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Genetic variability and association studies in rice (*Oryza sativa* L.)

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ABSTRACT

The study aims to study genetic variability and correlation among yield and yield-related traits in land races of rice. High heritability estimates coupled with high genetic advance was recorded for plant height, ear bearing tillers per plant, number of filled grains per panicle and test weight indicating that direct selection of these characters based on phenotypic expression using a simple selection procedure for yield improvement would be more accurate. The results of correlation and path coefficient analysis revealed that the traits *viz*., days to 50% flowering, number of filled grains per panicle and test weight exhibited positive association along with high positive direct effects both at genotypic and phenotypic levels. Hence direct selection for these traits will simultaneously improve grain yield per plant.

Keywords: *Correlation, Genetic variability, Genetic advance, Rice and Path coefficient analysis.*

Rice (*Oryza sativa* L.) is a key staple food crop consumed by more than half of the world's population (Sharma *et al*., 2012), occupying nearly one-fifth of the total arable land area under cereal cultivation. The population may increase to 9 billion by the end of 2050 and food production is sufficient to meet the present requirements of only 60% of the population (Anonymous, 2018). Traditional land races are important reservoirs of valuable traits and need special attention for future conservation. Landraces provides a vast genetic variability for the present day rice improvement programme (Zhenshan *et al*., 1996). Landraces possess a wealth of abiotic tolerances, biotic resistances and other superior characters and harbor a great genetic potential for rice improvement. Land races served as reservoirs for many unique genes and there is a need to evaluate and know the genetic diversity in land races for their exploration in rice breeding programmes. Studies on variability parameters and correlation will assist the plant breeders to use land races in the rice improvement.

MATERIAL AND METHODS

The material for the present study composed of 36 land races along with the checks *viz*., Improved Samba Mahsuri, TN 1, MTU1121 and BPT 5204 (Table 1). The material was sown and twenty five days old seedlings of these genotypes were transplanted in Alpha Lattice Design in 3 rows of 3m length with two replications by adopting 20 x 15 cm spacing between and within the rows. All the recommended package of practices were adopted to raise the healthy crop. At different stages of plant growth data was recorded on various yield and yield component traits *viz*., days to 50% flowering, plant height (cm), ear bearing tillers per plant, panicle length (cm), number of filled grains per panicle, test weight (g) and grain yield per plant (g). The mean data was used for analysis of various genetic parameters as per standard statistical procedures. The genotypic and phenotypic correlation coefficients were estimated using the method given by Johnson *et al*. (1955). Path coefficient analysis was carried out by using the procedure originally proposed by Wright (1921) which was subsequently elaborated by Dewey and Lu (1959) to estimate direct effects as well as indirect effects of the individual characters on yield.

RESULTS AND DISCUSSION

The analysis of variance for seven characters studied in rice genotypes indicated the existence of significant differences among all the genotypes studied. The genotypic and Phenotypic coefficients of variation, heritability and genetic advance as per cent of mean values obtained for various yield components presented in Table 2**.** The highest phenotypic and genotypic coefficients of variation observed for

Table 1. Experimental material used for evaluation and characterization

S. No.	Genotype	S. No.	Genotype
1	Chittimutyalu- 2	21	Veduru sanna
2	Assam chud	22	Tulasi Baso
3	Loyamalli	23	Basmalnavi
4	Jaavepula- 2	24	Gangaram Basmati
5	Kabirjassal	25	Sannajajulu-2
6	Kalamuch	26	Surekha
7	Gurumuthya	27	Kaajsaala
8	Karikalave	28	Indrani
9	Chittimutyalu- 3	29	Ramjeera
10	Doodeswar	30	Galiya
11	Sonamali	31	Kundadam-2
12	Ambemohar- 3	32	Moghar
13	Nagaraa-2	33	Ramla
14	Bansapatri	34	Dosmat
15	Chittimutyalu-1	35	Basmati
16	Jaavepula-1	36	HMT-5
17	Sonamali-2	37	ISM
18	Moti	38	TN-1
19	Sannajajulu-1	39	MTU-1121
20	Godhi kajra	40	BPT-5204

Table 2. Variability, heritability and genetic advance as per cent of mean for yield and yield component traits

S. No.	Character	Coefficient of variation		Heritability (%)	Genetic advance as per cent of mean
		GCV (%)	PCV (%)	(broad sense)	
1	Days to 50% flowering	4.93	6.15	64.13	8.13
2	Plant height (cm)	11	12.03	83.62	20.72
3	Ear bearing tillers per plant	19.52	19.96	95.63	39.32
4	Panicle length (cm)	5.41	7.07	58.55	8.53
5	Number of filled grains per panicle	21.99	22.45	95.95	44.37
6	Test weight (g)	20.15	20.64	95.31	40.52
8	Grain yield per plant (g)	18.46	19.03	94.09	36.89

number of filled grains per panicle (22.45 and 21.99, respectively) while days to 50% flowering manifested the least values (6.15 and 4.93, respectively). Knowledge of genetic parameters will help in understanding the nature of gene action for the characters under study. Moderate to high estimates of genotypic as well as phenotypic coefficients of variation coupled with high heritability and high genetic advance as per cent of mean were recorded for plant height, ear bearing tillers per plant, number of filled grains per plant, test weight and grain yield per plant. Similar results were observed by Panika *et al*. (2022), Thuy *et al*. (2023), Deepthi *et al*. (2022), Surjaye *et al*. (2022) and Parimala *et al*. (2020). Moderate to high heritability coupled with genetic advance as per cent of mean indicating the preponderance of additive and non-additive gene actions, thus direct selection for these traits may not be effective for improvement of these characters. Remaining traits under study *viz.*, days to 50% flowering and panicle length recorded low genotypic and phenotypic coefficients of variation coupled with low to moderate heritability and genetic advance as per cent of mean suggesting that both additive and non-additive gene actions are involved in the inheritance of these traits. Similar results were reported by Deepthi *et al*. (2022) and Archana *et al*. (2018).

The perusal of association studies between yield and yield component traits revealed that positive association of grain yield per plant with days to 50% flowering, number of filled grains per panicle and test weight indicating simultaneous improvement of grain yield with improvement of these characters (Table 3). Hence, priority should be given to these traits while making selection for improvement of grain yield. These results are in confirmation with Krishna *et al*. (2022), Archana *et al*. (2018) and Devi *et al*. (2022). Days to 50% flowering exhibited positive and non-significant correlation with grain yield per plant and significant positive correlation with filled grains per panicle (0.501**) and (0.379**) at genotypic and phenotypic levels, respectively indicating that the genotypes possessing longer duration had more number of filled grains per panicle. Significant positive phenotypic (0.234*) and genotypic (0.337*) correlation was observed for plant height with panicle length and also with ear bearing tillers per plant (0.429**) and (0.458**). These results indicated that the genotypes with tall plant stature possess longer panicles and more number of filled grains per panicle and higher grain yield per plant. The relationship of panicle length with test weight was significantly positive both at genotypic (0.383**) and phenotypic levels (0.294*) suggesting that the land races possessing longer panicles used in this study recorded more test weight.

In contrast ear bearing tillers per plant recorded significant negative genotypic (-0.240*) and phenotypic (-0.228*) correlation with filled grains per panicle and test weight (-0.252* and -0.237*), suggesting that the genotypes with less ear bearing tillers manifested more number of filled grains per panicle and bold grains. The trait panicle length exhibited significant and negative association with grain yield per plant at genotypic level (-0.232*) indicating that genotypes with longer panicles recorded lower grain yield per plant. Filled grains per panicle recorded positive genotypic (0.1214) and phenotypic (0.1203) correlation with grain yield per plant indicating that the genotypes possessing more number of filled grains per panicle recorded high grain yield per plant. Test weight recorded non-significant positive genotypic (0.1668) and phenotypic (0.1662) with grain yield per plant. Among the yield components, positive and significant relationship was observed between days to 50% flowering and number of filled grains per panicle; panicle length and test weight; plant height and ear bearing tillers per plant; plant height and panicle length advocating simultaneous selection for improvement of both the traits.

The direct and indirect effects of yield and yield components was presented in Tables 4 and 5. Among yield component traits, days to 50% flowering (0.7907, 0.0889), number of filled grains per panicle (0.554, 0.3798) and test weight (1.2215, 0.5004) manifested positive correlation coupled with positive direct effects at both phenotypic and genotypic levels. These results in agreement with Laxmi *et al*. (2023), Saha *et al*. (2019), Singh *et al*. (2020), Deepthi *et al*. (2022) and Heera *et al*. (2023). In contrast panicle length exhibited significantly negative correlation (-0.232*) along with negative direct effect (-0.9328, -0.312) at both phenotypic and genotypic levels. Hence the traits *viz.*, days to 50% flowering, number of filled grains per panicle and test weight may be given importance while making selection for improvement of grain yield. In the present study residual effect was 0.353

Table 3. Correlation of grain yield per plant with other yield component traits in rice

Character		DFF	PH	EBT	PL	NFG/P	TW	GY/P
DFF	rg	1	-0.708**	-0.337**	-0.0892	0.501**	-0.284*	0.1027
	rp	1	-0.521**	-0.266**	-0.1218	0.379**	-0.248*	0.0775
PH	rg		1	0.458**	0.337*	-0.1253	-0.1321	-0.1395
	rp		1	0.429**	0.234*	-0.1078	-0.1007	-0.0886
EBT	rg			1	0.0438	-0.240*	-0.252*	-0.0661
	rp			1	0.0136	-0.228*	-0.237*	-0.0674
PL	rg				1	0.0298	0.383**	-0.232*
	rp				1	0.0507	0.294*	-0.1401
NFG/P	rg					1	-0.505**	0.1214
	rp					1	-0.477**	0.1203
TW	rg						1	0.1668
	rp						1	0.1662

Table 4. Estimates of phenotypic direct and indirect effects of 6 traits on grain yield in rice

	DFF(days)	PH(cm)	EBT/Plant	PL(cm)	NFG/P	TW(g)	GY/Plant
DFF(days)	**0.7907**	-0.5726	-0.1291	-0.0832	0.2774	-0.3468	0.1027
PH(cm)	-0.56	**0.8085**	0.1569	-0.3141	-0.0694	-0.1614	-0.1395
EBT/Plant	-0.298	0.3702	**0.3426**	-0.0409	-0.1327	-0.3074	-0.0661
PL(cm)	0.0705	0.2722	0.015	**-0.9328**	0.0165	0.4677	-0.232*
NFG/P	0.3958	-0.1013	-0.0821	-0.0278	**0.554**	-0.6173	0.1214
TW(g)	-0.2245	-0.1068	-0.0862	-0.3571	-0.28	**1.2215**	0.1668

Table 5. Estimates of genotypic direct and indirect effects of 6 traits on grain yield in rice

	DFF(days)	PH(cm)	EBT/Plant	PL(cm)	NFG/P	TW(g)	GY/Plant
DFF(days)	**0.0889**	-0.0325	-0.037	0.038	0.1441	-0.124	0.0775
PH(cm)	-0.0463	**0.0623**	0.0597	-0.073	-0.0409	-0.0504	-0.0886
EBT/Plant	-0.0236	0.0267	**0.1392**	-0.0043	-0.0867	-0.1187	-0.0674
PL(cm)	-0.0108	0.0146	0.0019	**-0.312**	0.0193	0.147	-0.1401
NFG/P	0.0337	-0.0067	-0.0318	-0.0158	**0.3798**	-0.2388	0.1203
TW(g)	-0.022	-0.0063	-0.033	-0.0916	-0.1813	**0.5004**	0.1662

DFF-Days to 50% flowering, PH- Plant height, EBT- Ear bearing tillers per plant, PL- Panicle length, NFG/P- Number of filled grains per panicle, TW- Test weight, GY/P- Grain yield per plant.

and 0.284 at genotypic and phenotypic levels, respectively. This indicated that 64.7% (genotypic) and 71.6% (phenotypic) variability was exploited by the variables mentioned in this study. In addition to the mentioned factors, some other factors which have not been considered here need to be included in the analysis to account for the complete variation present in the material.

CONCLUSION

The estimates of phenotypic coefficient of variation for all the characters under study were higher than the estimates of genotypic coefficient of variation. Most of the traits showed high heritability estimates except for panicle length. The other characters under study *viz.*, ear bearing tillers per plant, plant height, number of filled grains per panicle and test weight exhibited moderate to high estimates for PCV and GCV coupled with high heritability and genetic advance as per cent of mean suggesting the influence of additive and non-additive gene actions and simple selection is not advocated for improvement of these traits. The results of correlation and path coefficient analysis revealed that the traits *viz.*, days to 50% flowering, number of filled grains per panicle and test weight exhibited positive association along with high positive direct effects both at genotypic and phenotypic levels. Hence direct selection for these traits will simultaneously improve grain yield per plant.

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