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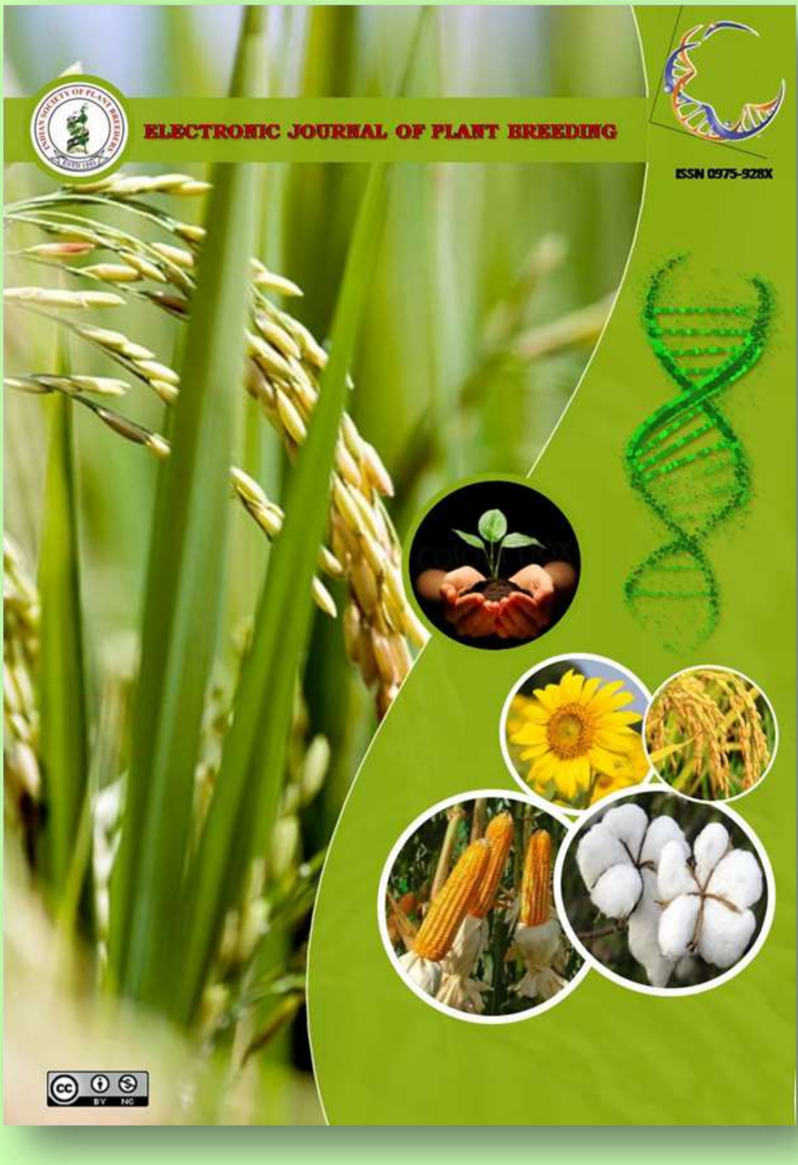

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Research Article

Genetic variability and association studies in F_2 generation of rice (*Oryza sativa* L.)

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Abstract
The F_2 segregating generation of two crosses *viz*., CO 52 × CR Dhan 310 and RNR 15048 × CB 13543 were evaluated for variability parameters, character association and path coefficient analysis. The results revealed that both the crosses exhibited high GCV and PCV for the traits *viz*., number of productive tillers per plant, number of filled grains per panicle and single plant yield. The traits *viz.,* number of productive tillers per plant, number of filled grains per panicle, hundred grain weight and single plant yield showed high heritability coupled with high genetic advance indicating the presence of additive gene effect and selection for these traits may be effective. Correlation studies revealed that plant height, number of productive tillers and panicle length had significant positive association with single plant yield in both crosses. Number of productive tillers per plant showed high positive direct effect on grain yield. Path analysis revealed that number of productive tillers per plant showed high positive direct effect on grain yield.

Key words
Rice, F_2, variability, correlation, path analysis

Introduction

Rice, the most vital crop among cereals serves as the staple food for more than 3.5 billion population of the world. Rice provides nearly 50 to 80 per cent of total calorific intake of the Asian population for whom rice is the prime source of energy. The current world population of 7.7 billion is estimated to reach 8.1 billion by 2025 and 9.6 billion by 2050. This population hike will be mostly experienced by the developing countries of Asia and Africa placing a challenge before the rice researchers and producers of these countries. Increased production efficiency of rice is needed to satisfy the hunger of the increasing population and also to compensate the decreasing arable land (Okpala *et al*., 2017).

The base for any crop improvement programme relies on availability of genetic variability and adoption of appropriate selection techniques (Rani *et al*., 2016). Being a segregating population, the F_2 generation is more vital for improving plant types by enforcing further selection improvement. Heritability coupled with genetic advance would provide a clearcut approach for selection of desirable trait (Shet *et al*., 2012). Correlation studies provide knowledge on contribution of various traits on yield (Allard, 1960). But correlation does not provide the relation among cause and effect. Hence, the direct and indirect contribution of traits towards yield is predicted by path coefficient analysis. The present investigation was done to assess the genetic variability and association between traits.

Materials and Methods

The material for the present study comprised of F_2 generation of two cross combinations *viz*., CO 52 × CR Dhan 310 and RNR 15048 × CB13543. The experimental study was carried out at Agricultural College and Research Institute, Madurai during *Kharif*, 2018. Single seedlings per hill were maintained at a spacing of 20 × 20 cm and all cultural practices were followed. In F_2 generation single plants were selected randomly and observations was recorded on plant height, number of productive tillers per plant, panicle length, number of filled grains per panicle, single plant yield, 100 grain weight, kernel length, kernel breadth and kernel L/B ratio. The Phenotypic and genotypic coefficient of variation were computed by the method reported by Burton and De Vane (1953). Correlation and path analysis were done using the GENERES statistical software.

Results and Discussion

In the present investigation, the Phenotypic Coefficient of Variation (PCV) was greater than the Genotypic Coefficient of Variation (GCV) for all traits studied in both F_2 crosses representing the magnitude of environmental influence (Table 1). In the cross CO 52 × CR Dhan 310, number of productive tillers per plant, number of filled grains per panicle and single plant yield showed high GCV and PCV which were in accordance with Rani *et al.* (2016). Low GCV and PCV were recorded by plant height, kernel length, kernel breadth and kernel L/B ratio. Similar results were observed by Sala *et al.* (2015) and Rani *et al.* (2016) for kernel characters. Savitha and Ushakumari (2015) and Roy *et al*. (2015) reported low GCV and PCV for plant height. Number of filled grains per panicle and panicle length had moderate GCV and PCV. High heritability was reported for all the traits under study. High genetic advance as per cent of mean (GAM) was observed for number of productive tillers per plant, panicle length, number of filled grains per panicle, hundred grain weight and single plant yield. Plant height, kernel breadth and kernel L/B ratio reported moderate GAM whereas kernel length alone had low GAM.

In the cross RNR 15048 × CB 13543 number of productive tillers per plant, number of filled grains per panicle and single plant yield had high GCV and PCV. These results were similar to the results of Mamata *et al*. (2018). The traits *viz.*, plant height, panicle length and hundred grain weight showed moderate GCV and PCV. Dhanwani *et al*. (2013) reported similar findings. Low PCV and GCV were reported for kernel length, kernel breadth and kernel L/B ratio which was similar to the results of Rani *et al*. (2016). Except plant height all the characters showed high heritability. High GAM was reported for plant height, number of productive tillers per plant, number of filled grains per panicle, hundred grain weight and single plant yield which was similar to the results of Dhanwani *et al*. (2013). Panicle length, kernel length and kernel breadth had moderate GAM. Kernel L/B ratio showed low genetic advance as per cent of mean.

Analysis of variability parameter revealed that in both crosses the characters *viz.*, number of productive tillers per plant, number of filled grains per panicle and single plant yield registered high GCV and PCV. High heritability coupled with high genetic advance was observed for traits *viz.*, number of filled grains per panicle, number of productive tillers per plant, single plant yield and hundred grain weight indicating the presence of additive gene effect and it inferred that simple selection may be effective for improvement of these traits.

Grain yield being a complex and quantitatively inherited character, its improvement should be done by indirect selection of characters which contribute for yield. This can be done with the aid of association studies. Association of yield with other contributing traits becomes the base for selecting genotypes with high yield potential. The correlation study revealed that in the cross CO 52 × CR Dhan 310, grain yield had significant and positive association with number of productive tillers per plant (0.802), plant height (0.345) and panicle length (Table 2). Lakshmi *et al*. (2014) reported significant positive association of plant height and panicle length with yield and Roy *et al*. (2015) noticed significant positive association of number of productive tillers per plant with yield. Plant height had significant positive inter correlation with number of productive tillers per plant and kernel length. Kernel length showed positive correlation with hundred grain weight. Hence during selection priority should be given for plant height, number of productive tillers per plant and panicle length for improvement of grain yield. Kernel L/B ratio showed significant negative association with yield and this paves the way for selection of high yielding but slender grain type segregants simultaneously. Path coefficient analysis revealed that the number of productive tillers had high positive direct effect on grain yield (Table 4) which was in accordance with the findings of Shet *et al.* (2012).

In the cross RNR 15048 × CB 13543 the traits *viz.*, plant height, panicle length, number of productive tillers and number of filled grains per panicle exhibited significant positive association with grain yield (Table 3). Immanuel *et al*. (2011) reported similar results. Plant height had significant positive association with panicle length, number of productive tillers per plant and number of filled grains per panicle. Kernel length and kernel breadth had positive correlation with hundred grain weight. Partitioning of characters by path analysis revealed that number of productive tillers per plant and kernel length had high direct effect on yield and kernel L/B ratio (Table 5). Kernel breadth showed high negative direct effect on yield. These results were in accordance with the findings of Kumar (2012).

Outcome of association analysis in both the crosses suggest that selection based on plant height, number of productive tillers per plant, panicle length and number of filled grains per panicle will be effective to improve yield potential as they showed high direct positive effect in path analysis and positive significant association with grain yield.

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Table 1. Genetic parameters for various traits in F_2 generation of two crosses

Crosses / Parameters	CO 52 X CR Dhan 310							RNR 15048 X CB 13543						
	Mean	Range		PCV (%)	GCV (%)	Heritability (%)	GAM (%)	Mean	Range		PCV (%)	GCV (%)	Heritability (%)	GAM (%)
		Min	Max						Min	Max				
PH (cm)	102.67	86.20	127.10	7.62	7.55	98.09	15.40	112.72	77.50	134.20	10.33	10.22	97.83	20.82
NPT	11.42	4.00	23.00	34.52	33.01	91.49	65.05	10.38	4.00	25.00	38.04	34.19	80.77	63.29
PL (cm)	23.39	18.20	30.10	11.26	10.47	86.47	20.05	23.99	16.20	30.80	12.53	9.66	59.51	15.36
NGPP	108.26	56.00	223.00	30.82	25.53	68.63	43.57	168.76	85.00	334.00	32.67	32.00	95.94	64.56
HGW (g)	2.05	1.50	2.50	18.20	17.46	92.08	34.52	1.50	1.30	2.20	17.51	17.09	95.22	34.39
SPY (g)	17.91	4.00	44.20	46.47	45.63	96.40	92.29	19.46	4.90	41.70	45.68	45.18	97.82	92.04
KL (mm)	6.34	5.80	6.80	3.45	3.33	92.94	6.61	5.81	5.40	6.50	5.25	5.12	95.22	10.29
KB (mm)	2.06	1.60	2.80	9.95	9.60	92.95	19.06	1.90	1.70	2.30	7.14	6.21	75.83	11.15
L/B ratio	3.17	2.90	3.88	9.42	9.06	92.46	17.94	3.07	2.67	3.41	5.49	3.71	45.53	5.15

PH- Plant height, PL- Panicle length, NPT- Number of productive tillers per plant, NFGP- Number of filled grains per panicle, KL- Kernel length, KB- Kernel breadth, L/B ratio- Kernel length/breadth ratio, HGW- Hundred grain weight, SPY- Single plant yield

PCV- Phenotypic coefficient of variation , GCV- Genotypic coefficient of variation, GAM- Genetic advance as percent of mean

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Table 2. Correlation coefficients among yield and yield components in F_2 generation of the cross CO 52 × CR Dhan 310

	PH	NPT	PL	NFGP	HGW	KL	KB	L/B ratio	SPY
PH	1	0.358**	0.3	0.109	0.151	0.287*	-0.011	0.045	0.345**
NPT		1	0.266	0.023	-0.043	-0.07	0.116	-0.258*	0.802**
PL			1	0.024	-0.221	0.03	-0.079	0.164	0.234**
NFGP				1	-0.303**	-0.174	-0.11	0.115	0.122
HGW					1	0.358**	0.016	-0.112	0.077
KL						1	0.105	0.056	0.033
KB							1	-0.85	0.126
L/B ratio								1	-0.275**
SPY									1

* Significant at 5 %, **Significant at 1%

Table 3. Correlation coefficients among yield and yield components in F_2 generation of the cross RNR 15048 × CB 13543

	PH	NPT	PL	NFGP	HGW	KL	KB	L/B ratio	SPY
PH	1	0.305**	0.439**	0.341**	-0.195	-0.329**	-0.042	-0.256	0.399**
NPT		1	0.29	0.136	-0.157	0.155	0.065	0.066	0.711**
PL			1	0.276*	-0.098	-0.209	-0.081	-0.095	0.409**
NFGP				1	-0.343**	-0.321**	-0.325**	0.096	0.349**
HGW					1	0.372**	0.499**	-0.262	-0.143
KL						1	0.613**	0.175	0.076
KB							1	-0.668**	0.013
L/B ratio								1	0.051
SPY									1

* Significant at 5%, **Significant at 1%

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Table 4. Direct and Indirect effects of different traits on grain yield in F_2 generation of the cross CO 52 × CR Dhan 310

	PH	NPT	PL	NFGP	HGW	KL	KB	L/B ratio	SPY
PH	**-0.00225**	0.26744	0.02444	0.0182	0.01829	0.02782	0.00154	-0.01028	0.345**
NPT	-0.00080	**0.74749**	0.02172	0.00383	-0.00525	-0.00683	-0.01632	0.05857	0.802**
PL	-0.00067	0.19905	**0.08156**	0.00405	-0.02666	0.0029	0.01119	-0.03725	0.234**
NFGP	-0.00024	0.01711	0.00198	**0.16721**	-0.03658	-0.01684	0.01554	-0.02618	0.122
HGW	-0.00034	-0.03246	-0.01800	-0.05064	**0.12078**	0.03476	-0.00233	0.02535	0.077
KL	-0.00064	-0.05262	0.00244	-0.02902	0.04326	**0.09705**	-0.01479	-0.01271	0.033
KB	0.00002	0.0864	-0.00646	-0.01840	0.00199	0.01016	**-0.14123**	0.19333	0.126
L/B ratio	-0.0001	-0.19255	0.01336	0.01926	-0.01347	0.00543	0.12009	**-0.22736**	-0.275**

Residual effect= 0 .55, * Significant at P= 5%, **Significant at 1%

Table 5. Direct and Indirect effects of different traits on grain yield in F_2 generation of the cross RNR 15048 × CB 13543

	PH	NPT	PL	NFGP	HGW	KL	KB	L/B ratio	SPY
PH	**0.12986**	0.17802	0.06637	0.07671	-0.00748	-0.21249	0.02986	0.13789	0.399**
NPT	0.03956	**0.58432**	0.04381	0.03055	-0.006	0.10033	-0.04579	-0.03566	0.711**
PL	0.05703	0.1694	**0.15113**	0.06207	-0.00375	-0.13503	0.05711	0.05129	0.409**
NFGP	0.04434	0.07945	0.04175	**0.22469**	-0.01313	-0.20726	0.23062	-0.05154	0.349**
HGW	-0.02538	-0.09156	-0.01482	-0.07708	**0.03829**	0.24019	-0.35385	0.14111	-0.143
KL	-0.04271	0.09074	-0.03158	-0.07207	0.01423	**0.64612**	-0.43456	-0.09453	0.076
KB	-0.00547	0.03773	-0.01217	-0.07307	0.0191	0.39593	**-0.70917**	0.36029	0.013
L/B ratio	-0.03321	0.03865	-0.01438	0.02148	-0.01002	0.11328	0.47392	**-0.53914**	0.051

Residual effect= 0 .62, * Significant at 5%, **Significant at 1%