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Research Article

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Variability, Correlation and Path Analysis Studies of Yield and Yield Attributing Traits in Advanced breeding lines of rice (*Oryza sativa* L.)

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ABSTRACT

The present investigation was carried out to determine the nature and magnitude of genetic variability, the degree of association between grain yield and yield attributing characters and their direct, indirect effects on grain yield in twenty-seven advanced breeding lines of rice with four checks. The experiment was carried out in Randomised Complete Block Design (RCBD) with three replications at three locations viz., ZAHRS, Shivamogga, AHRS, Kathalagere and AHRS, Ponnampet during Kharif 2017. The result from the study revealed that all the thirteen traits under study showed a wide range of variation. Moderate to high PCV and GCV values were observed for plant height, number of filled grains per panicle, number of spikelets per panicle, test weight, straw yield and grain yield. High heritability coupled with high GAM for plant height, test weight and straw yield. Straw yield and harvest index showed significant positive correlation with grain yield per hectare. Therefore, the improvement of these traits through selection will automatically result in increased grain yield. Straw yield, days to maturity, harvest index, panicle length, days to fifty per cent flowering, number of productive tillers per plant, number of filled grains per panicle and test weight exhibited a positive direct effect on grain yield indicating that the selection for these characters was likely to bring about an overall improvement in grain yield directly.

Key words: *Correlation, Path coefficient, Rice, Variability.*

INTRODUCTION

Rice (*Oryza sativa* L.), belongs to family Gramineae. Rice has a unique position as a source of providing over 75 percent of Asian population and about 65 per cent of world population's meal. In India area under rice cultivation is 43.95 million hectare and production is 104.32 million tonnes with the productivity of 2404 kilograms per hectare (Agriculture statistics at a glance, 2015-16). Most of the traits of interest to breeders are complex and are the result of the interaction of a number of components. Understanding the relationship between yield and its components is of importance for making the best use of these relationships in selection.

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A critical estimate of nature and magnitude of genetic variability is a prerequisite for any crop improvement programme. The variation observed in any population could be due to the genetic and environmental factors and also due to the interaction (G × E) between these factors. The broad sense heritable is the ratio of genotypic variance to the total variance in the non-segregating population[6,7]. High heritability linked with high genetic advance was reported to be more useful in practicing selection in a population[9].

Grain yield depends on various component characters and knowledge of correlations among yield component traits and yield is of great importance in the selection of elite genotypes for breeding programmes. Correlation studies among yield and its component traits give a better view towards the relationship between yield and its components[10]. Phenotypic correlation provides the extent to which the two variables are associated and is governed by genotypic and environmental correlation. Genotypic correlation plays a vital role in the development and execution of suitable breeding programmes[11].

Path analysis also helps in determining the direct and indirect causes of association and formulation of effective breeding strategies for development of better genotypes. The present study with 31 (27 advanced breeding lines + 4 checks) lines of rice was carried out for computing the interrelationship between the thirteen quantitative traits for developing new genotypes with better combinations of these characters.

MATERIAL AND METHODS

The experimental material for the contemporary study comprises of twenty-seven advanced breeding lines of F_6 generation (Developed through cross combinations of Mysore Mallige × Akkalu, Mysore Mallige × IET sanna, Mysore Mallige × BPT-5204, Mysore Mallige × KPR-2, Mysore Mallige × KMLT-4, KPR-2 × IET sanna, JGL-1798 × KPR-2.) with four checks JGL-1798, KPR-2, BPT-5204 and Mysore mallige collected from Department of genetics and plant breeding, College of Agriculture Shivamogga. The research was carried out during *kharif* 2017 at three locations *viz.* AHRS, Kathalagere, ZAHRS, Shivamogga and AHRS, Ponnampet.

The experiment was laid out in Randomised Complete Block Design (RCBD) with two replications in puddle field at all locations. Seedlings were transplanted to the main field at the rate of one to two seedlings per hill with a spacing of 20 × 15. The recommended package of practice was followed to get normal healthy crop. Observations were recorded for yield and yield attributing characters on five randomly selected competitive plants for each entry in each replication. The averages of observations recorded on these five plants were considered for statistical analysis.

Data on five plants from each replicate were recorded on Days to fifty per cent flowering, Days to maturity, Plant height, Number of total tillers, Number of productive tillers, Panicle length (cm), Straw yield per hectare (kg/ha), Harvest index (%), Number of total spikelets per panicle, Number of filled grains per panicle, Panicle fertility (%), Test weight (1000 grain weight in grams) and Grain yield per hectare (kg/ha). Statistical analyses for the above characters were done following Singh and Chaudhary[17] for correlation coefficient and Dewey and Lu[3] for path analysis.

RESULTS AND DISCUSSION

The genetic variability parameter *viz.,* mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (broad sense) and genetic advance as per cent mean for all the sixteen characters are mentioned in Table 1.

All the thirteen traits under study showed a wide range of variation indicating enough opportunity for bringing about improvement in essential direction. In contemporary study, low GCV and PCV were recorded for days to fifty per cent flowering, days to maturity, panicle length and panicle fertility, only low GCV value observed for number of tillers per plant, number of productive tillers per plant and harvest index. These results were conformity with Mallimar *et al.*[21], for days to fifty per cent flowering, days to maturity and panicle length. Nirmaladevi *et al.*[12], also recorded same results for panicle fertility.

The moderate to high PCV and GCV values were observed for plant height, number of spikelets per panicle, number of filled grains per panicle, test weight, straw yield and grain yield. These results were conformity with Jan *et al.*[19], for number of spikelets per panicle, number of filled grains per panicle and grain yield. Lakshmi *et al.*[8], recorded same results for plant height. Mallimar *et al.*[21], observed similar results for test weight. Kole *et al.*[13], recorded similar results for straw yield and harvest index. The magnitude of PCV was higher than the corresponding GCV for the all characters suggesting the influence of environment on the expression of these traits. The difference between PCV and GCV were less for some characters indicated low environmental influence and predominance of genetic factor controlling variability in those traits.

The high heritability was observed for days to fifty per cent flowering, days to maturity, plant height, panicle length, test weight, straw yield, grain yield and harvest index. It revealed that these characters are less influenced by environment and there could be greater correspondence between phenotypic and breeding values. Genetic advance as per cent of mean was high for plant height, test weight and straw yield, moderate for number of spikelets per panicle, number of filled grains per panicle and grain yield. High heritability coupled with high GAM for plant height, test weight and straw yield. Lakshami *et al.*[8], reported similar results for plant height and test weight. It indicates the control of additive gene and selection may be effective for these traits.

Phenotypic correlations were assessed among thirteen characters to find the nature of association present among the characters (Table 2). Genotypic correlation coefficients in general were higher than phenotypic correlation coefficients indicating strong inherent association between the traits. In this investigation straw yield (0.1537*) and harvest index (0.4556**) showed significantly positive correlation with grain yield per hectare. Therefore, improvement of these traits through selection will automatically result in increased grain yield. Similar results were also reported by Jan *et al.*[19], for harvest index, Chaudhary and Motiramant[2] for straw yield. While days to fifty per cent flowering, days to maturity, panicle length, number of tillers per plant, number of productive tillers per plant, number of spikelets per panicle, number of grains per panicle, panicle fertility and test weight showed positive correlation with grain yield per hectare. Similar kind of association was revealed by Ramya Rathod *et al*.[5], for days to fifty percent flowering and test weight, Nagesh *et al.*[15], for days to maturity and panicle length, Sharma and Sharma[14] for number of productive tillers per plant and Borbora *et al.*[20], for number of grains per panicle.

It was observed that plant height was recorded negative association with grain yield per hectare at phenotypic level. Similar results were reported by Lakshami *et al.*[8], Nagesh *et al*.[15], Afzal Zahid *et al*.[1], and Chaudhary and Motiramani[2]. Therefore, selection of semi-dwarf genotypes/lines will be preferred to increase the grain yield in rice. Plant height had a significant positive correlation with days to fifty per cent flowering, days to maturity, panicle length, straw yield and test weight as reported by Mamata Behera *et al*.[4], for panicle length and test weight, Babu *et al.*, for test weight. Days to fifty per cent flowering had significant positive correlations with days to maturity, plant height, test weight and straw yield. Panicle length had a significant positive association with days to maturity, plant height, straw yield and test weight as reported by Ramya Rathod *et al*.[5], for plant height, Lakshami *et al.*[8], for test weight.

Number of productive tillers per plant had a significant positive association with number of tillers per plant and panicle fertility, whereas significant negative association with days to fifty per cent flowering, days to maturity, plant height, number of spikelets per panicle and test weight. Number of filled grains per panicle had a positive association with number of spikelets per panicle, panicle length, panicle fertility, test weight and harvest index, whereas it exhibited a significant negative association with days to fifty per cent flowering, plant height, number of tillers and straw yield. Harvest index had a significant positive association with panicle fertility, number of productive tillers, number of spikelets per panicle, number of grains per panicle, test weight and grain yield as reported by Sahu *et al*.[18], for grain yield.

In the present study, the path coefficient analysis was done at the phenotypic level (Table 3). The phenotypic path coefficient analysis for yield related characters *viz.*, straw yield, days to maturity, harvest index, days to fifty per cent flowering, panicle length, number of productive tillers per plant, number of filled grains per panicle and test weight exhibited a positive direct effect on grain yield indicating that the selection for this characters was likely to bring about an overall improvement in grain yield directly. Similar results were reported by Ramya Rathod *et al*.[5], for days to fifty per cent flowering. Lakshami *et al.*[8], for number of filled grains per panicle, test weight and number of productive tillers per plant. Jan *et al.*[19], for days to fifty per cent flowering, straw yield and harvest index. Afzal Zahid *et al*.[1], for test weight and number of filled grains per panicle. Further, negative direct effect on grain yield per hectare was recorded in plant height, number of spikelets per panicle, panicle fertility and number of tillers per plant. Similar results were reported by Afzal Zahid *et al*.[1], for plant height and number of tillers per plant.

Number of filled grains per panicle had a positive indirect effect on yield through the characters such as days to maturity, plant height, panicle length, number of tillers per plant, test weight and harvest index. Panicle fertility *via* plant height, number of productive tillers, number of filled grains per panicle and harvest index had a positive indirect effect on grain yield.

Table 1: Estimates of mean, range, PCV, GCV, heritability and genetic advance per cent of mean for yield and yield component traits in twenty-seven advanced breeding lines of rice across the three different locations

SL. No.	Characters	Mean	Range		Coefficient of variation (%)		h^2 broad sense (%)	GAM (%)
			Minimum	Maximum	PCV	GCV		
1	Days to 50%fiowering	105.11	89.83	117.17	5.77	4.74	67.30	8.02
2	Days to maturity	137.03	122.17	149.17	3.95	3.33	71.02	5.78
3	Plant height(cm)	82.73	69.55	115.88	14.89	13.52	82.41	25.28
4	Panicle length(cm)	20.62	17.96	23.68	9.74	5.94	37.30	7.47
5	No. of tillers per plant	15.17	12.63	17.27	12.15	6.53	28.80	7.22
6	No. of productive tillers per plant	13.07	10.43	16.13	15.93	5.96	14.38	4.59
7	No. of spikelets per panicle	153.77	116.53	198.39	19.70	9.98	25.76	10.42
8	No. of filled grains per panicle	126.58	95.90	162.74	20.74	11.20	28.60	12.26
9	Panicle fertility (%)	80.88	74.94	86.21	5.62	2.74	23.70	2.75
10	L/B Ratio (%)	3.29	2.81	4.00	10.48	8.06	59.09	12.76
11	Test weight(1000 seeds) (g)	19.20	15.04	27.42	17.44	14.10	65.30	23.47
12	Grain yield (Kg/Ha)	5904.96	4685.77	7295.09	15.47	10.97	50.30	16.03
13	Straw yield (Kg/Ha)	5981.44	4831.09	8696.65	25.01	15.62	38.99	20.08
14	Harvest index (%)	50.21	40.99	56.90	12.04	6.91	33.00	8.18

Table 2: Estimates of phenotypic correlation coefficients for fourteen yield and its component characters in twenty seven advanced breeding lines of rice

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
X_1	1											
X_2	0.7667**	1										
X_3	0.4500**	0.5749**	1									
X_4	-0.1643*	-0.2057**	-0.2460**	1								
X_5	-0.2196**	-0.1961**	-0.2486**	0.8363**	1							
X_6	0.0658	0.2238**	0.4365**	-0.1644*	-0.1268	1						
X_7	0.3978**	0.3628**	0.5514**	-0.0300	-0.0718	0.2090**	1					
X_8	-0.3109**	-0.2701**	-0.4358**	0.0170	0.0318	-0.1359	-0.7541**	1				
X_9	0.0235	0.0310	-0.0493	-0.1059	-0.1457*	0.1252	-0.0507	0.0725	1			
X_{10}	-0.0205	0.0099	-0.0965	-0.0481	-0.0925	0.1010	-0.1025	0.1031	0.9578**	1		
X_{11}	-0.1081	-0.0342	-0.1745*	0.1968**	0.1777*	-0.0524	-0.1592*	0.1393	0.1914**	0.4455**	1	
X_{12}	0.1625*	0.2155**	0.3086**	-0.0516	-0.1478*	0.1760*	0.1713*	0.0634	0.0803	0.0486	0.0015	1
X_{13}	0.0492	0.0543	-0.0063	0.0165	0.0015	0.0849	0.1528*	0.5000**	0.0420	0.0130	0.0338	0.3201

*5% level of significance, **1% level of significance

Where,

X_1-Days to 50% flowering X_6-Panicle length (cm) X_{11}-Panicle fertility (%)

X_2-Days to maturity X_7-Straw yield (kg/ha) X_{12}-Test weight (g)

X_3-Plant height (cm) X_8-Harvest index (%) X_{13}- Grain yield (kg/ha)

X_4-No. of tillers per plant X_9-No. of spikelets per panicle

X_5-No. of productive tillers per plant X_{10}-No. of grains per panicle

Table 3: Estimates of direct and indirect effects of yield components on yield at phenotypic level in twenty seven advanced breeding lines of rice

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
X_1	**0.0301**	0.0231	0.0135	-0.0049	-0.0066	0.0020	0.0120	-0.0094	0.0007	-0.0006	-0.0033	0.0049
X_2	0.0232	**0.0303**	0.0174	-0.0062	-0.0059	0.0068	0.0110	-0.0082	0.0009	0.0003	-0.0010	0.0065
X_3	-0.0704	-0.0899	**-0.1564**	0.0385	0.0389	-0.0683	-0.0862	0.0681	0.0077	0.0151	0.0273	-0.0483
X_4	0.0065	0.0081	0.0097	**-0.0394**	-0.0330	0.0065	0.0012	-0.0007	0.0042	0.0019	-0.0078	0.0020
X_5	-0.0180	-0.0161	-0.0204	0.0685	**0.0819**	-0.0104	-0.0059	0.0026	-0.0119	-0.0076	0.0145	-0.0121
X_6	0.0045	0.0152	0.0297	-0.0112	-0.0086	**0.0680**	0.0142	-0.0092	0.0085	0.0069	-0.0036	0.0120
X_7	0.4940	0.4506	0.6848	-0.0373	-0.0819	0.2596	**0.8902**	-0.9080	-0.0629	-0.1273	-0.1977	0.2127
X_8	-0.4347	-0.3776	-0.5092	0.0238	0.0444	-0.1901	-0.7193	**0.9361**	0.1014	0.1441	0.1948	0.0886
X_9	-0.0036	-0.0048	0.0076	0.0162	0.0223	-0.0192	0.0078	-0.0111	**-0.1532**	-0.1467	-0.0293	-0.0123
X_{10}	-0.0035	0.0017	-0.0166	-0.0083	-0.0159	0.0174	-0.0176	0.0177	0.1647	**0.1720**	0.0766	0.0084
X_{11}	0.0104	0.0033	0.0168	-0.0189	-0.0171	0.0050	0.0153	-0.0134	-0.0184	-0.0429	**-0.0962**	0.0083
X_{12}	0.0067	0.0089	0.0127	-0.0021	-0.0061	0.0072	0.0071	0.0026	0.0033	0.0020	-0.0035	**0.0412**
X_{13}	0.0493	0.0543	-0.0063	0.0165	0.0015	0.0849	0.1528	0.5000	0.0420	0.0130	0.0338	0.3201
R value	0.0015	0.0016	0.0010	-0.0006	0.0001	0.0058	0.1897	0.6991	-0.0064	0.0022	0.0033	0.0132

Residual effect=0.2874

Where,

X_1-Days to 50% flowering X_6-Panicle length (cm) X_{11}-Panicle fertility (%)

X_2-Days to maturity X_7-Straw yield (kg/ha) X_{12}-Test weight (g)

X_3-Plant height (cm) X_8-Harvest index (%) X_{13}- Grain yield (kg/ha)

X_4-No. of tillers per plant X_9-No. of spikelets per panicle

X_5-No. of productive tillers per plant X_{10}-No. of grains per panicle

CONCLUSION

The rice advanced breeding lines considered in the present investigation possess potential variation for economic traits. Early generation selection schemes would be effective for improvement and there is scope for isolation of promising lines from advanced breeding lines under study for yield improvement. Concerning characters showing significant correlation with yield, high heritability and high genetic advance per cent of mean, it is suggested that hybridization of advanced breeding lines possessing different combinations of such traits is the most useful approach for obtaining desirable high yielding advanced breeding lines.

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