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Genetic Variability Studies in Segregating Generation for Yield and Component Traits in Rice (*Oryza sativa* L.)

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ABSTRACT

Rice is the premier staple food among the Indian population. Therefore, a better insight to the association of yield with its component traits can be helpful in improving the paddy yield. The present study comprised of F_3 segregating progenies of two cross viz., Cross I (IR-28 x GAR-13) and Cross II (GR-7 x GAR-13) of rice were evaluated to assess the genetic variability, heritability and genetic advance, correlation and direct and indirect effects among yield and yield components. The progenies were evaluated during Summer-2016. The results corresponding to analysis of variance showed significant progeny mean square values for all the traits for all the F_3 progenies studied. The progenies of the both crosses had higher values of GCV and PCV for grain yield per plant and straw yield per plant indicating that there is great scope for improvement by applying selection on these traits in desirable direction. The progenies of both the crosses had high heritability coupled with high genetic advance as percent mean for grain yield per plant and straw yield per plant was observed. The correlation studies revealed that in both crosses panicle length, straw yield per plant and harvest index showed significant positive correlation with grain yield per plant. Path analysis revealed that straw yield per plant and harvest index had high positive direct effect on grain yield per plant.

Key words: *Rice (Oryza sativa L.), Genetic variability, Heritability and Genetic advance, Correlation and Path coefficient*

INTRODUCTION

Rice (*Oryza sativa* L., 2n=24) belongs to family Poaceae and subfamily Oryzoidae. It is believed to be originated in South East Asia. Rice, the world's most important cereal crop, is the primary source of food and calories for about half of the mankind[6]. "Rice is life" was the famous theme of International Year of Rice, 2004 denoting it's over whelming importance as an item of food and commerce. Besides being the chief source of carbohydrate and protein, it also provides minerals and dietary fiber[17]. It is also a good source of thiamine, riboflavin and niacin.

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Rice constitutes about 42 per cent of the total food grain production and 45 per cent of total cereal production of our country. In India, it is grown in 44.10 million hectares in diverse ecological conditions with an annual production of 105.5 million tonnes and productivity of 2391 kg/ha[1]. In Gujarat, rice is cultivated on an area of 7.88 lakh hectares with total production of 16.36 lakh tonnes and productivity about 2076 kg/ha.

Genetic variability for economic traits is pre-requisite for any successful breeding programme. Rice is a self pollinated crop, the efforts of the breeder to evolve better yielding genotypes is mainly aimed at exercising selection in segregating generation. The selection within a segregating generation partly may fulfill the objective in improving polygenic character like yield. Generally direct selection for yield is not effective due to its low heritability; hence it is desirable to adopt indirect selection of component traits for yield improvements. The estimates of variability, heritabi1ity and genetic advance for the yield components and their correlations with yield have been considered to be of great importance. The genetic variability could be determined with the help of genetical parameters such as Genetic Coefficient of Variation (GCV), heritability estimates and genetic advance (GA). GCV indicates the relative degree of genetic variability existing for different characters in a population of genotypes. The heritability expresses the relative amount of heritable portion of the variation. However, the heritability estimates along with genetic gain is more useful in selecting the best population individual. Furthermore, the study of character correlations is important to design appropriate selection strategy for genetic improvement in yield and other characters. Though these correlations provide information on the components on yield, they do not provide an exact picture of the cause and effect relationship. Thus, relative importance of direct and indirect effects of each of the component traits towards yield has to be understood to decide effective selection indices. In this context, the path co-efficient analysis technique[18,4] is an important tool in the hands of plant breeder in partitioning the correlation coefficients into direct and indirect effects of the independent variables on dependent variable.

MATERIAL AND METHODS

The material for the present study consisted of two crosses of rice *viz.,* Cross I (IR-28 x GAR-13) and Cross II (GR-7 x GAR-13). The 30 F_3 progenies each of the two crosses of rice were grown during Summer-2016. Thirty days old seedlings were transplanted in randomized block design replicated tries. Distances between hills and between rows were 20 cm and 15 cm respectively. Normal agronomic practices were followed throughout the crop growth period to obtain a good harvest. The observations were recorded on five randomly selected plants from each progeny row for the following thirteen characters *viz.,* days to 50% flowering, days to maturity, plant height(cm), panicle length(cm),productive tillers per plant, no. of gains per panicle, 100 grain weight (g), Kernel length (mm), kernel breadth (mm), kernel L/B ratio, grain yield per plant (g), straw yield per plant (g) and harvest index (%). The Phenotypic and Genotypic Coefficients of Variability (PCV & GCV) were computed as per the methods of Burton and De vane[3]. For the estimation of broad sense heritability and Genetic advance as percent of mean, the method of Johnson *et al*.[5], was followed. The Phenotypic correlation coefficients and Path analysis were performed using the software INDOSTAT.

RESULT AND DISCUSSION

Analysis of variance revealed significant differences among F_3 progenies each of two crosses for all the traits studied (Table 1&2). Genetic variability in both F_3 Populations (Table 3&4) indicated that, range of variation, a simple measure of variability was quite high for all the characters. Values of Phenotypic Coefficient of Variation (PCV) in both F_3 generations were higher than the Genotypic Coefficient of Variation (GCV) for the traits

studied. The narrow difference between PCV and GCV observed for most traits was an indication of low environmental influence for traits under study. GCV and PCV estimates were classified as low (0- 10%), moderate (10-20%) and high (>20%) as per Johnson *et al.*[5]. Accordingly, days to maturity, days to 50% flowering, plant height, panicle length, 100 grain weight, kernel length, kernel breadth, kernel L/B ratio showed low GCV and PCV in both crosses excluding moderate PCV observed for plant height in both the crosses. Similar results were obtained by Mokate *et al.*[10], Krishna *et al.*[8], and Bhati *et al*. Straw yield per plant showed high GCV and PCV in both the crosses. Whereas moderate GCV and PCV observed for no. of grains per panicle and harvest index in both the crosses. These results are in agreement with Shet *et al.*[16]. As per Robinson *et al.*[15], broad sense heritability estimates were categorized into low (0- 30%), moderate (30-60%) and High (>60%). In both crosses, straw yield per plant and harvest index showed high heritability whereas days to maturity, 100 grain weight and kernel breadth showed moderate heritability in both populations. The estimates of Genetic advance as per cent of mean were classified as low (<10%), moderate (10-20%) & high (>20%) as suggested by Johnson *et al.* (1955). Except days to 50% flowering, days to maturity, plant height, panicle length, 100 grain weight, kernel length, kernel breadth and L/B ratio all the remaining traits *viz.*, productive tillers per plant, no. of gains per panicle, grain yield per plant, straw yield per plant and harvest index depicted moderate to high genetic advance as per cent mean in Cross I. whereas, in Cross II excluding days to 50% flowering, days to maturity, plant height, productive tillers per plant, 100 grain weight, kernel length and kernel breadth all the remaining traits *viz.*, panicle length, no. of gains per panicle, grain yield per plant, L/B ratio, straw yield per plant and harvest index depicted moderate to high genetic advance as per cent mean. Grain yield improvement being the primary concern in the present study, presence of high variability for the trait in both crosses is an indication of scope for selection. Also, high heritability coupled with highest genetic advance as per cent mean was shown by the trait suggests additive gene effect of the trait and effectiveness of selection. The results of the present study closely agree with the earlier reports in rice by Ramalingam *et al*.[14], Panwar *et al.*[12], and Shet *et al.*[16]. In order to understand the nature and magnitude of association between different quantitative traits, genotypic correlation was studied in both F_3 populations (Table 5&6). In the Cross I, association of panicle length, no. of grains per panicle, kernel length, straw yield per plant and harvest index showed significant positive correlation with grain yield per plant whereas, in case of Cross II panicle length, no. of grains per panicle and harvest index showed significant positive correlation with grain yield per plant. This is in agreement with the results of Shet *et al.*[16], Kiran *et al.*[7], Rajeshwari & Nadarajan[13], Krishna veni and Shobha Rani[9]. However, in Cross II 100 grain weight, kernel length and kernel breadth showed significant negative correlation with grain yield per plant. Path analysis (Table 7&8) indicated that in both F_3 populations of crosses IR-28 x GAR-13 and GR-7 x GAR-13, days to 50% flowering, panicle length, productive tillers per plant, 100 grain weight, kernel length, straw yield per plant and harvest index had high positive direct effect on grain yield per plant. This is in accordance with the report of Rajeshwari and Nadarajan[13], Suman *et al.*, Shet *et al*. [16] Nandeshwar *et al.*[11], about high positive direct effect of straw yield per plant and harvest index on grain yield. In both the crosses, kernel breadth and L/B ratio had negative direct effect on grain yield per plant. This is in accordance with the report of Suman *et al*., and Shet *et al.*[16]. Hence selection based on straw yield per plant and harvest index would be most effective for grain yield improvement in these two populations of rice as these traits exerted highest direct effect and also indirect effect on grain yield.

Table-1: Analysis of variance for various characters in F_3 progenies of the cross IR28 X GAR-13

Sr. No.	Character	Mean square		
		Replication	Progenies	Error
	Degree of freedom	2	29	58
1	Days to 50% flowering	1.662	39.392**	9.540
2	Days to Maturity	3.632	37.203**	7.155
3	Plant height (cm)	58.180	130.420**	55.749
4	Panicle length (cm)	1.572	3.071**	1.500
5	Productive tillers per plant	1.095	6.366**	0.740
6	No. of grains per panicle	97.640	569.326**	85.805
7	100 grain weight (g)	0.005	0.042**	0.012
8	Kernel length (mm)	0.087	0.153**	0.077
9	Kernel breadth (mm)	0.007	0.030**	0.012
10	Kernel L/B ratio	0.001	0.114**	0.035
11	Grain yield per plant (g)	1.336	25.508**	1.880
12	Straw yield per plant (g)	0.037	83.944**	2.376
13	Harvest index (%)	2.533	183.660**	5.995

**- Significant at 1.0 per cent level of probability,
*- Significant at 5.0 per cent level of probability

Table-2: Analysis of variance for various characters in F_3 progenies of the cross GR-7 x GAR-13

Sr. No.	Character	Mean square		
		Replication	Progenies	Error
	Degree of freedom	2	29	58
1	Days to 50% flowering	6.778	39.686**	5.556
2	Days to Maturity	10.326	40.709**	8.392
3	Plant height (cm)	61.268	131.938**	60.094
4	Panicle length (cm)	1.616	10.188**	0.290
5	Productive tillers per plant	0.691	1.643**	0.677
6	No. of grains per panicle	114.757	494.718**	101.512
7	100 grain weight (g)	0.012	0.061**	0.021
8	Kernel length (mm)	0.004	0.335**	0.064
9	Kernel breadth (mm)	0.002	0.041**	0.011
10	Kernel L/B ratio	0.005	0.138**	0.022
11	Grain yield per plant (g)	3.480	13.946**	3.086
12	Straw yield per plant (g)	4.494	69.395**	4.063
13	Harvest index (%)	4.749	149.359**	8.304

**- Significant at 1.0 per cent level of probability,
*- Significant at 5.0 per cent level of probability

Table-3: Estimation of genetic variability parameters for thirteen quantitative characters in F_3 progenies of cross IR-28 X GAR-13

Characters	Range	σ^2g	σ^2p	GCV (%)	PCV (%)	h^2 (b)	GAM
Days to 50% flowering	93.17-106.44	9.95	19.49	3.19	4.47	51.06	4.69
Days to Maturity	121.13-135.43	10.01	17.17	2.49	3.27	58.33	3.93
Plant height (cm)	68.27-100.07	24.89	80.63	6.44	11.60	30.87	7.38
Panicle length (cm)	19.47-23.97	0.52	2.02	3.32	6.53	25.89	3.48
Productive tillers per plant	6.10-11.73	1.87	2.61	14.80	17.47	71.69	25.81
No. of grains per panicle	83.53-133.57	161.17	246.97	11.90	14.73	65.26	19.81
100 grain weight (g)	1.67-2.21	0.0098	0.022	5.36	8.07	44.23	7.35
Kernel length (mm)	5.75-6.70	0.025	0.10	2.57	5.17	24.79	2.64
Kernel breadth (mm)	1.87-2.25	0.0059	0.018	3.66	6.43	32.48	4.30
Kernel L/B ratio	2.67-3.40	0.026	0.061	5.44	8.36	42.35	7.29
Grain yield per plant (g)	8.79-21.62	7.87	9.75	19.58	21.80	80.73	36.25
Straw yield per plant (g)	9.69-29.47	27.18	29.56	28.55	29.77	91.96	56.41
Harvest index (%)	30.12-59.39	59.22	65.21	17.22	18.07	90.81	33.80

σ^2g = Genotypic variance, σ^2p = Phenotypic variance, GCV = Genotypic Coefficient of Variance, PCV = Phenotypic Coefficient of Variance, h^2 (b) = Heritability (Broad sense), GAM = Genetic advance as per cent mean.

Table-4: Estimation of genetic variability parameters for thirteen quantitative characters in F_3 progenies of cross GR-7 X GAR-13

Characters	Range	σ^2g	σ^2p	GCV (%)	PCV (%)	h^2 (b)	GAM
Days to 50% flowering	91.80-105.47	11.37	16.93	3.36	4.10	67.19	5.68
Days to Maturity	120.27-133.87	10.77	19.16	2.56	3.42	56.21	3.96
Plant height (cm)	73-101.30	23.94	84.04	6.05	11.33	28.50	6.65
Panicle length (cm)	16.99-23.94	3.30	3.59	8.42	8.78	91.92	16.63
Productive tillers per plant	7.15-9.95	0.32	0.99	7.04	12.41	32.22	8.23
No. of grains per panicle	86.90-150.23	131.06	232.58	10.36	13.81	56.35	16.03
100 grain weight (g)	1.61-2.13	0.013	0.034	6.20	9.90	39.28	8.01
Kernel length (mm)	5.52-6.95	0.09	0.15	4.88	6.38	58.62	7.71
Kernel breadth (mm)	1.93-2.41	0.010	0.020	4.62	6.62	48.74	6.64
Kernel L/B ratio	2.33-3.29	0.038	0.060	6.89	8.60	64.27	11.38
Grain yield per plant (g)	12.18-21.34	3.62	6.70	11.96	16.29	53.98	18.11
Straw yield per plant (g)	12.89-32.51	21.77	25.84	22.64	24.66	84.28	42.81
Harvest index (%)	29.32-53.64	47.01	55.32	15.55	16.87	84.99	29.53

σ^2g = Genotypic variance, σ^2p = Phenotypic variance, GCV = Genotypic Coefficient of Variance, PCV = Phenotypic Coefficient of Variance, h^2 (b) = Heritability (Broad sense), GAM = Genetic advance as per cent mean.

Table-5: Inter character correlation in F_3 progenies of the cross IR-28 x GAR-13 in rice

Characters	DFF	DM	PH	PL	PTP	NGP	100GW	KL	KB	L/B ratio	SYP	HI	GYP
DFF	1.0000	0.965**	-0.357**	0.137	-0.404	0.057	-0.079	-0.063	-0.561**	0.364**	-0.006	0.040	0.063
DM		1.0000	-0.289**	0.064	-0.413**	0.205	-0.048	-0.204	-0.453**	0.205	0.012	0.031	0.058
PH			1.0000	0.641**	0.009	-0.104	0.307**	0.145	0.109	-0.023	0.350**	-0.410	-0.068
PL				1.0000	-0.148	0.405**	0.112	0.325**	-0.454**	0.461**	0.423**	-0.169	0.341**
PTP					1.0000	-0.102	-0.454**	-0.318**	0.108	-0.213*	0.689	-0.621**	0.147
NGP						1.0000	-0.204	-0.446**	-0.396**	0.044	0.098	0.077	0.246*
100GW							1.0000	0.452**	0.224*	0.068	-0.335**	0.204	-0.197
KL								1.0000	-0.479**	0.789**	-0.020	0.227*	0.248*
KB									1.0000	-0.917**	-0.277**	0.123	-0.114
L/B ratio										1.0000	0.185	0.013	0.187
SYP											1.0000	-0.779**	0.317**
HI												1.0000	0.322**

DFF – Days to 50% flowering **PTP** – Productive tillers per plant **KB** – Kernel breadth (mm)

DM – Days to maturity **NGP** – No. of grains per panicle **GYP** – Grain yield per plant (g)

PH – Plant height (cm) **100GW** – 100 grain weight (g) **SYP** – Straw yield per plant (g)

PL – Panicle length (cm) **KL** – Kernel length (mm) **HI** – Harvest index (%)

**- Significant at 1.0 per cent level of probability, *- Significant at 5.0 per cent level of probability

Table-6: Inter character correlation in F_3 progenies of the cross GR-7 x GAR-13 in rice

Characters	DFF	DM	PH	PL	PTP	NGP	100GW	KL	KB	L/B ratio	SYP	HI	GYP
DFF	1.000	0.967**	-0.319**	0.291**	0.185	0.201	-0.366**	0.207	-0.260	0.319**	0.210*	-0.131	0.169
DM		1.000	-0.212*	0.370**	0.262*	0.187	-0.426**	0.204	-0.276**	0.326**	0.164	-0.089	0.185
PH			1.000	0.329**	0.089	0.086**	-0.016	-0.277**	-0.100	-0.149	-0.077	0.214*	0.534**
PL				1.000	-0.132	0.364**	-0.569**	0.013	-0.923**	0.610**	0.109	-0.043	0.230*
PTP					1.000	-0.093	-0.037	-0.106	-0.142	0.012	0.152	-0.046	0.202
NGP						1.000	-0.839**	-0.342**	-0.543**	0.111	-0.162	0.229*	0.263*
100GW							1.000	0.647**	0.832**	-0.085	-0.055	-0.114	-0.382**
KL								1.000	-0.091	0.759**	0.235*	-0.297**	-0.283**
KB									1.000	-0.715**	-0.242*	0.079	-0.364**
L/B ratio										1.000	0.310**	-0.244*	0.053
SYP											1.000	-0.949**	-0.409**
HI												1.000	0.669**

DFF – Days to 50% flowering **PTP** – Productive tillers per plant **KB** – Kernel breadth (mm)

DM – Days to maturity **NGP** – No. of grains per panicle **GYP** – Grain yield per plant (g)

PH – Plant height (cm) **100GW** – 100 grain weight (g) **SYP** – Straw yield per plant (g)

PL – Panicle length (cm) **KL** – Kernel length (mm) **HI** – Harvest index (%)

**- Significant at 1.0 per cent level of probability, *- Significant at 5.0 per cent level of probability

Table-7: A path coefficient analysis of component characters towards grain yield per plant in F_3 progenies of the cross IR-28 x GAR-13 in rice

Characters	DFF	DM	PH	PL	PTP	NGP	100GW	KL	KB	L/B ratio	SYP	HI	Genotypic correlation with Grain yield per plant
DFF	**0.3196**	0.3082	-0.1141	0.0437	-0.1292	0.0180	-0.0251	-0.0199	-0.1794	0.1107	-0.0018	0.0128	0.063
DM	-0.1798	**-0.1864**	0.0538	-0.0120	0.0769	-0.0381	0.0088	0.0380	0.0844	-0.0383	-0.0023	-0.0057	0.058
PH	0.0463	0.0374	**-0.1296**	-0.0831	-0.0011	0.0134	-0.0397	-0.0188	-0.0141	0.0029	-0.0453	0.0531	-0.068
PL	0.0243	0.0114	0.1141	**0.1779**	-0.0262	0.0721	0.0199	0.0578	-0.0808	0.0820	0.0752	-0.0300	0.341**
PTP	-0.1043	-0.1064	0.0022	-0.0380	**0.2579**	-0.0263	-0.1170	-0.0819	-0.0279	-0.0549	0.1777	-0.1600	0.147
NGP	0.0012	0.0046	-0.0023	0.0091	-0.0023	**0.0225**	-0.0046	-0.0100	-0.0089	0.0010	0.0022	0.0017	0.246*
100GW	-0.0069	-0.0041	0.0269	0.0098	-0.0398	-0.0179	**0.0878**	0.0397	0.0196	0.0059	-0.0294	0.0179	-0.197
KL	-0.1146	-0.3738	0.2665	0.5963	-0.5821	-0.8170	0.8291	**1.8333**	-0.8781	1.4458	-0.0366	0.4165	0.248*
KB	1.3632	1.1003	-0.2644	1.1033	-0.2628	0.9612	-0.5439	1.1630	**-2.4283**	2.2272	0.6731	-0.2981	-0.114
L/B ratio	-1.3328	-0.7905	0.0888	-1.7743	0.8201	-0.1698	-0.2623	-3.0342	3.5290	**-3.8475**	-0.7123	-0.0490	0.187
SYP	-0.0071	0.0157	0.4436	0.5356	0.8731	0.1254	-0.4251	-0.0253	-0.3513	0.2346	**1.2674**	-0.9870	0.317**
HI	0.0544	0.0415	-0.5531	-0.2278	-0.8375	0.1032	0.2750	0.3066	0.1657	0.0172	-1.0511	**1.3496**	0.322**

DFF – Days to 50% flowering **PTP** – Productive tillers per plant **KB** – Kernel breadth (mm)
DM – Days to maturity **NGP** – No. of grains per panicle **GYP** – Grain yield per plant (g)
PH – Plant height (cm) **100GW** – 100 grain weight (g) **SYP** – Straw yield per plant (g)
PL – Panicle length (cm) **KL** – Kernel length (mm) **HI** – Harvest index (%)

**- Significant at 1.0 per cent level of probability, *- Significant at 5.0 per cent level of probability, Residual = 0.045, Bold diagonal figures are the direct effects.

Table-8: A path coefficient analysis of component characters towards grain yield per plant in F_3 progenies of the cross GR-7 x GAR-13 in rice

Characters	DFF	DM	PH	PL	PTP	NGP	100GW	KL	KB	L/B ratio	SYP	HI	Genotypic correlation with Grain yield per plant
DFF	**0.5202**	0.5031	-0.1660	0.1514	0.0964	0.1048	-0.1902	0.1076	-0.1351	0.1657	0.1095	-0.0679	0.169
DM	-0.4133	**-0.4273**	0.0907	-0.1581	-0.1121	-0.0801	0.1819	-0.0869	0.1179	-0.1393	-0.0700	0.0380	0.185
PH	-0.0406	-0.0270	**0.1274**	0.0419	0.0114	0.0365	-0.0020	-0.0352	-0.0127	-0.0190	-0.0098	0.0272	0.534**
PL	0.0689	0.0876	0.0779	**0.2367**	-0.0312	0.0866	-0.1347	0.0031	-0.2185	0.1444	0.0258	-0.0100	0.230*
PTP	0.0096	0.0136	0.0046	-0.0068	**0.0520**	-0.0048	-0.0019	-0.0055	-0.0074	0.0006	0.0079	-0.0023	0.202
NGP	-0.0108	-0.0101	-0.0154	-0.0197	0.0050	**-0.0538**	0.0451	0.0184	0.0292	-0.0059	0.0087	-0.0123	0.263*
100GW	-0.0217	-0.0252	-0.0009	-0.0337	-0.0022	-0.0497	**0.0593**	0.0383	0.0494	-0.0050	-0.0032	-0.0067	-0.382**
KL	0.0899	0.0885	-0.1203	0.0058	-0.0461	-0.1487	0.2814	**0.4350**	-0.0397	0.3303	0.1021	-0.1293	-0.283**
KB	0.0801	0.0851	0.0308	0.2847	0.0438	0.1674	-0.2567	0.0280	**-0.3084**	0.2206	0.0748	-0.0245	-0.364**
L/B ratio	-0.2009	-0.2056	0.0940	-0.3848	-0.0077	-0.0700	0.0536	-0.4787	0.4510	**-0.6306**	-0.1955	0.1537	0.053
SYP	0.4349	0.3385	-0.1593	0.2258	0.3148	-0.3342	-0.1132	0.4852	-0.5010	0.6408	**2.0665**	-1.9601	-0.409**
HI	-0.3477	-0.2368	0.5701	-0.1135	-0.1219	0.6092	-0.3048	-0.7920	0.2114	-0.6494	-2.5260	**2.6631**	0.669**

DFF – Days to 50% flowering **PTP** – Productive tillers per plant **KB** – Kernel breadth (mm)
DM – Days to maturity **NGP** – No. of grains per panicle **GYP** – Grain yield per plant (g)
PH – Plant height (cm) **100GW** – 100 grain weight (g) **SYP** – Straw yield per plant (g)
PL – Panicle length (cm) **KL** – Kernel length (mm) **HI** – Harvest index (%)

**- Significant at 1.0 per cent level of probability, *- Significant at 5.0 per cent level of probability, Residual = 0.040, Bold diagonal figures are the direct effect

CONCLUSION

The present study revealed that characters having high GCV, PCV, heritability, coupled with high genetic advance as percent of mean that indicating presence of additive gene effects in its inheritance and such character could be improved by selection. Whereas low heritability and low genetic advance also indicates greater role of non additive gene action in their inheritance suggesting heterosis breeding could be useful for improving these traits. The traits which showing positive and significant correlation with yield per plant by improving those traits in desirable direction we can also improve yield per plant. Path analysis reveled that if the correlation between grain yield per plant and its contributing traits is due to direct effect of a traits, it reveals true relationship between them and direct selection for this trait will be rewarding for grain yield improvement.

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