Electronic Journal of Plant Breeding, 6(1): 269-273 (Mar 2015)
ISSN 0975-928X

Research Note

Genetic Variability Studies for Yield and Yield Components in Rice (*Oryza Sativa L.*)

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(Received: 23 Jun 2014; Accepted:07 Mar 2015)

Abstract
Twenty five rice genotypes were evaluated in randomized block design with three replications to examine the nature and magnitude of variability, heritability and genetic advance. Analysis of variance revealed that differences among the genotypes were significant for all the characters studied. Further, the traits, number of tillers per plant, productive tillers per plant, number of grains per panicle and number of filled grains per panicle showed higher estimates of genotypic and phenotypic co-efficient of variation, while high estimates of heritability were recorded for all the characters under study. High heritability coupled with high genetic advance as per cent of mean was also recorded for number of tillers per plant, productive tillers per plant, number of grains per panicle and number of filled grains per panicle suggesting that these traits were more useful for targetted yield improvement programmes in rice.

Keywords
Rice, Heritability, Genetic Advance, Variance.

Rice is the most important grain and staple food for more than 100 countries of the world and has been referred to as "Global Grain" (Shalini and Tulasi, 2008). India, though being the second largest producer of rice in the world, lags behind in productivity. The rising demand for rice coupled with saturation of cultivable area and low gross domestic production are likely to cause a shortage of the crop in the near future. It is also estimated that by 2025, about 785 million tones of paddy which is 70 per cent more than the current production will be needed to meet the growing demand. According to FAO, the productivity of rice in India is very low (3.21 t/ha) as compared to the average productivity of China (6.35 t/ha) and the world (4.15 t/ha). The low productivity in India is mainly attributed to non- availability of high yielding rice varieties. Rice being staple food of the Indian population, improving its productivity has become crucial.

Development of high yielding rice varieties requires thorough knowledge of existing genetic variability. Further, since the phenotypic expression of a character is the result of interaction between genotype and environment, total variation needs to be partitioned into variance due to genotype (heritable) and variance due to environment (non-heritable) for assessing the true breeding behaviour of the phenotype. Efficiency of selection in plant breeding therefore largely depends upon the amount of heritable variation present in the material. Further, the effective use of genetic variation for crop improvement programme is possible only if it is considered in relation to heritability. High heritability coupled with high genetic advance has been reported to be more useful in predicting the resultant effect of selection for yield and its components. It also helps in determining the environmental influence on expression of characters. In this context, the present investigation was undertaken to study the genetic parameters in rice.

The experiment was conducted during *Kharif* 2013 at College Farm of Agricultural College, Mahanandi with 25 rice genotypes sown in a randomized block design with three replications. Thirty day old seedlings of each genotype were transplanted in a row of 4.0 m length by adopting a spacing of 20 cm between rows and 15 cm between plants within the row. Observations were recorded on five randomly selected plants in each genotype in each replication and the average values were subjected for statistical analysis. Observations were recorded on plant basis for all characters, except days to 50 per cent flowering and days to maturity which were recorded on plot basis. The differences between 25 genotypes for different characters were tested for significance by using Analysis of Variance technique as proposed by Panse and Sukhatme (1961). The genetic parameters, namely, genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), heritability in broad sense (h2) and genetic advance as per cent of mean were estimated by the formulae suggested by Burton and Devane (1952) and Johnson *et al.* (1955).

The analysis of variance (ANOVA) revealed highly significant differences among all the 25 varieties for all the characters (Table 1) indicating the existence of sufficient variation in the experimental material.

The mean performance of rice varieties for different yield and yield components are presented in Table 2. A perusal of these results revealed the varieties, NLR 34449, NLR 40024, RNR 15038 and RNR 15048 to be high yielders. The high grain yield of NLR 34449 (23.57g) noticed in the present investigation is attributed to its high grain number (293.14) and high number of filled grains per panicle (262.27) in addition to relatively higher panicle length. These varieties are therefore identified as promising varieties for extensive commercial cultivation.

The estimates of co-efficient of variation, heritability and genetic advance observed for yield and yield components are presented in Table 3. In general, the phenotypic co-efficient of variation was higher than the genotypic co-efficient of variation indicating the influence of environment towards the total variance. Similar results were found by Mamata Singh *et al.* (2007). Further, high estimates of variability were recorded for productive tillers per plant (GCV=24.30; PCV=24.64) followed by number of tillers per plant (GCV=23.64; PCV=24.04), number of grains per panicle (GCV=20.67; PCV=20.78) and number of filled grains per panicle (GCV=20.57; PCV= 20.24) indicating the existence of wide genetic base among the varieties taken for the study and possibility of genetic improvement through selection for these traits. These results are in conformity with the findings of Bekele *et al.* (2013) for productive tillers per plant. However, moderate estimates of variation were recorded by grain yield per plant (GCV=12.95; PCV=14.04), number of ill-filled grains per panicle (GCV= 12.59; PCV=13.46) and harvest index (GCV=11.07; PCV=11.31). In contrast, low estimates of co-efficient of variation were observed for panicle length (GCV=8.93; PCV=9.54), days to 50 per cent flowering (GCV=5.99; PCV=6.14), plant height (GCV=5.95; PCV=6.67) and days to maturity (GCV=4.58; PCV=4.65) indicating little scope for improvement of these characters through simple selection. Similar findings were reported earlier by Idris and Mohammed (2013).

The efficacy of selection not only depends on the magnitude of variability present in the genotypes but also on the extent of heritability of the desirable character. Johnson *et al.* (1955) suggested that, high heritability coupled with high genetic advance as per cent mean gave better picture for the selection of superior genotypes. Thus heritability values coupled with high genetic advance as per cent mean were reported to be more reliable and useful in predicting the genetic gain under selection rather than heritability estimates alone. In the present investigation, high heritability coupled with high genetic advance as per cent mean were recorded for majority of the characters under study, namely, number of filled grains per panicle (99.40), total number of grains per panicle (98.97), productive tillers per plant (97.25), days to maturity (96.95), number of tillers per plant (96.63), harvest index (95.79), 1000 seed weight (95.48), days to 50 per cent flowering (95.05), number of ill-filled grains per panicle (87.46), panicle length (87.60), grain yield per plant (87.06) and plant height (79.60) indicating minimum influence of environment on these characters. Similar results were also reported by Selvaraj *et al.* (2011).

In conclusion, the results have revealed the potential of NLR 34449, NLR 40024, RNR 15038 and RNR 15048 varieties for extensive commercial cultivation. The results also revealed high variability (GCV), heritability and genetic advance for productive tillers per plant followed by number of tillers per plant, number of grains per panicle and number of filled grains per panicle, indicating a scope for improvement of these traits through simple selection.

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Table 1. Analysis of variance (ANOVA) for yield and yield components in rice

Source of variation	Degrees of freedom	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Number of tillers per plant	Productive tillers per plant	Panicle length (cm)	Number of grains per panicle	Number of ill-filled grains per panicle	Number of filled grains per panicle	1000 Seed weight (g)	Harvest index	Grain yield/ plant (g)
Replications	2	0.89	0.81	17.32	0.26	0.48	0.39	13.59	1.06	11.73	0.12	1.79	1.31
Varieties	24	120.06**	117.72**	137.71**	14.79**	13.94**	15.32**	5894.99**	19.52**	4802.74**	34.77**	65.73**	20.98**
Error	48	2.05	1.22	10.84	0.17	0.13	0.69	20.40	0.89	9.63	0.54	0.95	1.16

*, ** Significant at 0.05 and 0.01 levels, respectively.

Table: 2 Mean performance of rice varieties for yield and yield components

Variety	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Number of tillers/ plant	Productive tillers/ plant	Panicle length (cm)	Number of grains/ panicle	Number of ill-filled grains/ panicle	Number of filled grains/ panicle	1000 Seed weight (g)	Harvest index (%)	Grain yield/ plant (g)
BPT 2295	**129.33**	**158.33**	114.07	8.27	8.13	25.27	241.20	28.53	212.67	14.54	35.93	19.96
BPT 3291	109.67	140.33	109.80	7.60	7.00	22.45	180.20	13.93	166.27	21.65	41.50	18.75
BPT 5204	112.33	143.33	93.20	8.80	8.20	**20.53**	218.94	22.47	196.47	14.37	43.76	18.14
JGL 384	102.33	137.33	104.33	**11.43**	**11.27**	25.57	191.24	21.77	169.47	18.17	44.10	18.56
JGL 1798	96.67	125.67	98.47	11.27	9.20	24.57	192.20	19.80	172.40	15.68	**48.96**	**17.63**
JGL 3855	109.67	140.33	101.60	9.93	9.67	23.20	193.73	22.93	170.80	13.93	39.97	18.58
JGL 11118	93.67	122.33	116.27	11.27	11.12	26.03	231.54	**37.87**	193.67	12.15	42.55	18.67
JGL 11470	112.33	143.67	105.07	7.87	7.33	23.07	281.37	19.47	261.87	14.99	45.31	20.13
JGL 11727	105.67	134.33	101.60	8.87	8.77	**29.30**	233.94	20.07	213.87	17.87	48.69	20.27
JGL 19621	98.67	127.33	108.13	10.07	10.02	28.40	233.30	24.67	208.63	15.54	47.63	21.85
NDLR 7	103.00	137.33	103.10	10.47	10.33	23.63	197.73	14.20	183.53	14.19	38.69	18.63
NDLR 8	103.67	137.33	**87.13**	10.00	9.37	22.13	223.86	17.53	206.33	**11.69**	37.50	19.82
NLR 145	110.33	142.67	118.20	9.33	8.13	23.63	185.07	23.87	161.20	21.10	48.21	18.93
NLR 3042	93.33	134.00	118.27	9.60	9.07	25.33	184.93	12.20	172.73	16.56	43.74	19.65
NLR 3083	110.00	138.33	114.20	8.47	8.33	25.77	242.80	13.47	229.33	20.34	40.25	20.51
NLR 34449	106.00	134.33	118.27	9.40	9.10	26.57	**293.14**	30.87	**262.27**	15.12	47.99	**23.59**
NLR 40024	**89.67**	**117.67**	116.33	**7.40**	**6.87**	25.37	219.07	17.47	201.60	**25.22**	40.50	21.87
RDR 992	101.33	136.67	111.03	9.80	9.33	25.43	171.07	12.67	158.40	17.86	**32.86**	18.32
RGL 2332	112.67	147.33	120.07	9.40	8.27	24.33	**161.00**	**9.80**	**151.20**	22.13	34.84	18.82
RGL 11414	109.00	143.67	**124.53**	9.47	8.47	25.63	182.53	14.73	167.80	22.63	35.93	19.54
RNR 2354	100.33	131.33	115.27	8.67	8.40	24.70	206.46	19.73	186.73	17.02	41.25	19.05
RNR 2458	105.33	134.67	108.20	8.33	8.18	25.30	225.74	22.87	202.87	18.18	40.09	19.37
RNR 6378	109.13	140.67	114.67	8.87	8.60	23.73	190.06	14.13	175.93	16.84	41.89	21.32
RNR 15038	98.33	126.33	113.53	9.93	8.73	26.37	220.40	21.40	199.00	16.58	43.60	22.21
RNR 15048	95.33	126.67	96.47	8.87	8.97	22.17	250.53	18.60	231.93	12.73	43.99	21.96
Mean	**104.71**	**136.08**	**109.27**	**9.34**	**8.83**	**24.74**	**214.08**	**19.80**	**194.28**	**17.08**	**41.99**	**19.85**
S.E.	0.83	0.64	1.90	0.24	0.21	0.48	2.61	0.54	1.79	0.43	0.56	0.62
C.D. (0.05)	2.35	1.81	5.41	0.68	0.60	1.37	7.45	1.54	5.12	1.21	1.61	1.76

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Table: 3 Estimates of variability and genetic parameters for yield and yield components in rice

Character	Mean	Range		Co efficient of variation (%)		Heritability in broad sense (h^2_b)	Genetic Advance as per cent of mean
		Minimum	Maximum	Genotypic (GCV)	Phenotypic (PCV)		
Days to 50 per cent flowering	104.71	89.67	129.33	5.99	6.14	95.05	12.03
Days to maturity	136.08	117.67	158.33	4.58	4.65	96.95	9.29
Plant height (cm)	109.27	87.13	124.53	5.95	6.67	79.60	10.94
Number of tillers/plant	9.34	7.40	11.43	23.64	24.04	96.63	47.86
Productive tillers/plant	8.83	6.87	11.27	24.30	24.64	97.25	49.36
Panicle length (cm)	24.74	20.53	29.30	8.93	9.54	87.60	17.21
Number of grains/panicle	214.08	161.00	293.14	20.67	20.78	98.97	42.36
Number of ill-filled grains/panicle	19.80	9.80	37.87	12.59	13.46	87.46	24.25
Number of filled grains/panicle	194.28	151.20	262.27	20.57	20.64	99.40	42.26
1000 Seed weight (g)	17.08	11.69	25.22	19.78	20.24	95.48	39.81
Harvest index (%)	41.99	32.86	48.96	11.07	11.31	95.79	22.31
Grain yield/plant (g)	19.85	17.63	23.59	12.95	14.04	85.06	24.60