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Genetic variability, correlation and path analysis for grain yield and yield components in rice genotypes

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Abstract
The present investigation was undertaken with 60 rice genotypes to study the variability and genetic parameters in addition to character associations and path effects for grain yield and yield component characters. The results revealed highly significant mean squares due to genotypes for all traits studied, indicating the existence of sufficient variation among the genotypes and therefore an ample scope for effective selection. High phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance as per cent of mean was observed for total tillers per plant, ear bearing tillers per plant, filled and ill-filled grains per panicle in addition to grain yield per plant, indicating the effectiveness of direct selection for improvement of these traits. Days to 50 per cent flowering, days to maturity, total tillers per plant, ear bearing tillers per plant and filled grains per panicle had recorded positive and significant association with grain yield per plant. The results on path analysis also revealed high and positive direct effects for ear bearing tillers per plant and filled grains per panicle and hence, these traits were identified as the most effective selection criteria for improvement of grain yield per plant in rice genotypes.

Keywords: correlations, rice, grain yield, yield components, path effects, variability

Introduction
Rice is the staple food for more than 100 countries of the world and is the primary source of food and protein for about half of the mankind with an enormous nutritional and economic impact. It is the crucial dietary and food security source of many Asian countries (Kumar *et al.*, 2020) [5]. Significant improvement in rice production and productivity was achieved through green revolution, but the plateau in yield levels is limiting the efforts for increasing production to meet the demands of the ever growing population, especially in developing and under developed countries. Information on heritability, genetic advance and the extent of genetic variation available for grain yield and yield attributes in the experimental material would be of immense help to the breeders in the selection of elite genotypes for breaking of these yield plateaus being observed in rice. Further, knowledge of the direct and indirect effects in addition to degree and direction of relationship between grain yield and yield component characters would aid the breeders in the development of superior varieties. The present study is an attempt in this direction to identify effective selection criteria for grain yield improvement in rice.

Material and Methods
The experimental material consisted of 60 rice genotypes obtained from Regional Agricultural Research Station, Maruteru. All the 60 genotypes were sown at Regional Agricultural Research Station, Maruteu during *Rabi* 2016-17 on separate raised nursery beds. All recommended package of practices were adopted to raise a healthy nursery and thirty days old seedlings were transplanted in the main field laid out in Randomized Block Design (RBD) with three replications. Each genotype was transplanted separately in three rows of 2m length by adopting a spacing of 20 cm between rows and 15 cm between plants. All recommended package of practices were adopted throughout the crop growth period and need based plant protection measures were taken up to raise a healthy crop. Observations were recorded on five randomly selected plants for grain yield per plant and yield component characters, namely, plant height, total tillers per plant, ear bearing tillers per plant, panicle length, filled grains per panicle and ill-filled grains per panicle. Observations on days to 50 per cent flowering and days to maturity were recorded on plot basis. In contrast, observations for 100 seed weight were obtained from a random grain sample drawn from each plot in each genotype and replication using standard procedures.

The data collected was subjected to standard statistical procedures given by Panse and Sukhatme (1978) [8]. Correlation was worked out using the formulae suggested by Falconer (1964) [4]. Partitioning of the correlation coefficients into direct and indirect effects was carried out using the procedure suggested by Wright (1921) [16] and elaborated by Dewey and Lu (1959) [3]. Characterization of path coefficients was carried out as suggested by Lenka and Mishra (1973) [6].

Results and Discussion

The results on analysis of variance (ANOVA) for grain yield and yield component traits (Table 1) revealed highly significant mean squares due to genotypes for all traits studied, indicating the existence of sufficient variation among the genotypes and therefore an ample scope for effective selection. The results on mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance as per cent of mean for yield and yield component traits are furnished in Table 2. A perusal of these results revealed maximum range of variability for the trait filled grains per panicle (85-460) while minimum range (1.03-2.79) was recorded for 100 seed weight. Higher PCV, compared to GCV were recorded for all the traits studied in the present investigation, indicating the influence of environment. Similar findings were reported earlier by Tiwari *et al.* (2019) [15]. High phenotypic and genotypic coefficient of variation (>20%) was recorded for total tillers per plant, ear bearing tillers per plant, filled grains per panicle, ill-filled grains per panicle and grain yield per plant, indicating the existence of high amount of variability for effective selection towards improvement of these traits. However, moderate estimates (10-20%) of PCV and GCV were observed for days to 50 per cent flowering and 100-seed weight, while low PCV and GCV (<10%) was recorded for days to maturity, indicating little scope for improvement of these traits through selection. The results for ear bearing tillers per plant recorded in the present study are in conformity with the findings of Srilakshmi *et al.* (2018) [12]; days to 50 per cent flowering and 100-seed weight with Sudeepthi *et al.* (2020) [13]; panicle length with Nayak *et al.* (2016) [7]; filled grains per panicle with Ravikanth *et al.* (2018) [9]; and days to maturity with Kumar *et al.* (2020) [5].

Heritability estimates for the various traits studied ranged from 48.34 (panicle length) to 99.56 (filled grains per panicle). High estimates of heritability (> 60%) were recorded for all the traits studied, except panicle length. Similar results were reported Srilakshmi *et al.* (2018) [12]. A perusal of the results on genetic advance as percent of mean revealed high values (>20%) for days to 50 per cent flowering, plant height, total number of tillers per plant, ear bearing tillers per plant, filled and ill-filled grains per panicle, 100-seed weight and grain yield per plant. The results are in accordance with the reports of Srilakshmi *et al.* (2018) [12]. Further, moderate estimates (10-20%) of genetic advance as per cent of mean were observed for days to maturity and panicle length. The results are also in agreement with findings of Srilakshmi *et al.* (2018) [12].

High heritability coupled with high genetic advance as per cent of mean was recorded for days to 50 per cent flowering, plant height, total tillers per plant, ear bearing tillers per plant, filled and ill-filled grains per panicle, 100-seed weight and grain yield per plant indicating that heritability observed was due to additive gene effects and therefore selection would be effective in improvement of these traits. However, panicle length had recorded moderate heritability and genetic advance as per cent of mean. Further, information on genetic variation along with heritability and genetic advance estimates has been reported to give a better idea about the efficiency of selection (Burton, 1953) [2]. In the present study, high GCV and PCV coupled with high heritability and high genetic advance as per cent of mean was observed for total tillers per plant, ear bearing tillers per plant, filled and ill-filled grains per panicle and grain yield per plant, indicating the pre-ponderance of additive gene action and therefore scope for effective improvement of these traits through selection.

Character associations for grain yield and yield component traits studied in the present investigation are presented in Table 3. A perusal of these results revealed genotypic correlations to be of similar direction, but higher magnitude, compared to the phenotypic correlations, indicating the masking effect of environment. Positive and significant association of grain yield per plant was observed with days to 50% flowering, days to maturity, total and ear bearing tillers per plant and filled grains per panicle at both phenotypic and genotypic levels, indicating a scope for simultaneous improvement of these traits. Similar results were reported by Sudeepthi *et al.* (2020) [13] for days to 50% flowering, ear bearing tillers per plant, panicle length and filled grains per panicle. Studies on inter-character associations for yield component traits revealed significant and positive association of days to 50% flowering with days to maturity (Saha *et al*., 2019) [10], and total and ear bearing tillers per plant (Tejaswini *et al.* 2018) [14]; days to maturity with total and ear bearing tillers per plant (Ashok, 2015) [1]; and filled grains per panicle with ill-filled grains per panicle, indicating a scope for simultaneous improvement of these traits also through selection. In contrast, significant negative association was observed for the traits, namely, total and ear bearing tillers per plant with panicle length; and filled and ill-filled grains per panicle with 100-seed weight, probably due to competition for a common possibility such as nutrient supply. Balanced selection therefore needs to be practiced while attempting simultaneous improvement of these traits.

Path co-efficient analysis provides an effective means of finding out the direct and indirect causes of association and presents a critical examination of the specific forces acting to produce a given correlation and also measures the relative importance of each causal factor. Hence, the study of direct and indirect effects of traits on grain yield per plant was undertaken in the present investigation and the results obtained are presented in Table 4. A perusal of these results revealed high residual effect for both phenotypic (0.8728) and genotypic (0.8493) path analysis indicating that variables studied in the present experiment explained only about 12.72 and 15.07 per cent of variability for grain yield per plant at phenotypic and genotypic levels, and therefore several other attributes besides the characters studied are contributing for grain yield per plant.

A detailed analysis of the direct and indirect effects revealed high (>0.3) positive direct effect for number of ear bearing tillers per plant, filled grains per panicle and ill-filled grains per panicle. The traits, ear bearing tillers per plant and filled grains per panicle had also recorded significant and positive association with grain yield per plant. High direct effects of these traits therefore appear to be the main factor for their association with grain yield per plant. Hence, the traits should be considered as important selection criteria in all rice improvement programmes for grain yield and direct selection for these traits is recommended for effective yield improvement. The results are in conformity with the findings of Sudeepthi *et al.* (2020) [13]. However, ill-filled grains per panicle had recorded negative correlation and hence, a restricted simultaneous selection model needs to be followed for improvement of grain yield through the trait by imposing restrictions to nullify the undesirable indirect effects in order to make use of the direct effects (Singh and Kakar, 1977) [11]. Further, days to 50% flowering, days to maturity, plant height, total tillers per plant, panicle length and 100 seed weight had recorded negligible to low positive direct effects on grain yield per plant. These findings are in agreement with Sudeepthi *et al.* (2020) [13] for days to 50% flowering, plant height and panicle length. However, association of days to 50 per cent flowering, days to maturity and total tillers per plant was noticed to be positive and significant with grain yield per plant indicating indirect effects to be the cause of correlation and hence, the need for consideration of indirect causal factors during selections for yield improvement through these traits.

Table 1: Analysis of variance for grain yield and yield components in rice

Source of variation	Degrees of freedom	Days to 50 per cent flowering	Days to maturity	Plant height	Total tillers per plant	Ear bearing tillers per plant	Panicle length	Filled grains per panicle	Ill-filled grains per panicle	Spikelet fertility	100-Seed weight	Grain yield per plant
Replications	2	2.87	2.87	31.15	1.80	2.15	1.03	17.51	11.60	5.67	0.04	2.53
Genotypes	59	232.27**	236.79**	819.99**	4.54**	3.66**	14.80**	18002.36**	2234.70**	1156.56**	0.31**	223.64**
Error	118	1.69	1.67	15.27	1.49	1.54	2.74	24.67	8.86	4.77	0.02	2.74

*,**Significant at 5 and 1 per cent levels, respectively

Table 2: Variability, heritability and genetic advance for grain yield and yield components in rice

Character	Mean	Range		Genotypic coefficient of variation (GCV)	Phenotypic coefficient of variation (PCV)	Heritability (%)	Genetic advance as per cent mean
		Minimum	Maximum				
Days to 50 per cent flowering	97.60	78.33	124.33	10.45	10.57	97.80	21.30
Days to Maturity	127.60	108.33	154.33	8.01	8.05	98.90	16.42
Plant height (cm)	111.26	83.00	218.70	16.96	20.13	70.94	29.42
Total tillers per plant	13.16	7.10	24.90	24.35	26.20	86.37	46.61
Ear bearing tillers per plant	11.18	5.10	22.90	28.60	30.84	86.03	54.65
Panicle length (cm)	25.20	19.60	43.20	8.86	12.75	48.34	12.70
Filled grains per panicle	241.56	85.00	460.00	28.22	28.28	99.56	58.00
Ill- filled grains per panicle	33.04	4.66	103.00	71.03	71.35	99.11	45.67
100 seed weight (g)	1.86	1.03	2.79	18.07	19.99	81.73	33.67
Grain yield per plant (g)	28.59	5.53	57.36	44.82	45.15	98.53	91.65

Table 3: Character association among grain yield and yield components in rice

Character		Days to Maturity	Plant height	Total tillers per plant	Ear bearing tillers per plant	Panicle length	Filled grains per panicle	Ill- filled Grains per panicle	100 seed weight	Grain yield per plant
Days to 50 per cent flowering	P	0.9635**	-0.1257	0.2937*	0.2986*	0.1422	0.0513	0.2052	-0.0889	0.3375**
	G	0.9833**	-0.1545	0.3155*	0.3216*	0.2034	0.0737	0.2107	-0.0982	0.3402**
Days to Maturity	P		-0.1300	0.2953*	0.3003*	0.1380	0.0521	0.2077	-0.0904	0.3373**
	G		-0.1519	0.3147*	0.3207*	0.2064	0.0733	0.2194	-0.1074	0.3404**
Plant height	P			-0.1982	-0.2001	0.0775	0.1262	0.0061	0.0102	0.0036
	G			-0.2493	-0.2519*	0.1040	0.1523	0.0153	0.0117	0.0081
Total tillers per plant	P				0.9585**	-0.3261**	0.0038	-0.0131	-0.0808	0.3285**
	G				0.9701**	-0.4200**	0.0050	-0.0159	-0.0968	0.3531**
Ear bearing tillers per plant	P					-0.3265**	0.0006	-0.0145	-0.0816	0.3285**
	G					-0.4206**	0.0086	-0.0159	-0.0873	0.3538**
Panicle length	P						0.0644	0.1148	0.0910	0.0477
	G						0.0950	0.1653	0.1279	0.0703
Filled grains per panicle	P							0.2516*	-0.2940*	0.2609*
	G							0.2526*	-0.3107*	0.2849*
Ill-filled grains per panicle	P								-0.2716*	-0.1547
	G								-0.2842*	-0.1566
100 seed weight	P									0.0146
	G									0.0183

*,**Significant at 5 and 1 per cent levels, respectively

Table 4: Path coefficients for grain yield and yield component characters in rice

Character		Days to 50 per cent flowering	Days to Maturity	Plant height	Total tillers per plant	Ear bearing Tillers per plant	Panicle length	Filled Grains per panicle	Ill- filled grains per panicle	100 seed weight	Correlation with Grain yield per plant
Days to 50 per cent flowering	P	0.0667	0.1790	-0.0071	0.0579	0.0242	0.0014	0.0126	0.0132	-0.0103	0.3376**
	G	0.0772	0.1806	-0.0131	0.0624	0.0286	0.0021	0.0145	0.0136	-0.0257	0.3402**
Days to Maturity	P	0.1656	0.0795	-0.0074	0.0582	0.0243	0.0014	0.0128	0.0134	-0.0105	0.3373**
	G	0.1721	0.0852	-0.0195	0.0662	0.0255	0.0042	0.0141	0.0145	-0.0219	0.3404**
Plant height	P	-0.0210	-0.0103	0.0567	-0.0391	-0.0162	0.0008	0.0311	0.0004	0.0012	0.0036

	G	-0.0227	-0.0125	0.0592	-0.0468	-0.0202	0.0021	0.0344	0.0089	0.0057	0.0081
Total tillers per plant	P	0.0490	0.1235	-0.0112	0.0871	0.0908	-0.0013	0.0009	-0.0008	-0.0094	0.3286**
	G	0.0528	0.1295	-0.0148	0.0924	0.1087	-0.0045	0.0011	-0.0015	-0.0106	0.3531**
Ear bearing tillers per plant	P	0.0498	0.0239	-0.2114	0.1968	0.3809	-0.0013	0.0002	-0.1009	-0.0095	0.3285**
	G	0.0773	0.0633	-0.3149	0.2222	0.4234	-0.0045	0.0004	-0.1027	-0.0107	0.3538**
Panicle length	P	0.0237	0.0110	0.0044	-0.0249	-0.0102	0.0099	0.0158	0.0074	0.0106	0.0477
	G	0.0299	0.0202	0.0062	-0.0284	-0.0243	0.0204	0.0215	0.0091	0.0157	0.0703
Filled grains per panicle	P	0.0085	0.0041	0.0072	0.0007	0.0001	0.0006	0.3061	0.0162	-0.0826	0.2609*
	G	0.0099	0.0052	0.0090	0.0247	0.0002	0.0019	0.3259	0.0139	-0.1258	0.2649*
Ill Filled grains per panicle	P	0.0342	0.0165	0.0003	-0.2430	-0.3106 - -	0.0011	0.0619	0.3049	-0.0200	-0.1547
	G	0.0410	0.0283	0.0009	-0.2255	0.3377	0.0034	0.0671	0.3184	-0.0225	-0.1566
100 seed weight	P	-0.0148	-0.0072	0.0006	-0.0159	-0.0066	0.0009	-0.0477	-0.0111	0.1164	0.0146
	G	-0.0155	-0.0132	0.0007	-0.0252	-0.0081	0.0026	-0.0496	-0.0101	0.1367	0.0183

Residual Effect = 0.8728 (Phenotypic) and 0.8493 (Genotypic); *,**Significant at 5 and 1 per cent levels, respectively; Diagonal bold values indicate direct effects P=Phenotypic; G=Genotypic

Conclusion

High PCV, GCV, heritability, genetic advance as per cent of mean along with significant and positive correlation coupled with high and positive direct effect was observed for ear bearing tillers per plant and filled grains per panicle in the present study indicating their effectiveness as important selection criterion for grain yield improvement in rice.

References

1. Ashok S. Genetic divergence studies for yield components and grain quality parameters in Rice (*Oryza sativa* L.). M.Sc (Ag.) Thesis. Acharya N.G. Ranga Agricultural University, Guntur, India 2015.
2. Burton GW, Devane EW. Estimating heritability in tall fescue (*Festuca arundiraceae*) from replicated clonal material. Agronomy Journal 1953;45:478-481.
3. Dewey DR, Lu KH. A Correlation and path coefficient analysis of components of crested wheat grass seed production. Agronomy J 1959;51(9):515-518.
4. Falconer DS. An Introduction of Quantitative Genetics-Second edition. Oliver and Boyd, Edinburgh 1964, 312-324.
5. Kumar Saurabh Singh, Suneetha Y, Vinay Kumar G, Srinivasa Rao V, Sandeep Raja D, Srinivas T. Variability, Correlation and Path Studies in Coloured Rice 2020.
6. Lenka D, Mishra B. Path coefficient analysis of yield in rice varieties. Indian J of Agri. Science 1973;43:376-379.
7. Nayak R, Singh VK, Singh AK, Singh PK. Genetic variability, character association and path analysis of rice genotypes. Annals of Plant and Soil Research 2016;18(2):161-164.
8. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. ICAR, New Delhi 1978, 103-108.
9. Ravikanth B, Satyanarayana PV, Chamundeswari N, Rani AY, Rao SV, Babu RD. Genetic variability studies on agronomic and physiological traits suitable for direct seeding in rice (*Oryza sativa* L.). The Andhra Agri. J 2018;65(2):315-319.
10. Saha SR, Hassan L, Haque A, Islam MM, Rasel M. Genetic variability, heritability, correlation and path analyses of yield components in traditional rice (*Oryza sativa* L.) landraces. Journal of Bangladesh Agricultural University 2019;17(1):26-32.
11. Singh RK, Kakar SN. Control of individual trait means during index selection. Proc. Third Congr. SABRAO (Canberra) 1977;3(d):22-25.
12. Srilakshmi P, Chamundeswari N, Ahamed LM, Rao SV. Assessment of genetic variability studies in wet direct sown rice. The Andhra Agricultural Journal 2018;65(3):555-560.
13. Sudeepthi K, Srinivas T, Ravi Kumar BNVSR, Jyothula DPB, Nafeez Umar SK. Assessment of Genetic Variability, Character Association and Path Analysis for Yield and Yield Component Traits In Rice (*Oryza sativa* L.). Electronic Journal of Plant Breeding 2020;11(1):144-148.
14. Tejaswini KLY, Ravikumar BNVSR, Mohammad LA, Raju K. Character association studies of F_5 families in rice (*Oryza sativa* L.). International J of Agri. Sciences 2018;10(4):5165-5169.
15. Tiwari DN, Tripathi SR, Tripathi MP, Khatri N, Bastola BR. Genetic variability and correlation coefficients of major traits in early maturing rice under rainfed lowland environments of Nepal. Advances in Agri 2019, 1-9.
16. Wright S. Correlation and causation. J of Agric. Research 1921;20:557-585.