

Variability and Interrelationships for Yield and Yield Related Traits in Land Races of Rice (*Oryza sativa* L.)

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Abstract

The present study aims to estimate the genetic parameters of seven yield-attributing traits to assess genetic variability and correlation of yield and yield-related traits in land races of rice. High heritability estimates coupled with high genetic advance were 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 would be more accurate for yield improvement. 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 both the traits.

Keywords: Rice, genetic variability, genetic advance, correlation, path coefficient analysis

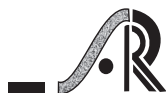
Introduction

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 global population may increase to 9 billion by the end of 2050 and food production is sufficient to meet the 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. Land races provides a vast genetic variability for the present-day rice improvement programme (Zhenshan *et al.*, 1996). Land races possess a wealth of abiotic tolerances, biotic resistances and other superior characters and harbor a great genetic potential for rice improvement. Land races serve as reservoirs for many unique genes. Need for new gene and genetic diversity in crop species is essential to sustain the

levels of high productive rice. Heritability coupled with genetic advance provides a basis for isolation of best genotypes from the population.

Materials and Methods

The material for the present study comprised of 36 land races along with the four checks viz., Improved Samba Mahsuri, TN 1, MTU 1121 and BPT 5204. Twenty-five days old seedlings of these genotypes were transplanted in Alpha Lattice Design in 3 rows of 3 m 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 (days), 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 the indirect effects of the individual characters on grain yield.

Results and Discussion

The results of analysis of variance for seven characters studied in rice genotypes indicated the existence of significant differences among all the genotypes studied. Mean performance of all the genotypes was given in **Table 1**. The results of *per se* performance revealed that BPT5204 recorded maximum grain yield per plant when compared to other genotypes, followed by Indrani (35.00 g), Surekha (32.70 g), Karikalave (32.45 g) and Bansapatri (32.35 g). These genotypes also manifest high values for other yield attributing traits in the desirable directions. The genotypic and phenotypic coefficient of variation, heritability and genetic advance as per cent of mean values obtained for various yield components were presented in **Table 2**. The higher phenotypic and genotypic coefficients of variation were observed for 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). Priyanka *et al.*, (2023) also reported high coefficients of variation

for number of filled grains per panicle in a study involving 49 advanced rice genotypes of rice derived from multiple crosses. 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 coefficient 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. These findings indicate the preponderance of additive gene action, thus direct selection for these traits may be effective for improvement of these characters. Similar results were earlier reported by Bose (2024), Panika *et al.*, (2022), Thuy *et al.*, (2023), Deepthi *et al.*, (2022), Surjaye *et al.*, (2022) and Parimala *et al.*, (2020).

These findings indicate the preponderance of additive gene action, thus direct selection for these traits may be effective for improvement of these characters. Remaining traits under study *viz.*, days to 50 % flowering and panicle length recorded low genotypic and phenotypic coefficient 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 Sridevi (2018), Deepthi *et al.*, (2022) and Archana *et al.*, (2018).

Table 1: Experimental material used for evaluation of yield and yield components

Sl. No.	Designation	DFF (days)	PH (cm)	EBT/P	PL (cm)	NFG/P	TW (g)	GY/P (g)
1	Chittimutyalu- 2	87	148	23	24	138	21.85	24.00
2	Assam chud	87	147	20	27	159	18.60	31.50
3	Loyamalli	84	137	10	23	114	22.45	24.45
4	Jaavepula- 2	80	144	22	23	143	21.85	29.70
5	Kabirjassal	89	135	21	24	88	28.05	28.40
6	Kalamuch	86	148	23	25	118	13.95	18.55
7	Gurumuthya	89	137	18	26	161	19.00	17.25
8	Karikalave	84	158	18	24	134	18.85	32.45
9	Chittimutyalu- 3	88	144	14	24	143	19.90	21.35
10	Doodeswar	86	131	20	27	128	19.00	20.00

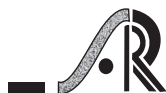
Sl. No.	Designation	DDF (days)	PH (cm)	EBT/P	PL (cm)	NFG/P	TW (g)	GY/P (g)
11	Sonamali	85	160	20	27	142	23.00	24.50
12	Ambemohar- 3	88	149	18	27	158	18.40	19.25
13	Nagaraa-2	87	157	21	23	103	19.15	24.45
14	Bansapatri	86	137	17	25	127	25.50	32.35
15	Chittimutyalu-1	94	145	17	24	168	13.45	15.95
16	Jaavepula-1	85	155	16	24	206	17.80	28.60
17	Sonamali-2	92	140	21	24	157	18.35	26.55
18	Moti	89	131	13	26	132	25.05	17.85
19	Sannajajulu-1	89	140	19	26	158	19.40	17.30
20	Godhikajra	91	139	13	26	130	24.95	23.30
21	Vedurusanna	92	120	15	24	155	18.05	27.65
22	Tulasibaso	84	170	22	23	118	13.50	26.15
23	Basmalnavi	89	123	17	24	149	23.60	28.65
24	Gangaram Basmati	93	119	18	25	178	20.40	28.90
25	Sannajajulu-2	85	160	17	28	181	19.50	26.45
26	Surekha	92	161	17	26	212	18.15	32.70
27	Kaajsaala	90	156	21	26	120	20.80	25.00
28	Indrani	95	97	11	23	129	20.85	35.00
29	Ramjeera	89	127	17	22	204	13.15	22.25
30	Galiya	97	121	19	22	176	14.95	31.65
31	Kundadam-2	87	168	22	27	186	15.80	31.25
32	Moghar	87	138	15	27	146	28.40	29.90
33	Ramla	85	130	20	26	127	23.00	22.65
34	Dosmat	83	158	13	25	121	24.30	26.50
35	Basmati	93	141	20	26	92	25.30	25.05
36	HMT-5	83	148	17	25	175	18.80	23.35
37	Improved Samba Mahsuri (BRC)	103	104	11	25	226	16.65	29.45
38	TN1	83	132	18	24	116	26.70	29.20
39	MTU1121 (BSC)	99	112	18	27	206	22.25	25.30
40	BPT5204 (YC)	110	94	20	23	210	14.75	35.45

DDF - Days to 50 % flowering, PH - Plant height, EBT/P - 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

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

Sl. No.	Character	Coefficient of variation		Heritability (%) (broad sense)	Genetic advance as per cent of mean
		GCV (%)	PCV (%)		
1	Days to 50 % flowering	4.93	6.15	64.13	8.13
2	Plant height (cm)	11.00	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
7	Grain yield per plant (g)	18.46	19.03	94.09	36.89

GCV: Genotypic coefficient variation; PCV: Phenotypic coefficient variation



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 a 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 possessed longer panicles and more number of filled grains per panicle and higher grain yield per plant. The relationship of panicle length with test weight is significantly positive both at genotypic (0.383 **) and phenotypic level (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) correlations with grain yield per plant, indicating that the genotypes possessing more number of filled grains per panicle recorded higher 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. Similar findings were earlier reported by Satish Chandra *et al.*, (2024).

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

Character		DFF	PH	EBT/P	PL	NFG/P	TW	GY/P
DFF	r_g	1.000	-0.708**	-0.337**	-0.0892	0.501**	-0.284*	0.1027
	r_p	1.000	-0.521**	-0.266**	-0.1218	0.379**	-0.248*	0.0775
PH	r_g		1.000	0.458**	0.337*	-0.1253	-0.1321	-0.1395
	r_p		1.000	0.429**	0.234*	-0.1078	-0.1007	-0.0886
EBT	r_g			1.000	0.0438	-0.240*	-0.252*	-0.0661
	r_p			1.000	0.0136	-0.228*	-0.237*	-0.0674
PL	r_g				1.000	0.0298	0.383**	-0.232*
	r_p				1.000	0.0507	0.294*	-0.1401
NFG/P	r_g					1.000	-0.505**	0.1214
	r_p					1.000	-0.477**	0.1203
TW	r_g						1.000	0.1668
	r_p						1.000	0.1662

DFF: Days to 50 % flowering, PH: Plant height, EBT/P: 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

The direct and indirect effects of yield and yield components were represented in **Table 4**. 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 correlations, 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 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 the 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 in yield.

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

Character		DFF (days)	PH (cm)	EBT/ P	PL (cm)	NFG/P	TW (g)	GY/ P
DFF(days)	r_p	0.7907	-0.5726	-0.1291	-0.0832	0.2774	-0.3468	0.1027
	r_g	0.0889	-0.0325	-0.037	0.038	0.1441	-0.124	0.0775
PH(cm)	r_p	-0.56	0.8085	0.1569	-0.3141	-0.0694	-0.1614	-0.1395
	r_g	-0.0463	0.0623	0.0597	-0.073	-0.0409	-0.0504	-0.0886
EBT/Plant	r_p	-0.298	0.3702	0.3426	-0.0409	-0.1327	-0.3074	-0.0661
	r_g	-0.0236	0.0267	0.1392	-0.0043	-0.0867	-0.1187	-0.0674
PL(cm)	r_p	0.0705	0.2722	0.015	-0.9328	0.0165	0.4677	-0.232*
	r_g	-0.0108	0.0146	0.0019	-0.312	0.0193	0.147	-0.1401
NFG/P	r_p	0.3958	-0.1013	-0.0821	-0.0278	0.554	-0.6173	0.1214
	r_g	0.0337	-0.0067	-0.0318	-0.0158	0.3798	-0.2388	0.1203
TW(g)	r_p	-0.2245	-0.1068	-0.0862	-0.3571	-0.28	1.2215	0.1668

DFF - Days to 50 % flowering, PH - Plant height, EBT/P - 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

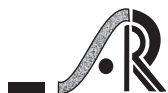
Conclusion

In general, 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 gene action and simple selection is 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 both the traits.

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