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Research Article

Studies on variability, correlation and path coefficient analysis for yield and quality traits in rice (*Oryza sativa* L.) genotypes

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Abstract
The research work was conducted to study the variability parameters, correlation and path coefficient analysis for yield and quality traits in rice. Analysis of variance revealed the existence of significant differences among the genotypes for all traits under investigation. Traits *viz.,* filled grain number per panicle and weight of 1000 grains showed high PCV and GCV. Total grain number per panicle, filled grain number per panicle, weight of 1000 grains, grain yield per plant, weight of panicle, head rice recovery, length of kernel after cooking, linear elongation ratio, length of kernel and kernel length/breadth ratio exhibited high heritability along with high genetic advance as percentage of mean. Days to 50% flowering and weight of 1000 grains had associated significantly positive with grain yield. Filled grain number per panicle, days to 50% flowering, total number of productive tillers per plant, length of kernel after cooking, height of the plant and length of panicle exhibited a high positive direct effect on grain yield per plant per plant. Therefore, these traits should be exploited in the selection process to identify superior rice lines with higher yield and quality genetic potential.

Keywords: Rice, Yield and quality traits, Variability, Correlation, Path analysis

INTRODUCTION

Rice is an important crop, in terms of human nutrition and caloric intake and being the staple food for more than 100 countries of the world and has been referred to as "Global Grain". The motto "Rice is Life" is particular for India, as grain is essential to our national food security and provides income to millions of rural communities. It is the primary source of food for about half of the population with an enormous nutritional and economic impact. It is a crucial dietary and food security source of many Asian countries Kumar *et al.* (2020). Physical attributes such as size, shape, uniformity and general look are most important when rice is consumed as whole grain and customers prefer this coupled with high cooking qualities. These characteristics largely depend on the physico-chemical properties of starch, which make up 90% of milled rice. To benefit all rice growers and consumers, improvements in grain quality that do not reduce yield are need of the hour. Assessment of variability for yield and quality traits are basic factors to be focused on during selection. Correlation analysis gives the nature and degree of relationship among the traits and path analysis can be used to study direct and indirect cause and effect relationships. Recognizing the need to improve rice productivity and quality, the current study was taken up for yield and quality parameters in several rice genotypes.

MATERIALS AND METHODS

The research was conducted using 30 rice genotypes and was raised in Randomized Block Design (RBD) in two replications during *Kharif*, 2019 at Rice Research Centre (RRC), Agricultural Research Institute (ARI), Rajendranagar, Hyderabad (**Table 1**). Data was recorded on yield traits and grain quality traits in randomly selected five plants for each entry and subjected to statistical analysis. The data was recorded on days to 50 % flowering, height of the plant (cm), total number of productive tillers per plant, length of panicle (cm), weight of panicle (g), filled grain number per panicle (g), weight of 1000 grains (g), grain yield per plant (g), length of kernel (mm), breadth of kernel (mm), kernel length/breadth ratio, percentage of hulling, percentage of milling, head rice recovery (%), length of kernel after cooking (mm), breadth of kernel after cooking (mm), linear elongation ratio and amylose content (%).

The standard procedure given by Panse and Sukhatme (1985) was used for the analysis of variance for each character. Burton and Devane, (1953) proposed the estimation of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) and Johnson *et al*. (1955) gave the range of genetic advance a as percentage of mean based on classes as high (20 and above), medium (10 - 20) and low (0-10). GCV and PCV values were classed as high (20 and

Table 1. List of genotypes with parentage

S. No.	Rice genotypes	Parentage
1	RNR -28393	RGL 11414 X WGL 3962
2	RNR -28376	Bhadrakali X VIR 79216-141-1-3-3
3	RNR -28355	BPT 5204 X CSR-23
4	RNR – 29086	BPT 5204 X (BPT 5204/NLR145) /BLNR1
5	RNR – 29090	Tellahamsa X (BPT 5204/NLR145)/BLNR6
6	RNR – 29092	BPT 5204 X NBR-16
7	RNR – 29183	CN 1757-5-3-7 MLD-18 X RNR15048
8	RNR – 29194	CN 1757-5-3-7 MLD-18 X RNR15048
9	RNR – 29094	BPT 5204/BM7(BBM-1)//BPT 5204 X BM71(BBM2)
10	RNR – 29397	Bhadrakali X IR 79597-56-1-2-1
11	JGL -1798	BPT 5204 / Kavya
12	JS – 1	Local cultivar
13	GK – 1	Local cultivar
14	RNR -21278	RNR 2465 X NLR 3449
15	JGL-3828	Sambamahsuri / Agani
16	KNM -118	MTU 1010 X JGL13595
17	JGL-11727	JGL 420 / MTU 1001
18	JGL-3844	Sambamahsuri/ARC 5984//Kavya
19	JGL-17004	WGL 14377/JGL 3855
20	JGL-11118	IET 8585/JGL1798
21	JGL-11470	JGL 418/Gedongbetan
22	JGL-3855	BPT 5204/ARC 5984//Kavya
23	KNM -733	MTU 1010 X JGL-11470
24	RNR -15435	RNR 17818 X Vasumathi
25	JGL-18047	MTU 1010 X JGL 13595
26	RNR – 15459	RNR 17818 X Chittimuthyalu
27	RNR – 11718	MTU 1010 X NLR 34449
28	RNR – 2354	Early Samba X RNR 19994
29	RNR – 15048	MTU 1010 X JGL 3855
30	HMT SONA	Local cultivar

beyond), medium (10-20) and low (0-10) as given by Sivasubramanian and Menon (1973).) Lush (1949) and Hanson *et al*. (1956) suggested that heritability in a broad sense was estimated as the ratio of genotypic variance to the total variance and expressed as a percentage. Johnson *et al*. (1955) classified the estimates of heritability as high (61-100), moderate (30-60) and low (0-29). Falconer's (1964) formula was used to calculate correlation coefficients at the genotypic and phenotypic levels. The method given by Dewey and Lu (1959) was used for the computation of path analysis. INDOSTAT software was used to conduct all statistical analyses.

RESULTS AND DISCUSSION

For all of the traits under investigation, analysis of variance revealed substantial variations between genotypes (**Table 2**). The results pertaining to genetic variability parameters *viz*., mean, genotypic coefficient of variation, phenotypic coefficient of variation, broad sense heritability (h^2) and genetic advance as percentage of mean (GAM) for yield and quality traits are given in **Table 3**. For all the traits, the values of PCV were higher than the GCV values indicating that these characters are influenced by the environment. High PCV and GCV values were observed for filled grain number per panicle and weight of 1000 grains. High PCV and GCV values indicate that these traits are showing high variability and can be directly selected for crop improvement. Similar results were observed by Chandra Mohan *et al*. (2016) and Parimala *et al.* (2020). Whereas moderate PCV and GCV values were observed for grain yield per plant, head rice recovery percentage, weight of panicle, length of kernel and kernel length/breadth ratio. Similar findings were given by Edukondalu *et al*. (2017) for grain yield per plant, head rice recovery percentage, weight of panicle, length of kernel, kernel length/breadth ratio, Dhurai *et al.* (2014) and Nirmala devi *et al.* (2015) for linear elongation ratio, Rathi *et al*. (2010) and Rakesh *et al.* (2013) for length of kernel after cooking and breadth of kernel after cooking. Days to flowering, total number of productive tillers per plant, height of the plant, length of panicle, breadth of kernel, percentage of hulling, percentage of milling and amylose content had a low genotypic and phenotypic coefficient of variation. This is in accordance with the findings of Chakraborty and Chakraborty (2010) and Yadav *et al.* (2010) for days to flowering, Pavan Shankar *et al.* (2016) for breadth of kernel and amylose content, Rakesh *et al.* (2013) and Edukondalu *et al*. (2017) for percentage of hulling and percentage of milling, Anis *et al.* (2016) for total number of effective tillers per plant, height of the plant and length of panicle.

Tables 2. Analysis of variance for yield, its components and quality parameters in rice genotypes

S. No.	Characters	Mean sum of squares		
		Replications (d.f. = 1)	Treatments (d.f. = 29)	Error (d.f.= 29)
1	Days to 50% flowering	4.81	64.19**	6.64
2	Total no. of Productive tillers per plant	0.60	1.86**	0.18
3	Height of the plant	21.00	103.50**	12.03
4	Length of panicle	2.32	7.79**	2.14
5	Weight of panicle	0.03	0.90**	0.20
6	Filled grain number per panicle	46.81	5014.06**	102.85
7	Weight of 1000 grains	0.09	21.24**	0.26
8	Grain yield per plant	0.32	25.21**	0.52
9	Length of kernel	0.08	1.15**	0.04
10	Breadth of kernel	0.0001	0.02**	0.006
11	Kernel length/breadth ratio	0.003	0.36**	0.02
12	Percentage of hulling	3.45	34.91**	1.33
13	Percentage of milling	9.28	34.84**	1.23
14	Head rice recovery	0.12	167.32**	1.88
15	Length of kernel after cooking	0.33	5.05**	0.20
16	Breadth of kernel after cooking	0.03	0.29**	0.08
17	Linear elongation ratio	0.15	0.06**	0.04
18	Amylose content	0.50	3.96**	0.13

** Significant at 1 level of probability

Table 3. Genetic Variability parameters for yield, its component characters and quality parameters in rice genotypes

S.No.	Characters	Mean	Range		Pheno-typic Variance	Geno-typic Variance	PCV (%)	GCV (%)	Heritability in broad sense (h^2) (%)	Genetic Advance as % mean
			Minimum	Maximum						
1	Days to 50% flowering	94.25	72.00	102.00	35.42	28.78	6.32	5.69	81.20	10.57
2	Number of productive tillers per plant	11.00	9.00	13.00	1.02	0.84	9.20	8.32	81.80	15.51
3	Height of the plant (cm)	96.05	79.70	113.50	57.77	45.73	7.91	7.04	79.20	12.91
4	Length of panicle (cm)	22.73	19.00	28.50	4.97	2.82	9.81	7.39	56.80	11.48
5	Weight of panicle (g)	3.41	2.06	4.90	0.55	0.35	21.78	17.26	62.80	28.18
6	Grains number per panicle	173.75	92.50	285.50	2558.46	2455.60	29.11	28.52	96.00	57.56
7	Weight of 1000 grains(g)	15.11	10.85	22.45	10.75	10.49	21.71	21.44	97.60	43.64
8	Grain yield per plant(g)	19.12	10.45	26.75	12.87	12.35	18.7	18.38	96.00	37.09
9	Length of kernel (cm)	5.74	3.65	8.02	0.60	0.56	13.49	13.01	93.10	25.87
10	Breadth of kernel (mm)	1.61	1.39	1.91	0.01	0.17	7.22	5.47	57.40	8.54
11	Kernel Length/Breadth ratio	3.54	2.63	5.10	0.20	17.04	12.57	11.63	85.60	22.16
12	Percentage of hulling (%)	72.95	62.23	80.80	18.12	16.79	5.83	5.61	92.60	11.13
13	Percentage of milling (%)	67.43	59.6	72.1	18.03	16.80	6.29	6.07	93.20	12.08
14	Head rice recovery (%)	55.56	36.25	68.68	84.61	2.43	16.56	16.37	97.80	33.34
15	Length of kernel after cooking (mm)	8.16	4.50	11.00	2.63	0.11	19.87	19.10	92.40	37.82
16	Breadth of kernel after cooking (mm)	2.39	2.00	3.00	0.19	0.03	18.22	13.82	57.50	21.59
17	Linear elongation ratio	1.42	1.06	1.83	0.04	1.82	14.40	12.08	70.50	20.90
18	Amylose content (%)	21.63	17.35	23.57	2.04	1.91	6.60	6.39	93.70	12.75

Total filled grain number per panicle, weight of 1000 grains, grain yield per plant per plant, weight of panicle, head rice recovery, length of kernel after cooking, linear elongation ratio, length of kernel and kernel length/breadth ratio recorded high heritability and high genetic advance as percentage of mean indicating the role of additive gene effect and direct selection of these traits can be used for improvement. Similar findings were reported by Edukondalu *et al*. (2017) for total filled grain number per panicle, weight of 1000 grains, grain yield per plant and head rice recovery and Abdul *et al*. (2011) for weight of 1000 grains. Rakesh *et al.* (2013) and Gampala *et al*. (2015) for kernel length/breadth ratio and length of kernel after cooking, Rakesh *et al.* (2013), Vanisri *et al.* (2013) for length of kernel and Dhurai *et al.* (2014) for linear elongation ratio. For the selection of traits for improving yield along with PCV and GCV values heritability and genetic advance has to be considered to get reliable results.

Days to 50% flowering, total number of productive tillers per plant, milling percentage, percentage of hulling and amylose content showed high estimates of heritability with moderate genetic advance as a percentage of mean indicating the role of additive and non-additive gene effects on the traits limiting further improvement. Similar findings were reported by Yadav *et al.* (2010) and Sandeep *et al.* (2018) for days to 50% flowering, Kumar *et al*. (2018) and Chinnapa *et al.* (2019) for total number of productive tillers per plant, Sahu *et al*. (2017) for hulling percentage and Rukmini Devi *et al.* (2017) for percentage of milling, Pratap *et al.* (2012) and Nirmala devi *et al.* (2015) for amylose content.

The correlation coefficient from the combined data was presented in **Table 4**. In the present study, genotypic correlations were found to be higher than the phenotypic correlations, indicating that while there is a strong underlying relationship between the traits studied, their expression is hampered by environmental factors. Grain yield per plant revealed a significant and positive association with days to 50% flowering and weight of 1000 grains indicating that days to 50% flowering and weight of 1000 grains have important role in improving yield potential in rice. Similar findings were given by Vanisri *et al.* (2013), Abdul *et al.* (2011) and Rachana *et al*. (2018) for days to 50 % flowering, Vanisri *et al.* (2013) and Basavaraja *et al.* (2011) for weight of 1000 grains. However, it had a negative and significant correlation with amylose content. Correlation analysis gives nature and degree of relationship only, path analysis can be used to study direct and indirect cause and effect relationships.

Table 4. Correlation analysis of yield and quality traits in rice genotypes

Character		DFF	NET	PH	PL	PW	NGP	TW	KL	KB	L/B	HULL	MILL	HRR	KLAC	KBAC	KER	AC	GYP
DFF	G	1.00	0.04	0.47**	0.32*	-0.02	0.02	0.15	0.17	0.06	0.14	-0.31*	-0.34**	-0.12	0.17	-0.24	-0.08	0.02	0.49**
	P	1.00	0.04	0.30*	0.17	0.01	0.01	0.13	0.13	-0.09	0.17	-0.26*	-0.28*	-0.11	0.14	-0.14	-0.07	0.01	0.38**
NET	G		1.00	-0.02	-0.02	-0.23	0.09	-0.11	-0.10	-0.43**	0.12	-0.32*	-0.21	0.13	-0.13	0.01	0.30	0.04	0.20
	P		1.00	-0.03	0.03	-0.17	0.05	-0.08	-0.06	-0.30*	0.12	-0.27*	-0.17	0.13	-0.13	0.01	0.11	0.00	0.18
PH	G			1.00	0.91**	0.22	-0.01	0.07	0.32*	-0.36**	0.50**	-0.39**	-0.44**	-0.40**	0.33**	-0.40**	-0.57**	-0.03	0.24
	P			1.00	0.67**	0.17	-0.04	0.05	0.27*	-0.11	0.34**	-0.32*	-0.39**	-0.36**	0.26*	-0.32*	-0.12	-0.04	0.21
PL	G				1.00	0.38*	-0.11	0.11	0.52**	-0.34**	0.73**	-0.30*	-0.33*	-0.32*	0.61	-0.40	-0.06	0.01	0.18
	P				1.00	0.21	-0.07	0.08	0.40**	-0.03	0.47**	-0.19	-0.22	-0.25	0.42**	-0.24	-0.09	-0.01	0.10
PW	G					**1.00**	0.48**	-0.24	0.17	0.27*	0.09	-0.10	-0.24	0.05	0.08	-0.39**	-0.76	0.21	-0.30*
	P					**1.00**	0.41**	-0.21	0.10	0.03	0.15	-0.08	-0.22	0.02	0.10	-0.32*	-0.13	0.18	-0.23
NGP	G						1.00	-0.56**	-0.61**	-0.36**	-0.53**	-0.32*	-0.28*	0.23	-0.62**	-0.55**	-0.92**	0.23	-0.09
	P						1.00	-0.53**	-0.57**	-0.28*	-0.46**	-0.31*	-0.27*	0.23	-0.57*	-0.41**	-0.37*	0.23	-0.08
TW	G							**1.00**	0.66**	0.79**	0.39**	0.36**	0.16	-0.31*	0.54**	0.65**	0.42**	-0.44**	0.38**
	P							**1.00**	0.6**	0.57**	0.34**	0.34**	0.16	-0.30*	0.51**	0.47**	0.21	-0.41**	0.36**
KL	G								1.00	0.53**	0.91**	0.15	-0.05	-0.49**	0.79**	0.17	0.22	0.02	0.05
	P								1.00	0.44**	0.82**	0.13	-0.06	-0.46**	0.70**	0.15	0.11	0.01	0.04
KB	G									1.00	0.13	0.59**	0.37**	-0.17	0.49**	0.51**	0.25*	-0.33**	0.17
	P									1.00	-0.09	0.49**	0.25*	-0.12	0.36**	0.36**	0.10	-0.24	0.15
L/B	G										1.00	-0.13	-0.24	-0.42**	0.71**	0.00	0.24	0.15	-0.04
	P										1.00	-0.16	-0.22	-0.39**	0.59**	-0.05	0.11	0.12	-0.05
HULL	G											1.00	0.92**	0.12	0.04	0.45**	0.16	-0.12	0.06
	P											1.00	0.86**	0.12	0.06	0.33**	0.05	-0.11	0.06
MILL	G												1.00	0.15	-0.15	0.35**	0.22	-0.21	0.04
	P												1.00	0.14	-0.14	0.25	0.04	-0.19	0.04
HRR	G													1.00	-0.24	0.05	0.27*	0.33**	0.04
	P													1.00	-0.23	0.05	0.09	0.31*	0.04
KLAC	G														1.00	0.33**	1.10**	-0.21	0.20
	P														1.00	0.27*	0.36**	-0.18	0.20
KBAC	G															1.00	1.92**	-0.33*	0.12
	P															1.00	0.37**	-0.23	0.11
LER	G																**1.00**	-0.44**	0.22
	P																**1.00**	-0.22	0.10
AC	G																	**1.00**	-0.41**
	P																	**1.00**	-0.38**

Table 5. Phenotypic (P) and Genotypic (G) path coefficients of yield and quality traits in rice genotypes

Character		DFF	NET	PH	PL	PW	NGP	TW	KL	KB	L/B	HULL	MILL	HRR	KLAC	KBAC	KER	AC	GYP
DFF	G	**0.3681**	0.0164	0.1740	0.1173	-0.0061	0.0071	0.0562	0.0627	0.0217	0.0533	-0.1137	-0.1237	-0.0425	0.0641	-0.0875	-0.0298	0.0079	0.4922**
	P	**0.2946**	0.0112	0.0893	0.0511	0.0015	0.0021	0.0391	0.0387	-0.0251	0.0509	-0.0788	-0.0844	-0.0316	0.0399	-0.0408	-0.0214	0.0027	0.3829**
NET	G	-0.0074	**-0.1650**	0.0034	0.0034	0.0383	-0.0141	0.0179	0.0164	0.0702	-0.0199	0.0529	0.0339	-0.0211	0.0210	-0.0014	-0.0501	-0.0059	0.2017
	P	0.0079	**0.0697**	-0.0018	0.0020	-0.0119	0.0038	-0.0059	-0.0045	-0.0210	0.0087	-0.0193	-0.0119	0.0089	-0.0088	0.0010	0.0079	-0.0003	0.1860
PH	G	0.3519	-0.0152	0.7447	0.6754	0.1607	-0.0105	0.0522	0.2371	-0.2649	0.3712	-0.2886	-0.3244	-0.2959	0.2441	-0.3013	-0.4279	-0.0190	0.2407
	P	0.0783	-0.0065	0.2585	0.1743	0.0429	-0.0091	0.0119	0.0722	-0.0275	0.0894	-0.0838	-0.1009	-0.0935	0.0683	-0.0829	-0.0312	-0.0091	0.2182
PL	G	-0.0328	0.0021	-0.0935	-0.1030	-0.0390	0.0115	-0.0118	-0.0535	0.0352	-0.0756	0.0310	0.0338	0.0331	-0.0624	0.0417	0.0057	-0.0008	0.1767
	P	0.0089	0.0015	0.0347	0.0515	0.0109	-0.0038	0.0040	0.0208	-0.0016	0.0245	-0.0097	-0.0115	-0.0130	0.0220	-0.0122	-0.0047	-0.0007	0.1022
PW	G	0.0145	0.2025	-0.1881	-0.3297	**-0.8716**	-0.4145	0.2082	-0.1515	-0.2361	-0.0743	0.0871	0.2048	-0.0475	-0.0727	0.3410	0.6586	-0.1846	-0.2990*
	P	-0.0016	0.0513	-0.0501	-0.0638	**-0.3017**	-0.1249	0.0619	-0.0306	-0.0104	-0.0442	0.0248	0.0675	-0.0057	-0.0292	0.0967	0.0393	-0.0529	-0.2368
NGP	G	0.0158	0.0697	-0.0116	-0.0912	0.3881	**0.8161**	-0.4529	-0.4956	-0.2898	-0.4323	-0.2605	-0.2308	0.1916	-0.5024	-0.4481	-0.7510	0.1855	-0.0901
	P	0.0024	0.0187	-0.0121	-0.0255	0.1423	**0.3437**	-0.1844	-0.1974	-0.0970	-0.1608	-0.1072	-0.0957	0.0775	-0.1993	-0.1411	-0.1279	0.0796	-0.0889
TW	G	-0.0527	0.0375	-0.0242	-0.0394	0.0824	0.1915	**-0.3451**	-0.2266	-0.2724	-0.1339	-0.1240	-0.0563	0.1076	-0.1851	-0.2245	-0.1453	0.1519	0.3777**
	P	0.0182	-0.0115	0.0063	0.0106	-0.0281	-0.0734	**0.1369**	0.0838	0.0780	0.0470	0.0474	0.0218	-0.0415	0.0711	0.0647	0.0283	-0.0570	0.3665**
KL	G	-0.4433	0.2589	-0.8285	-1.3509	-0.4524	1.5805	-1.7089	**-2.6027**	-1.3697	-2.3621	-0.3933	0.1179	1.2760	-2.0637	-0.4392	-0.5751	-0.0557	0.0506
	P	0.0147	-0.0072	0.0314	0.0453	0.0114	-0.0645	0.0687	**0.1122**	0.0504	0.0931	0.0142	-0.0063	-0.0526	0.0789	0.0167	0.0127	0.0007	0.0453
KB	G	0.0518	-0.3735	-0.3122	-0.2999	0.2378	-0.3118	0.6928	0.4620	0.8778	0.1101	0.5203	0.3227	-0.1460	0.4273	0.4455	0.2212	-0.2873	0.1701
	P	0.0090	0.0317	0.0112	0.0034	-0.0036	0.0297	-0.0601	-0.0474	-0.1054	0.0093	-0.0525	-0.0266	0.0126	-0.0384	-0.0389	-0.0103	0.0257	0.1557
L/B	G	0.4385	0.3653	1.5093	2.2226	0.2580	-1.6042	1.1750	2.7482	0.3798	3.0282	-0.3829	-0.7223	-1.2769	2.1506	-0.0004	0.7201	0.4443	-0.0413
	P	-0.0253	-0.0182	-0.0507	-0.0700	-0.0215	0.0687	-0.0504	-0.1217	0.0130	-0.1467	0.0228	0.0319	0.0576	-0.0872	0.0070	-0.0163	-0.0181	-0.0587
HULL	G	-0.1079	-0.1120	-0.1354	-0.1050	-0.0349	-0.1115	0.1255	0.0528	0.2071	-0.0442	0.3494	0.3215	0.0426	0.0132	0.1557	0.0555	-0.0426	0.0557
	P	-0.0084	-0.0087	-0.0102	-0.0059	-0.0026	-0.0098	0.0109	0.0040	0.0156	-0.0049	0.0313	0.0270	0.0038	0.0019	0.0105	0.0017	-0.0034	0.0617
MILL	G	-0.0352	-0.0215	-0.0456	-0.0344	-0.0246	-0.0296	0.0171	-0.0047	0.0385	-0.0250	0.0964	0.1048	0.0156	-0.0158	0.0367	0.0233	-0.0217	0.0391
	P	-0.0304	-0.0182	-0.0414	-0.0236	-0.0237	-0.0295	0.0169	.0060	0.0268	-0.0231	0.0914	0.1061	0.0151	-0.0146	0.0263	0.0046	-0.0206	0.0487
HRR	G	-0.0274	0.0303	-0.0941	-0.0760	0.0129	0.0556	-0.0739	-0.1161	-0.0394	-0.0999	0.0289	0.0353	0.2369	-0.0567	0.0114	0.0645	0.0774	0.0391
	P	-0.0133	0.0158	-0.0447	-0.0312	0.0023	0.0279	-0.0375	-0.0580	-0.0148	-0.0486	0.0148	0.0176	0.1236	-0.0279	0.0063	0.0115	0.0384	0.0439
KLAC	G	-0.0790	0.0579	-0.1487	-0.2747	-0.0378	0.2793	-0.2433	-0.3598	-0.2209	-0.3223	-0.0172	0.0685	0.1086	-0.4538	-0.1503	-0.5011	0.0963	0.2047
	P	0.0396	-0.0367	0.0773	0.1249	0.0282	-0.1695	0.1517	0.2054	0.1066	0.1737	0.0176	-0.0403	-0.0660	0.2922	0.0797	0.1069	-0.0532	0.2005
KBAC	G	-0.0140	0.0005	-0.0238	-0.0239	-0.0231	-0.0324	0.0383	0.0099	0.0299	0.0000	0.0263	0.0206	0.0028	0.0195	0.0589	0.1129	-0.0193	0.1228
	P	-0.0040	0.0000	-0.0010	-0.0008	-0.0010	-0.0013	0.0015	0.0005	0.0012	-0.0002	0.0011	0.0008	0.0002	0.0009	0.0032	0.0012	-0.0007	0.1114
LER	G	-0.0123	0.0461	-0.0872	-0.0085	-0.1147	-0.1397	0.0639	0.0336	0.0383	0.0361	0.0241	0.0338	0.0414	0.1677	0.2909	0.1519	-0.0663	0.2277
	P	-0.0056	0.0088	-0.0093	-0.0070	-0.0101	-0.0289	0.0160	0.0088	0.0075	0.0086	0.0042	0.0033	0.0072	0.0284	0.0288	0.0775	-0.0172	0.1040
AC	G	-0.0080	-0.0133	0.0095	-0.0030	-0.0788	-0.0846	0.1638	-0.0080	0.1218	-0.0546	0.0454	0.0771	-0.1216	0.0790	0.1219	0.1625	**-0.3722**	-0.4100**
	P	-0.0033	0.0088	0.0128	0.0049	-0.0637	-0.0841	0.1511	-0.0024	0.0883	-0.0447	0.0393	0.0706	-0.1127	0.0660	0.0834	0.0806	**-0.3630**	-0.3864**

DFF: Day to 50% flowering, NET: Total number of productive tillers per plant, PH: Height of the plant , PL: Length of panicle ,PW:weight of panicle , NGP: filled grain number per panicle, TW: weight of 1000 grains , KL:Length of kernel ,KB: Breadth of kernel , L/B: Length Breadth ratio, HULL:Percentage of Hulling , MILL:Percentage of milling , HRR: Head Rice Recovery ,KLAC: Length of kernel after Cooking ,KBAC: Breadth of kernel after Cooking , LER :Linear elongation ratio, AC: Amylose content , GYP: Grain yield per plant .

Total filled grain number per panicle, days to 50% flowering, length of kernel after cooking, height of the plant, weight of 1000 grains, head rice recovery, length of kernel, percentage of milling, total number of productive tillers per plant, length of panicle, percentage of hulling and breadth of kernel after cooking showed a higher positive direct effect on grain yield per plant . Similar findings were given by Laxuman *et al*. (2011) and Sreedhar and Reddy (2019) for days to 50% flowering, Rahman *et al*. (2014) and Basavaraja *et al.* (2011) for total number of productive tillers per plant, Rahman *et al*. (2014) and Shinde *et al*. (2015) for a positive direct effect of height of the plant on grain yield per plant . Abdus *et al*. (2009) and Menaka *et al.* (2015) for a positive direct effect of filled grain number per panicle on grain yield per plant, Patel *et al*. (2017) for a direct effect of length of panicle on grain yield per plant (**Table 5**).

In conclusion, analysis of variance revealed that all genotypes had significant differences for all traits under study indicating that genotypes possessed inherent genetic differences. It was observed that total filled grain number per panicle, weight of 1000 grains, grain yield per plant, weight of panicle, head rice recovery, length of kernel after cooking, linear elongation ratio, length of kernel and kernel length/breadth ratio had high heritability and high genetic advance as percentage of mean and indicating that inheritance was controlled by additive gene action. Simple selection can be done to improve these traits. The remaining traits, which had low to moderate estimates of genetic advance, were largely influenced by non-additive gene effects. Analysis of correlation studies revealed that selection of plants with more weight of 1000 grains and days to 50 % flowering would result in improvement of yield. Path coefficient analysis revealed that a higher positive direct effect on grain yield per plant was registered by total filled grain number per panicle, days to 50% flowering, total number of productive tillers per plant, length of kernel after cooking, height of the plant and length of panicle. Hence, these traits can be considered as critical for improving yield and grain quality. Therefore, these characters should be prioritized during the selection process in order to identify better lines with more genetic potential for higher rice yield and quality.

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