan)	Upland
ITA 150	NCRI	Upland
WAB189-B-B-B-HB	WARDA, Ibadan	“
NERICA 1	Ihitte Uboma	“
WAB56-50	WARDA ,Ibadan	“

The laboratory analysis was conducted at the Analytical Laboratory of International Institute for Tropical Agriculture (IITA, Ibadan) and the Grain Quality Laboratory of African Rice Centre (Benin). The rough rice was dehulled using Satake rice mill. The milled rice was ground with Cyclone sample mil. The protein was calculated from nitrogen which was determined by the Micro Kjeldahl method. Amylose content was determined by the procedure described by Juliano (1971). Moisture, fat and fibre were determined following AOAC, Washing (1984).

Slide calipers were used to measure the grain length and width of twenty grains of each line and means were recorded. Three classes were obtained from the measurement as >6mm (long), 5-6mm (medium) and < 5mm (short) grains. The ratio of the grain length/width was used to further classify the grains into: Slender (>3), bold (2-3) and round (<2) to determine the size and shape of the rice grains.

The data obtained were statistically analyzed using conventional Analysis of Variance (ANOVA) while the Least significant difference was used to compare the varietal means according to Steel and Torrie (1980). Coefficient of Variations due to the genotypes and their phenotypes were calculated as well as heritability in the broad sense following Burton (1952). These were calculated according as:

$$g\,c\,v = \frac{\sigma g \;X\; 100}{x}$$

$$PCV = \frac{\sigma p}{x} \; x \; 100$$

$$H = \frac{\sigma^2 g \; x \; 100}{\sigma^2 p}$$

Where $\sigma^2 p = (\sigma^2 g + \sigma^2 e)$.

These were calculated to express the variability observed for each character **.**

RESULTS AND DISCUSSION

The pooled character mean, range, phenotypic and genotypic variances for the two seasons 2006 and 2007 are presented in Table 2. The number of spikelets per panicle had the highest phenotypic variance (419.80) followed by plant height at flowering (294.36) and number of days to anthesis (288.63).The number of seeds per secondary branch of panicle had the least phenotypic variance (15.84). On the other hand, number of days to anthesis had the highest genotypic variance (261.77) followed by the plant height at flowering (153.23) and number of spikelets per panicle (135.8) while the number of seeds per secondary branch of panicle had 10.59.

Table 3 shows the results of the physical characteristics of the varieties investigated. The rice varieties fall into two distinct classes of long and medium with slender or bold shapes. Estimates of genotypic and phenotypic coefficients of variation including heritability in the broad sense of both yield and quality traits are presented in Table 4. The genotypic coefficients of variation ranged from 4.87% for number of tillers per stand to 26.2% for numbers of seeds per secondary branch of panicle.

Table 2: Pooled Character Means, Range, Standard Error, Phenotypic And Gentoypic Variances For The Agronomic Characters Evaluated In 2006 And 2007 Growing Reasons.

	Agronomic Characters	**Grand mean of Character**	**Range of Mean**	**Standard Error of Means**	**Phenotypic variance**	**Genotypic Variance**
1	T/std	9.63	4.00 – 28.00	2.23	32.7	22.9
2	DA	81.32	62.00 – 110.00	5.18	288.63	261.76
3	Ht Flwg	97.6	72.67 – 142.5	13.59	294.36	153.23
4	% FS	89.31	72.30-100	5.84	85.65	51.58
5	Sds Brch $^{-1}$	12.42	8.00 – 22	2.29	15.84	10.59
6	Spkts Pan $^{-}$1	99.9	76.00 – 183.0	16.85	419.8	135.8
7	1000 sd. Wt	24.47	18.20 – 33.45	1.96	30.8	26.98

However, the phenotypic coefficient of variation ranged from 10.36% in percentage fertile spikelets to 32.64% in number of seeds per secondary branch of panicle. Heritability estimate was highest in grain length (93.2%) and number of days to anthesis (90.7%). However, this parameter was lowest in number of spikelets per panicle (32.3%) and number of tillers per stand (49.03%). Table 5 shows the pooled genotypic mean, coefficient of variation and least Significant difference for both years.

TBALE 3: PHYSICAL CHARACTERISTICS OF THE RICE GENOTYPES

	Genotype	**Grain Length (mm)**	**Grain Width (mm)**	**Length/Width (mm)**	**Size And Shape Ratio**
1	Canada	5.7	**2.27**		Medium, Bold
2	Mass	6.7	1.9	3.53	Long Slender
3	Sipi 6902 (F-44)	6.8	2.1	3.24	Long Slender
4	ITA 321 (F-53)	5.7	2.43	2.35	Medium Bold
5	Wit 4	6.6	1.83	3.61	Long Slender
6	WB 99 – 1 – 1	6.56	2.33	2.82	Long Bold
7	ITA 150 (F-46)	6.23	2.53	2.46	Long Bold
8	WAB 189 – HB (F-541)	6.53	2.56	2.55	Long Bold
9	NER 1	6.42	2.47	2.6	Long Bold
10	WAB 56 – 50	6.76	2.2	3.07	Long Slender
X		6.4	2.33	2.87	
LSD		0.343	0.210	0.322	
(0.05)	* Long > 6mm Medium 5–6mm Short < 5mm	GL/GW ratio Slender > 3 Bold 2 – 3 Round < 2			

Moderate to high variation was observed among the genotypes for the characters studied. The characters that varied most among the genotypes include number of tillers per stand with coefficient of variation of 20.8% followed by percentage fibre (18.7%) and number of seeds per secondary branch of panicle (18. 5%). Conversely, percentage amylose content varied least (1.9%) followed by grain length (4.4%) and percentage protein content (5.1%). High variability was observed for chemical composition of the grain among the genotypes evaluated. Sipi 692033 had the highest percentage amylose (26.6%) followed by NERICA 1, (26.4%) and Mass (24.6%).

Wita4 had the least percentage amylose (21.1%), ITA 150 had higher percentage protein (9.63%) followed by Sipi 692033 (9.22%) a nd NERICA 1 (9.01%) while WAB189-B-B-B-HB had the lowest (6.24%) and Canada (7.13%).The range of variation exhibited by the genotypes in yield and physicochemical attributes for most of the quantitative characters investigated is a great indication that the characters can readily lend themselves to selection.

Table 4: Estimates Of Genotype And Phenotypic Coefficient Of Variation, Heritabilit For Agronomic And Quality Characters Studied For Both Years.

T/std DA Ht at Flwg %FS Sds brch1- Spkts Pan-1 1000 Sd wt %AC %PC %Fb %Ft $\%H_2$

Estimates	T Std^{-1}	DA (Days)	Ht at Flw((cm)	%FS	Sds $brch^{-1}$	Spkt Pan^{-1}	1000 Sds at (g)	%AC	%PC	%Fb	%Ft	$\%H_2O$	GL (mm)	GW (mm)	GL/GW ratio
Phenotype coefficient of Variation PVC (%)	9.907	20.9	17.6	10.36	32.04	20.5	22.7	12.5	18.4	29.8	12.5	12.9	14.4	20.9	20.5
Genotypic Coefficient of variation (GVC(%)	4.857	19.9	12.7	8.04	26.2	11.7	21.0	11.3	14.9	23.6	10.4	10.11	13.9	19.3	18.6
Heritability (Broad Sense (%)	49.03	90.7	52.1	60.14	66.86	32.34	87.6	82.5	66.5	62.3	69.5	60.8	93.2	85.1	82.2

The little difference between phenotypic and genotypic coefficients of variation values of days to anthesis, 1000 seed weight, percentage amylose and moisture contents as well as grain length, grain width and grain length/ grain width ratio indicate that the variability observed was primarily due to genotypic differences. This is further strengthened by their high heritability values. This agrees with Singh *et al.* (1994) who reported that characters with high heritability are more heritable and suggested that selection of such traits would be useful. On the other hand, environmental factors affected the other characters.

Low coefficient of variation had been reported for percentage amylose content and grain length/width ratio (Chauha *et al*., 1997).The present study made a similar observation (Table 5). Dipti *et al.* (2002) revealed that all slender and bold type rice is known as fine rice. In the present evaluation, four varieties: Mass, Sipi 692033, Wita4 and WAB56-50) had long slender grains. Canada and ITA 321 varieties had medium and bold grains while the remaining varieties had long and bold grains.

Amylose content of rice has been reported to determine the cooking quality of rice (Dipti *et al*., 2002 and Juliano, 1972). Further more, Anonymous (1997) reported that rice having 20-25% amylose gives soft and relatively sticky cooked rice. Thus, all the varieties studies are likely to cook soft and sticky with the exception of Sipi 692033 and NERICA 1 which had 26.6% and 26.4% amylose content respectively.

Table 5: Variation In The Agronomic And Quality Characters Of The Ten Genotypes Studied For The 2006 And 2007 Growing Seasons

S/ No	Genotype	$TStd^{-1}$	DA	HT at flwg	%FS	Sds $Brch^{-1}$	Spkt pan^{-1}	1000 sd wt	%AC	%PC	%Fb	%Ft	$\%H_2O$	GL	GW	GL/GW
1	Canada	5.67	74.83	87.0	92.25	13.83	103.5	21.62	23.05	7.13	0.840	1.627	9.513	5.7	2.27	2.51
2	Mass	18.83	98.83	115.7	88.42	13.00	96.0	21.25	24.59	8.02	0.575	1.478	8.488	6.7	1.90	3.53
3	Sipi6902	7.63	86.50	107.1	85.00	10.17	99.2	21.22	26.6	9.22	1.120	1.767	9.258	6.8	2.1	3.24
4	ITA321	6.33	81.33	99.6	83.25	9.00	89.7	23.65	21.46	8.5	1.101	1.792	9.54	5.7	2.430	2.35
5	Wt4	21.43	101.00	47.5	90.83	12.00	100.0	20.84	21.09	7.51	0.886	1.567	9.075	6.6	1.83	3.61
6	WB99-1-1	5.93	71.00	80.3	80.25	14.00	86.8	22.92	22.81	7.77	0.537	1.568	8.177	6.56	2.33	2.82
7	ITA 150	9.17	86.17	90.7	87.80	9.17	96.0	31.03	22.78	9.63	0.542	1.530	8.478	6.232	2.53	2.46
8	WB189-HB	8.50	71.17	98.5	92.07	12.67	126.3	29.55	21.12	6.24	0.725	1.407	8.132	6.53	2.56	2.55
9	NER I	8.67	68.33	105.8	93.55	17.17	97.7	28.07	26.4	9.01	0.768	1.718	8.537	6.42	2.47	2.6
10	WB56-50	5.17	74.00	93.9	99.62	13.17	103.6	24.50	22.2	8.10 8.07	0.708	1.697	10.302	6.76	2.2	3.07
	Grand Mean	9.63	81.82	97.6	89.31	12.42	99.9	24.47	23.211	8.11 8.10	0.807	1.615	8.95	6.47	2.33	2.87
	CV (%)	20.8	6.4	13.9	6.5	18.5	16.9	8.0	1.9	5.1	18.7	11.8	8.1	4.4	8.1	8.6
	LSD (0.05)	2.62	6.048	15.85	6.818	2.674	19.67	2.281	0.512	0.484	0.185	0.411	0.847	0.343	0.210	.3218

The protein content of rice is a crucial criterion in nutrition quality of rice. The protein content of the varieties evaluated are moderate and agrees with the findings of Kaul *et al*. (1982) and Dutta *et al*. (1998) who reported that protein content of fine grain rice is not very high. The varieties studied were more divergent in their fibre and fat contents and more genetically similar in other traits as they had lower values for coefficients of variation.

Variety Mass and Wita4 combine high number of tillers per stand with high percentage fertile spikelets and high number of seeds per secondary branch of panicle which are indices of high yield with good fine grains. On the other hand, Sipi 692033 and NERICA 1 had higher percentage protein and amylose which are likely to be hard and fluffy on cooking (Anyanwu *et al.*, 2009) will lend themselves as varieties of choice to many Nigerian consumers. The present report is of the opinion that high income earners in Nigeria prefer the long slender grains while the low income group prefer bold grains.

Since the varieties assessed included some high yielding and others with better nutritional and cooking qualities, further studies are suggested as improvement programs to combine these good qualities. More germplasm could also be evaluated since there may be possibilities of getting varieties with high yields and better quality traits.

Table 5: Variation In The Agronomic And Quality Characters Of The Ten Genotypes Studied For The 2006 And 2007 Growing Seasons

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7	ITA 150	9.17	86.17	90.7	87.80	9.17	96.0	31.03	22.78	9.63	.542	1.530	8.478	6.232	2.53	2.46
8	WB189-HB	8.50	71.17	98.5	92.07	12.67	126.3	29.55	21.12	6.242	.725	1.407	8.132	6.53	2.56	2.55
9	NER I	8.67	68.33	105.8	93.55	17.17	97.7	28.07	26.4	9.0170	.768	1.718	8.537	6.42	2.47	2.6
10	WB56-50	5.17	74.00	93.9	99.62	13.17	103.6	24.50	22.2	8.10 8.07	.708	1.697	10.302	6.76	2.2	3.07
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	CV (%)	20.8	6.4	13.9	6.5	18.5	16.9	8.0	1.9	5.1	18.7	11.8	8.1	4.4	8.1	8.6
	LSD (0.05)	2.62	6.048	15.85	6.818	2.674	19.67	2.281	0.512	0.484	0.185	0.411	0.847	0.343	0.210	.3218

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5/1/2010