Genetic Variability and Character Association in Rainfed Upland Rice (*Oryza sativa* .L)

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Abstract

A study of genetic variation and interrelationship of grain yield and its component traits in upland direct seeded rice was carried out using thirty six exotic breeding lines. High genotypic coefficient of variation was exhibited for grain yield followed by harvest index and flag leaf length. Grain yield per plant had significant positive correlation with biological yield per plant, harvest index, panicles per plant, plant height, spikelets per panicle, panicle length, test weight, spikelet fertility and flag leaf length. Path analysis revealed that the biological yield was the major contributor of grain yield per plant followed by harvest index and spikelets per panicle. For maximizing the grain yield per plant emphasis should be given in selection of characters such as higher biological yield, harvest index and more number of spikelets per panicle for further crop improvement programmes.

Key words: Genetic Variability, Correlation, Path Analysis, Upland Rice.

Rice is staple food for many Asian countries. In many Asian countries, rice production would be decreased due to drought stress. Plant breeding and introducing drought resistant varieties as well as improve of drought resistance mechanisms will be useful to solve this problem. Grain yield is a complex polygenic quantitative trait, greatly affected by environment. Hence, selection of superior genotypes based on yield as such is not effective. Selection has to be made for the components of grain yield. The systematic breeding program involves the steps like creating genetic variability, practicing selection and utilisation of selected genotypes to evolve promising lines. Estimates of heritability and genetic advance will help in knowing the nature of gene action affecting the concerned trait. Generally, correlation coefficient shows relationships among independent characteristics. However path analysis is necessary to clarify relationships between characteristics deeply because correlation coefficients describe relationships in a simple manner. Path coefficient analysis separates the direct effects from the indirect effects through other related characters by partitioning the correlation coefficient. The present investigation was conducted aiming to assess the range of variability, heritability and genetic advance and association between yield and yield component traits in upland rice.

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Material and Methods

The present experiment was conducted with thirty six diverse genotypes under rainfed upland condition during *kharif* 2011 at Field Experimentation Center, Department of Genetics and Plant Breeding, Sam Higginbottom Institute of Agriculture, Technology and sciences, Allahabad in randomized complete block design. Each entry was sown in five row plots of 5m length with 20 cm inter row space with three replications. Five plants from each replication were selected at random and observations were recorded on 12 characters viz., plant height (cm), panicle length (cm), flag leaf length (cm), flag leaf width (cm), panicles per plant, spikelets per panicle, spikelet fertility (%), biological yield per plant, harvest index, test weight (g), grain yield per plant (g). Days to 50 percent flowering was computed on plot basis. The mean over replication of each character was subjected to statistical analysis. The phenotypic, genotypic coefficient of variability (PCV,GCV), heritability in broad sense and expected genetic advance at 5 percent selection intensity were computed by using formulae suggested by Johnson *et al* (1955)**.** The phenotypic and genotypic correlations were calculated following the method of singh and choudhary (1985) and path coefficient analysis as per method given by Dewey and Lu (1959).

Results and Discussion

Analysis of variance revealed significant differences among the genotypes for all the characters. A wide range of variability was exhibited by most of the traits under study. The results (Table 1) revealed that genotypic coefficient of variation (GCV) and phenotypic coefficient variation (PCV) were high for grain yield per plant followed by harvest index and flag leaf length; moderate for biological yield per plant, spikelets per panicle, plant height, panicles per plant and flag leaf width; and low for

days to 50 per cent flowering, panicle length, test weight and spikelet fertility. Difference between PCV and GCV for the studied characters was very less indicating low sensitivity to environment and consequently greater role of genetic factors influencing the expression of these characters. All characters showed high heritability. The estimates of genetic advance (GA) were highest for spikelets per panicle and plant height. Johnson *et al.* (1955) suggested for a more reliable conclusion, heritability and genetic advance should be considered together. The heritability and genetic advance as per cent of mean was high for harvest index followed by flag leaf length, biological yield per plant, spikelets per panicle and plant height, which indicates the preponderance of additive gene action.

The magnitude of genotypic correlation is higher than the phenotypic correlation indicating that elimination of environmental effects led to strengthen genetic association. The correlation analysis revealed that there is significant and positive association of grain yield with biological yield per plant (rp=0.805** rg=0.803**), harvest index (rp=0.749** ,rg=0.745**), panicles per plant (rp=0.639**, rg=0.761**), plant height (rp=0.6044**, rg=0.6163**), spikelets per panicle (rp=0.561**, rg=0.556**), panicle length (rp=0.462**, rg=0.514**), Test weight (rp=0.470**, rg=0.484**), spikelet fertility (rp=0.402**, rg=0.407**), flag leaf length (rp=0.213*, rg=0.232*) was observed. Several other workers viz., chauhan *et al.*(1993), chaturvedi *et al.*(2008) Reddy *et al.*(2008) and Rangare *et al.*(2012) have also observed positive and significant association between biological yield, harvest index, flag leaf length and plant height with grain yield. Hari *et al.* (2006) Nandan *et al.*(2010) and Rangare *et al.*(2012) also observed positive and significant association of spikelet fertility and number of spikelets per panicle with grain yield. Biological yield per plant had positively significant correlation with plant height, panicles/ plant, spikelets per panicle, test weight, harvest index, spikelet fertility and panicle length. Spikelet fertility had significant and positive association with flag leaf length, harvest index, panicles per plant, plant height and panicle length.

The variable grain yield is a result of interaction between component characters, which are either positively or negatively associated with each other. The path coefficient analysis revealed that biological yield had the maximum direct effect on grain yield, followed by harvest index, spikelets per panicle and panicles per plant (Table-3). Similar results were also observed by chaturvedi *et al.*(2008) and Rangare *et al.*(2012) observed biological yield had maximum direct effect on grain yield. The direct contribution of test weight, panicle length and flag leaf width was positive but of low magnitude. The direct contribution of biological yield to grain yield was supported by indirect effects of panicles per plant, spikelets per panicle, test weight, harvest index and panicle length. Similarly harvest index also contributed to higher grain yield via panicles per plant, spikelets per panicle, panicle length, biological yield per plant and test weight. Based on result of present study on correlation and path analysis, the characters namely, biological yield per plant, harvest index and spikelets per panicle influenced the grain yield per plant either directly or indirectly for higher grain yield potential these characters should be included in the breeding programme of upland rice.

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Table 1: Estimation of Genetic Parameters for 12 yield and yield attributing characters in Rice

Characters	M.S.T d.f=35	Coefficient of variation		h^2(bs) %	GA	GA as % of Mean
		GCV	PCV			
Days to 50% flowering	234.084**	10.04	10.09	99.00	18.074	20.581
Plant Height	584.1398**	17.06	17.17	98.80	28.505	34.925
Flag leaf length	102.2176**	21.19	21.85	94.00	11.534	42.306
Flag leaf width	0.081837**	13.06	13.67	91.30	0.320	25.709
Panicles per plant	2.12972**	16.09	18.56	75.10	1.427	28.724
Panicle length	9.83847**	8.43	9.82	73.80	3.030	14.924
Spikelets per panicle	698.152**	17.43	17.57	98.40	31.086	35.617
Spikelet fertility	68.8990**	5.46	5.58	96.00	9.602	11.024
Biological yield per plant	69.2895**	19.54	20.11	94.50	9.529	39.126
Harvest index	224.660**	23.10	23.76	94.60	17.171	46.277
Test weight	12.3943**	8.76	8.87	97.40	4.115	17.809
Grain yield	29.8666**	32.82	33.32	97.00	6.369	66.581

h^2(bs) (%)= Heritability (bs), VG= Genotypic variance, VP= Phenotypic variance, VE= Environmental variance, GCV= Genotypic coefficient of variance, PCV= phenotypic coefficient variance, GA= Genetic advance, M.S.T= Mean sum of squares due to treatment.

Table 2: Genotypic & Phenotypic correlation of yield attributing traits with grain yield per plant.

S.No	Character		Plant Height	Flag leaf Length	Flag leaf width	Panicles/ Plant	Panicle Length	Spikelet/ Panicle	Spikelet Fertility	Biological Yield/ plant	Harvest Index	Test weight	Grain yield
1	**Days to 50% flowering**	G	-0.1788	-0.1742	0.1273	-0.2952**	-0.2401*	0.1075	-0.2163*	-0.0826	-0.4732**	0.0083	-0.3601**
		P	-0.1772	-0.1698	0.1192	-0.2540**	-0.2085*	0.1042	-0.2115*	-0.0827	-0.4608**	0.0090	-0.3538**
2	**Plant height**	G	**1.0000**	0.4052**	-0.0950	0.2145*	0.6773**	0.6070**	0.3972**	0.5885**	0.5075**	0.2682**	0.6163**
		P	**1.0000**	0.3861**	-0.0902	0.1844	0.5764**	0.5997**	0.3843**	0.5714**	0.4935**	0.2585**	0.6044**
3	**Flag leaf Length**	G		**1.0000**	0.3511**	0.1541	0.3589**	0.1987*	0.4455**	0.2075*	0.2047*	0.0409	0.2320*
		P		**1.0000**	0.3187**	0.1112	0.2932**	0.1865	0.4219**	0.1866	0.1873	0.0504	0.2134*
4	**Flag leaf Width**	G			**1.0000**	-0.2835**	-0.0828	-0.0248	-0.2525**	-0.2615**	-0.1630	0.0060	-0.2714**
		P			**1.0000**	-0.2375*	-0.0707	-0.0196	-0.2455*	-0.2413*	-0.1553	0.0014	-0.2575**
5	**Panicles/Plant**	G				**1.0000**	0.2464*	0.1987*	0.4250**	0.6638**	0.4451**	0.1983*	0.7617**
		P				**1.0000**	0.1460	0.1545	0.3936**	0.5477**	0.3640**	0.1733	0.6393**
6	**Panicle length**	G					**1.0000**	0.5239**	0.3696**	0.2485**	0.6221**	0.1096	0.5142**
		P					**1.0000**	0.4716**	0.2944**	0.2380*	0.5517**	0.0875	0.4622**
7	**Spikelets/ panicle**	G						**1.0000**	-0.0048	0.5359**	0.3755**	0.3117**	0.5566**
		P						**1.0000**	-0.0036	0.5417**	0.3869**	0.3046**	0.5613**
8	**Spikelet Fertility**	G							**1.0000**	0.2508**	0.4180**	0.0271	0.4070**
		P							**1.0000**	0.2519**	0.4114**	0.0290	0.4020**
9	**Biological yield/plant**	G								**1.0000**	0.2232*	0.4755**	0.8035**
		P								**1.0000**	0.2608**	0.4560**	0.8057**
10	**Harvest Index**	G									**1.0000**	0.2988**	0.7452**
		P									**1.0000**	0.2861**	0.7491**
11	**Test weight**	G										**1.0000**	0.4841**
		P										**1.0000**	0.4700**

* & ** represent significant levels at 5% and 1% respectively.

Table 3: Genotypic Path of yield attributing traits with grain yield per plant.

S. No	Character		Days to 50% Flowering	Plant Height	Flag leaf Length	Flag leaf width	Panicles/ Plant	Panicle Length	Spikelets/ Panicle	Spikelet Fertility	Biological Yield/ plant	Harvest Index	Test weight
1	**Days to 50% flowering**	G	**-0.004**	0.0001	0.0001	0.0000	0.0001	0.0001	0.000	0.0001	0.000	0.0002	0.000
		P	**-0.0230**	0.0041	0.0039	-0.0027	0.0059	0.0048	-0.0024	0.0049	0.0019	0.0106	-0.0002
2	**Plant height**	G	0.0363	**-0.2033**	-0.0824	0.0193	-0.0436	-0.1377	-0.1234	-0.0808	-0.1197	-0.1032	-0.0545
		P	0.0087	**-0.0489**	-0.0189	0.0044	-0.0090	-0.0282	-0.0293	-0.0188	-0.0279	-0.0241	-0.0126
3	**Flag leaf length**	G	0.0072	-0.0168	**-0.0416**	-0.0146	-0.0064	-0.0149	-0.0083	-0.0185	-0.0086	-0.0085	-0.0017
		P	0.0029	-0.0067	**-0.0173**	-0.0055	-0.0019	-0.0051	-0.0032	-0.0073	-0.0032	-0.0032	-0.0009
4	**Flag leaf width**	G	0.0060	-0.0045	0.0166	**0.0474**	-0.0134	-0.0039	-0.0012	-0.0120	-0.0124	-0.0077	0.0003
		P	0.0001	0.00	0.0001	**0.0004**	-0.0001	0.000	0.0000	-0.0001	-0.0001	-0.0001	0.0000
5	**Panicles/ Plant**	G	0.0107	-0.0078	-0.0056	0.0103	**-0.0362**	-0.0089	-0.0072	-0.0154	-0.024	-0.0161	-0.0072
		P	-0.0264	0.0191	0.0115	-0.0246	**0.1034**	0.0151	0.0160	0.0407	0.0566	0.0376	0.0179
6	**Panicle length**	G	-0.0198	0.0558	0.0296	-0.0068	0.0203	**0.0824**	0.0432	0.0305	0.0205	0.0513	0.0090
		P	-0.0066	0.0183	0.0093	-0.0022	0.0046	**0.0317**	0.0150	0.0093	0.0075	0.0175	0.0028
7	**Spikelets/ panicle**	G	0.0101	0.0573	0.0188	-0.0023	0.0187	0.0494	**0.0944**	-0.0082	0.0506	0.0354	0.0294
		P	0.0161	0.0929	0.0289	-0.0030	0.0239	0.0730	**0.1548**	-0.0042	0.0839	0.0599	0.0472
8	**Spikelet fertility**	G	0.0530	-0.0974	-0.1092	0.0619	-0.1042	-0.0906	0.000	**-0.2451**	-0.0615	-0.1025	-0.0066
		P	0.0649	-0.1179	-0.1294	0.0753	-0.1207	-0.0903	0.0011	**-0.3068**	-0.0773	-0.1262	-0.0089
9	**Biological yield/ plant**	G	-0.0675	0.4812	0.1696	-0.2138	0.5428	0.2032	0.4382	0.2051	**0.8177**	0.1825	0.3888
		P	-0.0490	0.3388	0.1106	-0.1430	0.3247	0.1411	0.3212	0.1494	**0.5929**	0.1546	0.2704
10	**Harvest index**	G	-0.3157	0.3386	0.1365	-0.1088	0.2969	0.4151	0.2505	0.2788	0.1489	**0.6672**	0.1994
		P	-0.2524	0.2703	0.1026	-0.0850	0.1993	0.3021	0.2119	0.2253	0.1428	**0.5477**	0.1567
11	**Test weight**	G	0.003	0.0091	0.0014	0.0002	0.0067	0.0037	-0.0106	0.0009	0.0161	0.0101	**0.0339**
		P	0.0004	0.0103	0.0020	0.0001	0.0069	0.0035	-0.0122	0.0012	0.0182	0.0114	**0.0400**