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Genetic Variability, Correlation and Path Coefficient Studies for Grain Yield and Other Yield Attributing Traits in Rice *(Oryza Sativa* L.)

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Abstract: **The experiment was conducted with 40 genotypes of rice during *Kharif* 2013 in Randomized Block Design. The data were recorded for 13 quantitative characters to study genetic variability, heritability, genetic advance, correlation and path coefficient. On the basis of mean performance highest grain yield per plant reported in OM-6070 (46.93) genotype followed IR-8070-7-69-1-3-3 (44.55), IR-79228-9-2-3-1 (42.53) and IR-77186-148-3-4-3 (41.30). Analysis of variance revealed significant difference among 40 rice genotypes for all characters indicating the existence of variability. High GCV and PCV were observed for grain yield per plant and biological yield per plant. High heritability coupled with high genetic advance as percent mean for all the character except days to flowering, days to maturity, number of tillers per plant, number of panicle per plant and plant height. Correlation and path-coefficient analysis, concluded that, biological yield per plant and harvest index exhibited maximum positive direct effect on grain yield seems to be primary yield contributing characters and could be relied upon for selection of genotypes to improve genetic yield potential of rice. Hence, utmost importance should be given to these characters during selection for single plant yield improvement.**

Keywords: **Variability, Heritability, Genetic Advance, Correlation Coefficient and Path Coefficient Analysis.**

1. INTRODUCTION

Rice (*Oryza sativa* L.) is the world's largest food crop, providing the caloric needs of millions of people daily. It plays a pivotal role in Indian economy being the staple food for two third of the population. India stands second with 108.0 million tons as China occupies the first place with 144.0 million tons in the world's production table of 479.3 million tons **(USDA. May, 2013).** Rice is also called as the "Grain of Life", because it is not only the staple food for more than 70 per cent of the Indians but also a source of livelihood for about 120-150 million rural households. At the current rate of population growth accelerating at 1.8 per cent, rice requirement by the year 2020 would be around 140 million tons **(Anonymous, 2013).**

Genetic variability for agronomic traits is the key component of breeding programs for broadening the gene pool of rice. Plant breeders commonly select for yield components which indirectly increase yield. Genetic parameters such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are useful in detecting the amount of variability present in the germplasm **Idris *et al*., (2012).**

Since correlation coefficient measures the relationship between two characters and does not indicate relative importance of each factor, this study was conducted to determine the nature of relationship between grain yield and yield components.

Breeding strategy in rice mainly depends upon the degree of associated characters as well as its magnitude and nature of variation **Zahid *et al.*, (2006).**

Path coefficient analysis partitions into direct and indirect matrix presenting correlation in a more meaningful way. The present research study was conducted to find out the genetic variability among different plant traits, direct and indirect contribution of these parameters towards paddy yield and to identify better combinations as selection criteria for developing high yielding fine rice genotypes.

2. MATERIALS AND METHODS

The present experiment was carried out at experimentation centre of the Department of Genetics and Plant Breeding, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The experimental material was planted in three blocks. Each block consisted of forty genotypes randomized and replicated within each block. Twenty seven days old seedlings were transplanted 20 cm apart between rows and 15 cm within the row. All necessary precautions were taken to maintain uniform plant population in each treatment per replication. All the recommended package of practices was followed along with necessary prophylactic plant protection measures to raise a good crop. Observations were recorded and the data was subjected to statistical analysis. The variability was estimated as per procedure for analysis of variance suggested by **Panse and Sukhatme (1985)** PCV and GCV were calculated by the formula given by **Burton (1952)** heritability in broad sense (h^2) by **Burton and De Vane (1953)** and genetic advance i.e. the expected genetic gain were calculated by using the procedure given by **Johnson *et al.* (1955).** Correlation coefficient and path coefficient was worked out as method suggested by **Al Jibouri *et al.*, (1958), Deway and Lu (1959)** respectively.

3. RESULTS AND DISCUSSION

The analysis of variance showed highly significant differences among the various genotypes for the characters under study. This indicated that the genotypes were possessing inherent genetic variances among themselves with respect to the characters studied (Table 1) **Bekele *et al.*, (2013).** On the basis of mean performance highest grain yield per plant was exhibited by the genotypes OM-6070 (46.93) genotype followed IR-8070-7-69-1-3-3 (44.55), IR-82019-54-1-2 (40.33), IR-79228-9-2-3-1 (42.53), and IR-77186-148-3-4-3 (41.30). Maximum genotypic coefficient of variance (GCV) and phenotypic coefficient variance (PCV) was observed for grain yield per plant and biological yield per plant indicating that these characters could be used as selection for crop improvement. Similar findings were reported by **Singh *et al.*, (2002), Vivek *et al.*, (2004), Singh *et al.*, (2005) and Sreeparvathy *et al.*, (2010)**. High heritability were observed for all the characters except number of tillers per plant and number of panicle per plant. Similar results were also reported by **Warakad *et al.*, (2013).** High genetic advance were observed for number of spikelets per panicle. Similar results were also reported by **Nayak *et al.*, (2002) and Singh *et al.*, (2011)**. Genetic advance as percent of mean was observed on grain yield per plant, biological yield per plant, flag leaf length, number of spikelets per panicle, harvest index, test weight, flag leaf width and panicle length. Similar results were also reported by **Dhanwani *et al.*, (2013).** High heritability coupled with high genetic advance as percent mean were observed for grain yield per plant, biological yield per plant, flag leaf length & width, number of spikelets per panicle, harvesting index and test weight (Table 2). Similar results were also reported by **Singh *et al.*, (2013).**

Correlation studies revealed that grain yield per plant at genotypic and phenotypic level was positively significant correlated with biological yield per plant, harvest index, flag leaf width, test weight, number of spikelets per panicle and plant height (Table 3). A similar result was also reported by **Sarkar (2006)** and **Sharifi *et al.*, (2013).**

Path coefficient revealed that number of tillers per plant, biological yield per plant, harvest index, days to 50 percent flowering, panicle length and plant height had positive direct effect on yield both at the phenotypic and genotypic levels (Table 4 & 5). A similar result was also reported by **Reddy *et al.*, (2013), Ishwar *et al.*, (2012)** and **Neha and Lal (2012)**. These traits contributed maximum to higher grain yield compared to other characters, thus, selection for these characters helps in selection of superior fine rice genotypes.

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4. CONCLUSION

The present investigation concluded that among the 40 genotypes of rice on the basis of mean performances OM- 6070 genotype was found to be superior in grain yield. High heritability coupled with high genetic advance as percent of mean was registered for number of spikelet's, biological yields, flag leaf length, test weight, harvest index, grain yields per plant, flag leaf width and panicle length. Based on the studies on correlation and path coefficient analysis, it may be concluded that, biological yield per plant and harvest index exhibited maximum positive direct effect on grain yield seems to be primary yield contributing characters and could be relied upon for selection of genotypes to improve genetic yield potential of rice. Hence, utmost importance should be given to these characters during selection for single plant yield improvement. Similar results had been reported by **Ekka *et al.*, (2011).** Selection of plants on the basis of these traits would certainly lead to improvement in grain yield.

Table 1. Analysis of variance for 13 characters among 40 genotypes of rice

S. No	Characters	Mean Sum of Squares		
		Replication(d. f. =02)	Treatments(d. f. =39)	Error(d. f. =78)
1	Days to 50% Flowering	0.0583	46.95**	2.1694
2	Plant height	17.3797	321.63**	4.7721
3	Flag leaf length	1.8975	144.32**	1.6431
4	Flag leaf width	0.0122	0.11**	0.0045
5	Number of tillers / plant	3.3083	8.56**	1.6738
6	Number of panicles / plant	2.5603	8.46**	1.9381
7	Panicle length	1.5426	34.26**	1.4026
8	Number of spikelets / panicle	46.0343	3072.39**	16.2795
9	Days to maturity	7.3583	58.71**	2.4267
10	Biological yield per plant	40.4424	634.89**	25.1835
11	Harvest index	6.7483	209.49**	7.1983
12	Test weight	0.7139	34.22**	0.3712
13	Grain yield per plant	4.8250	179.76**	6.9718

*** Significant at 1% level of significance respectively.*

Table 2: Estimates of components of variance and genetic parameters for different characters in rice

S. No.	Characters	Mean	Range		GCV	PCV	H^2	G.A.	G.A. as % of Mean
			Lowest	Highest					
1	Days to 50%Flowering	89.85	77.33	100.33	4.30	4.60	87.30	7.44	8.28
2	Plant height	108.37	87.25	136.13	9.48	9.70	95.68	20.71	19.11
3	Flag leaf length	108.37	26.79	59.71	19.13	19.45	96.66	13.97	38.74
4	Flag leaf width	108.37	1.16	1.98	13.53	14.36	80.0	0.37	26.28
5	No of tillers per plant	108.37	13.20	21.46	8.34	10.96	57.93	2.38	13.07
6	No of panicle per plant	108.37	11.33	18.93	9.09	12.51	52.80	2.21	13.62
7	Panicle length	108.37	21.52	33.05	12.24	13.00	88.59	6.42	23.74
8	No. of spikelet's per panicle	108.37	117.06	272.13	18.83	18.98	98.42	65.23	38.49
9	Days to maturity	108.37	102.66	130.33	3.60	3.83	88.53	8.40	6.98
10	Biological yield per plant	108.37	34.53	95.00	21.22	22.49	88.98	27.70	41.23
11	Harvest index	108.37	33.66	78.13	17.84	18.76	90.35	16.08	34.93
12	Test weight	108.37	14.93	28.50	15.18	15.42	96.74	6.81	30.76
13	Grain yield per plant	108.37	17.86	46.93	24.86	26.32	89.20	14.77	48.36

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VG= Genotypic Variance, VP=Phenotypic Variance, GCV=Genotypic Coefficient of Variation, PCV=Phenotypic Coefficient of Variation, h^2 (bs)= Heritability (broad sense), GA= Genetic Advance.

Table 3. Estimates of Genotypic and Phenotypic Correlation coefficient between yield and its related traits in 40 rice genotypes

No.	Character		Plant height (cm)	Flag leaf length (cm)	Flag leaf width (cm)	No. tillers per plant	No. panicles per plant	Panicle length (cm)	Spikelets per panicle	Days to Maturity	Biological yield per plant (g)	Harvest Index %	Test Weight	Grain yield per plant (g)
1	Days to 50 % flowering	G	0.0865	-0.1418	0.2432**	-0.2554***	-0.2593***	-0.3864***	0.4610***	0.8447***	-0.1743	-0.0736	-0.0618	-0.2108*
		P	0.0848	-0.1289	0.1989*	-0.1515	-0.1607	-0.3244***	0.4276***	0.7510***	-0.1645	-0.0645	-0.0670	-0.1645
2	Plant height (cm)	G		-0.0460	0.3056***	-0.2894***	-0.2921***	0.0607	0.2906***	0.2483**	0.1661	0.0841	0.0260	0.2008*
		P		-0.0409	0.2783***	-0.2109*	-0.1967*	0.0652	0.2897***	0.2176*	0.1964*	0.0830	0.0271	0.1946*
3	Flag leaf length (cm)	G			-0.0358	0.1479	0.1185	0.5230***	-0.3510***	-0.2507**	-0.1938*	0.3008***	0.2557***	0.0181
		P			-0.0156	0.1201	0.1049	0.4807***	-0.3395***	-0.2363**	0.0280	0.2832**	0.2536**	0.0280
4	Flag leaf width (cm)	G				-0.2299*	-0.2410**	0.0723	0.5965***	0.3344***	0.3569***	0.0822	0.2147*	0.3580***
		P				-0.1295	-0.1230	0.0527	0.5596***	0.3052***	0.3209***	0.0686	0.2038*	0.3209***
5	No. tillers per plant	G					0.9890***	0.0433	-0.4281***	-0.3042***	0.1135	-0.2984***	0.0779	-0.0584
		P					0.9662***	0.0320	-0.3038***	-0.1882*	-0.0211	-0.2260*	0.0794	-0.0211
6	No. panicles per plant	G						0.0077	-0.4270***	-0.3538***	0.2119*	-0.3655***	0.0965	-0.0071
		P						-0.0048	-0.2786**	-0.2156*	0.0210	-0.2608**	0.0923	0.0210
7	Panicle length (cm)	G							-0.4824***	-0.3583***	-0.1615	0.2299*	0.2354**	0.0212
		P							-0.4536***	-0.3139***	0.0333	0.2334*	0.2156*	0.0333
8	Spikelets per panicle	G								0.5819***	0.2075*	0.1209	-0.0347	0.2269*
		P								0.5420***	0.1946*	0.1135	-0.0287	0.2152*
9	Days to maturity	G									-0.0612	0.1086	-0.0855	0.0075
		P									0.0017	0.0869	-0.0846	0.0017
10	Biological yield per plant (g)	G										-0.2046*	0.3735***	0.7847***
		P										0.4388***	0.3132***	0.7698***
11	Harvest index %	G											-0.0537	0.4372***
		P											-0.0523	0.4388***
12	Test weight	G												0.3308***
		P												0.3132***

Table 4: Direct and indirect effects between yield and its related traits in 40 rice genotypes at genotypic level.

No	Character	Days to 50 % Flowering	Plant Height	Flag Leaf Length	Flag Leaf Width	Tillers / Plant	Panicles/ Plant	Panicle Length	Spikelets/ Panicle	Days to Maturity	Biological Yields	Harvest Index	Test Weight
1	Days to 50 % flowering	**0.2457**	0.0213	-0.0348	0.0598	-0.0628	-0.0637	-0.0949	0.1133	0.2076	-0.0428	-0.0181	-0.0152
2	Plant height	0.0012	**0.0144**	-0.0007	0.0044	-0.0042	-0.0042	0.0009	0.0042	0.0036	0.0024	0.0012	0.0004
3	Flag leaf length	0.0056	0.0018	**-0.0393**	0.0014	-0.0058	-0.0047	-0.0205	0.0138	0.0098	0.0076	-0.0118	-0.0100
4	Flag leaf width	-0.0225	-0.0280	0.0033	**-0.0924**	0.0212	0.0223	-0.0067	-0.0551	-0.0309	-0.0330	-0.0076	-0.0198
5	No. of tillers/plant	-0.2937	-0.3328	0.1701	-0.2644	**1.1500**	1.1374	0.0498	-0.4923	-0.3498	0.1305	-0.3432	0.0896
6	Panicles/ plant	0.3066	0.3455	-0.1401	0.2850	-1.1698	**-1.1828**	-0.0091	0.5050	0.4185	-0.2507	0.4323	-0.1141
7	Panicle Length	-0.0204	0.0032	0.0276	0.0038	0.0023	0.0004	**0.0527**	-0.0254	-0.0189	-0.0085	0.0121	0.0124
8	Spikelets/ Panicle	-0.0026	-0.0016	0.0020	-0.0033	0.0024	0.0024	0.0027	**-0.0056**	-0.0033	-0.0012	-0.0007	0.0002
9	Days to Maturity	-0.1945	-0.0572	0.0577	-0.0770	0.0700	0.0815	0.0825	-0.1340	**-0.2302**	0.0141	-0.0250	0.0197
10	Biological Yields	-0.1911	0.1822	-0.2126	0.3914	0.1244	0.2324	-0.1772	0.2275	-0.0671	**1.0967**	-0.2244	0.4097
11	Harvest Index	-0.0458	0.0523	0.1871	0.0511	-0.1856	-0.2273	0.1430	0.0752	0.0676	-0.1273	**0.6219**	-0.0334
12	Test Weight	0.0005	-0.0002	-0.0022	-0.0018	-0.0007	-0.0008	-0.0020	0.0003	0.0007	-0.0032	0.0005	**-0.0085**
13	Grain Yields	**-0.2108**	**0.2008**	**0.0181**	**0.3580**	**-0.0584**	**-0.0071**	**0.0212**	**0.2269**	**0.0075**	**0.7847**	**0.4372**	**0.3308**
14	Partial R^2	-0.0518	0.0029	-0.0007	-0.0331	-0.0671	0.0085	0.0011	-0.0013	-0.0017	0.8607	0.2719	-0.0028

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Table 5: **Direct and indirect effects between yield and its related traits in 40 rice genotypes at phenotypic level.**

No	Character	Days to 50 % Flowering	Plant Height	Flag Leaf Length	Flag Leaf Width	Tillers / plant	Panicles/ Plant	Panicle Length	Spikelets/ Panicle	Days to Maturity	Biological Yields	Harvest Index	Test Weight
1	Days to 50 % Flowering	**0.0207**	0.0018	-0.0027	0.0041	-0.0031	-0.0033	-0.0067	0.0088	0.0155	-0.0028	-0.0013	-0.0014
2	Plant Height	0.0018	**0.0207**	-0.0008	0.0058	-0.0044	-0.0041	0.0014	0.0060	0.0045	0.0032	0.0017	0.0006
3	Flag Leaf Length	0.0030	0.0010	**-0.0235**	0.0004	-0.0028	-0.0025	-0.0113	0.0080	0.0055	0.0042	-0.0067	-0.0060
4	Flag Leaf Width	0.0017	0.0024	-0.0001	**0.0087**	-0.0011	-0.0011	0.0005	0.0049	0.0027	0.0028	0.0006	0.0018
5	Tillers / Plant	0.0033	0.0045	-0.0026	0.0028	**-0.0216**	-0.0208	-0.0007	0.0065	0.0041	-0.0018	0.0049	-0.0017
6	Panicles/Plant	-0.0108	-0.0132	0.0071	-0.0083	0.0651	**0.0673**	-0.0003	-0.0188	-0.0145	0.0105	-0.0176	0.0062
7	Panicle Length	0.0019	-0.0004	-0.0028	-0.0003	-0.0002	0.0000	**-0.0057**	0.0026	0.0018	0.0008	-0.0013	-0.0012
8	Spikelets/ Panicle	-0.0167	-0.0113	0.0132	-0.0218	0.0119	0.0109	0.0177	**-0.0390**	-0.0211	-0.0076	-0.0044	0.0011
9	Days to Maturity	-0.0083	-0.0024	0.0026	-0.0034	0.0021	0.0024	0.0034	-0.0060	**-0.0110**	0.0005	-0.0010	0.0009
10	Biological Yields	-0.1167	0.1369	-0.1557	0.2800	0.0750	0.1359	-0.1244	0.1703	-0.0380	**0.8753**	-0.1773	0.3030
11	Harvest Index	-0.0415	0.0534	0.1822	0.0441	-0.1454	-0.1678	0.1502	0.0730	0.0559	-0.1303	**0.6434**	-0.0337
12	Test Weight	-0.0029	0.0012	0.0110	0.0089	0.0035	0.0040	0.0094	-0.0012	-0.0037	0.0151	-0.0023	**0.0435**
13	Grain Yields	**-0.1645**	**0.1946**	**0.0280**	**0.3209**	**-0.0211**	**0.0210**	**0.0333**	**0.2152**	**0.0017**	**0.7698**	**0.4388**	**0.3132**
14	Partial R^2	-0.0034	0.0040	-0.0007	0.0028	0.0005	0.0014	-0.0002	-0.0084	0.0000	0.6739	0.2824	0.0136

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