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Research Note

Genetic variability, correlation and path coefficient studies in F_2 generation of aerobic rice (*Orzya sativa* L.).

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Abstract

The F_2 segregating populations of two crosses *viz.*, cross I (BPT 5204 × JBT 36/14) and Cross II (KMP 148 × JBT 36/14) of rice were evaluated to assess the genetic variability, correlation and direct and indirect effects among yield and yield components under aerobic condition. The results revealed that crosses registered high PCV and GCV values for almost all traits except days to 50 % flowering and panicle length. However, all traits registered high broad sense heritability accompanied with high genetic advance. The correlation studies of these crosses showed grain yield per plant exhibited highly significant positive association with productive tillers, filled grains per panicle and 1000 seed weight while days to 50 % flowering registered significant negative association with grain yield. The path analysis indicated that productive tillers had highest positive direct effect followed by filled grain per panicle on grain yield in both the crosses.

Key words: Genetic variability, Correlation, Path coefficient and Aerobic rice

Rice (*Oryza sativa* L.) is one of the three most important food grain crops in the world and forms the staple diet of 2.7 billion people. Except Antarctica it is grown in all the continents, occupying 159 million hectare area and producing 683 million tones (equivalent to 456 million tones of milled rice) (FAO,2009). In India it accounts for more than 40% of food grain production. It is grown in 44.6 million hectare under 4 major ecosystems: irrigated (21 mha), rainfed lowland (14 mha), rainfed upland (6 mha) and flood – prone (3 mha) with average annual production of 96.4 million tones (NABARD,2008). To feed increased population at alarming rate, production and productivity of rice has to be increased by using limited available precious resources like water. Aerobic rice cultivation is one of the most suited water saving cultivation practices which saves upto 50-60 % of irrigation water but, intermittent water limitation in this cultivation approach results in yield reduction ranging between 15 and 40 % which is not acceptable (George *et al.*, 2002). The most important criteria in any crop improvement programme is the selection of genotypes with all possible desirable yield contributing traits. Aerobic rice cultivation is a new method of growing rice characterized by direct seeding of high yielding varieties in nonpuddled condition without standing water and soils are kept aerobic throughout the growing season. Supplementary irrigation is applied as and when necessary. Most of the present aerobic rice cultivars are low yielders. Thus, there is need for developing high yielding cultivars suitable for aerobic condition. To improve the yield under aerobic condition, evaluation of segregating generation thereby selection of desirable line is the most important aspect because yield is a complex trait. Variability in segregating generation for yield and yield component traits forms the basic factor to be considered while making selection. Heritability along with genetic advance may provide a clearer picture for selection of a particular trait.

The knowledge regarding relative contribution of individual traits to yield may be obtained by correlation studies (Allard, R.W., 1960: Chaubey, P.K. and R. Singh, 1994). However, simple correlation does not provide the adequate information about the contribution of each factor towards yield. Therefore, the technique of path coefficient analysis is utilized to have an idea of direct and indirect contribution of traits towards the yield, the end product. The present investigation was undertaken to gather some useful information on genetic variability, character association and path analysis in two crosses of rice under aerobic condition.

The material for present study consisted of two crosses between germplasm line identified from CRRI Cuttack collections, JBT36/14 with two cultivated popular varieties *viz*., BPT 5204 and KMP 148. The crossing programme was carried out at Zonal Agricultural Research Station V. C. Farm, Mandya during Summer 2008 with the objective of transferring suitable characters under aerobic condition. The crossed seeds were sown during *kharif* 2008 along with parents. The F_1 plants were identified based on morphological characters of donor parent during *Kharif* 2008. The F_2 population of two crosses of rice *viz.,* BPT 5204 × JBT36/14 (Set I crosses) and KMP 148 × JBT36/14 (Set II crosses) were grown during summer 2009 along with parents. A total of 255 and 295 F_2 plants were selected from Set I and Set II crosses respectively for recording observation on nine quantitative traits *viz.*, Days to first flowering, Plant height (cm), Total tillers, Productive tillers, Panicle length(cm), Filled grain per panicle, Straw yield per plant (g), 1000 seed weight (g) and grain yield per plant. The phenotypic and genotypic coefficients of variability (PCV and GCV) were computed as per the methods of Burton and De Vane (1953). The method of (Johnson *et al.*, 1955) was followed for estimation of broad sense heritability (H^2) and genetic advance for all the traits recorded. The phenotypic correlation coefficients were computed as per the formula suggested by (Al-Jibouri *et al*., 1958). Path coefficient analysis was carried out following the method of Dewey and Lu (1959).

The improvement of character in a population is dependent on variability existing in the population. Hence, formulation of objectives in breeding programme should be essentially accompanied with assessment of existing variability.The variability quantified by range includes influence of environment and genotype × environmental components of variation. Since, all these variations are not heritable it is appropriate to partition the phenotypic variation into heritable (genetic) and non-heritable (environmental) components, and thus, true breeding value of the genotype can be precisely estimated by separating genetic variance from environmental variance. In this direction the components of variance such as PCV and GCV, heritability and predicted genetic advance as per cent mean were computed for all the characters studied and they are presented in Table 1.

In the present investigation values of phenotypic co-efficient of variation (PCV) in F_2 generations were higher than the genotypic co-efficient of variation (GCV) for all the traits. The difference between PCV and GCV was an indication of the magnitude of environmental influence. The range of variation was quite high for all the characters in F_2 generations in both the crosses.

Plant height, panicle length and all other yield and yield related traits like total tillers, productive tillers, filled grain per panicle, straw yield per plant (g), 1000 seed weight (g) showed high PCV and GCV except days to first flowering in both the crosses. But all the traits showed high broad sense heritability accompanied with high predicted genetic advance indicating traits are suitable for crop improvement except days to first flowering which has moderate predicted genetic advance. Panwar *et al.* (2007) and Balan *et al.* (1999) also noticed a similar type of observations. However, panicle length recorded moderate PCV and GCV and high heritability in both the crosses of F_2 generation, while genetic advance as per cent mean was high in cross I and moderate in cross II. The result of present study was in total agreement with earlier reports of Vivek Shukla *et al.* (2005).

The complexity of grain yield is amply exemplified by the fact that highest variability was observed for this trait. Interestingly, both PCV and GCV values were high with narrow range of difference between them, indicating low influence of environment on this trait expression in both the crosses of F_2 generations. This was further reflected with high level of heritability and genetic advance in both crosses. High heritability coupled with high genetic advance values suggest the preponderance of additive gene effects in their expression. Results of present study closely agree with the earlier reports of Ramalingam *et al.* (1994), Suman *et al*. (2005) and Panwar *et al.* (2007). Though the variability parameters, heritability and genetic advance indicated about simple direct selection for this trait, it entirely depends upon its intrinsic association with its attributing traits.

It is important to understand the relationship between two metric traits in the population, as it would be possible to bring about improvement in one character by selection of other. Grafius (1959) pointed out that there might not be any gene for yield as such but operates only through its components. Hence, the character association study through correlation will

surely help in selecting important yield attributes.In the present study, phenotypic correlation between grain yield and its component characters were studied. The association of productive tillers, filled grains per panicle, straw yield per plant and 1000 seed weight showed significant positive correlation with grain yield per plant in both the crosses (Table. 2). In general, the results suggest that, these characters can be advantageously used as a criterion for selection to improve yield owing to its favorable intrinsic association with yield in both the crosses populations. However days to first flowering recorded negative association with grain yield in both the crosses population. Plant height and panicle length had positive significant correlation with grain yield in Set II crosses (KMP 148 × JBT 36/14).
Similarly, significant positive association of grain yield with productive tillers (Rajeshwari and Nadarajan 2004 and Monalisa *et al.* 2006),filled grains per panicle (Choudhury and Das, 1998 and Ravindra Babu 1996) 1000 seed weight (Ravindra Babu,1996 and Raju *et al.,* 2004) straw yield per plant (Shashidhar *et al.,* 2005 and Monalisa *et al.,* 2006), plant height (Shashidhar *et al.,* 2005 and Patil *et al.,* 1993) and panicle length (Rajeshwari and Nadarajan, 2004 and Patil *et al.,* 1993) were noticed in their respective experiments.

Among the yield attributing characters, significant positive association was observed for plant height with productive tillers, panicle length, straw yield per plant and 1000 seed weight; productive tillers with panicle length, straw yield per plant and 1000 seed weight; panicle length with straw yield per plant and 1000 seed weight in both the crosses. These findings are in line with the reports of Shashidhar *et al.,* (2005) and Monalisa *et al.,* (2006).

The results of path analysis indicated that, two traits *viz*., productive tillers per plant and filled grains per panicle had high positive direct effect on grain yield in both the crosses (Table 3&4). Rajeshwari and Nadarajan, (2004) and Suman *et al*. (2006) reported high positive direct effect of productive tillers on grain yield. Yogameenakshi *et al*. (2004) reported high positive direct effect of filled grain per panicle on grain yield. However, 1000 seed weight recorded high positive direct effect on grain yield in cross I (BPT 5204 × JBT 36/14) but it was low in Set II crosses (KMP 148 × JBT 36/14). It may be due to the large variation observed for 1000 seed weight in parents (BPT 5204 and JBT 36/14) of Set I crosses.
Selection based on productive tillers, filled grain per panicle and 1000 seed weight for grain yield would be most effective under aerobic condition, since these characters have maximum positive direct effects as well as indirect effects of other characters *via* these traits.

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Table 1 : Mean, range values and estimates of genetic parameters for nine metric traits in the F_2 generation of two crosses.

Characters	Mean ± SE		Range				PCV (%)		GCV (%)		h^2 in broad sense (%)		GA as % mean	
			Cross I		Cross II									
	Cross I	Cross II	Lowest	Highest	Lowest	Highest	Cross I	Cross II	Cross I	Cross II	Cross I	Cross II	Cross I	Cross II
Days to first flowering	115.15±0.68	103.02±0.67	89	127	88	124	6.74	8.73	6.40	8.38	90.36	92.14	14.54	16.57
Plant height (cm)	89.37±1.30	86.89±1.17	62.5	120	52.5	123	16.65	18.13	16.23	17.46	95.09	92.81	34.53	34.66
Total tillers	12.82±0.39	11.13±0.36	4	27	4	37	34.56	42.88	32.32	40.65	87.61	89.81	67.18	79.33
Productive tillers	9.47±0.31	10.15±0.36	2	20	1	32	37.24	52.69	34.67	50.54	86.91	91.89	91.22	89.92
Panicle length(cm)	19.96±0.24	21.10±0.23	12	26.1	12.5	28	13.67	14.37	11.50	10.91	71.21	57.64	22.28	17.06
Filled grain per panicle	86.76±3.25	58.7±1.97	9	238	13	145	30.12	44.99	28.78	42.86	91.30	90.73	56.64	76.41
Straw yield per plant (g)	45.29±3.15	43.7±1.40	14	135.08	5.3	104.2	51.37	58.50	50.45	57.64	98.06	96.08	69.85	87.27
1000 seed weight (g)	18.77±0.24	20.49±0.17	12.55	27.05	16.12	27.05	14.77	11.06	14.62	10.72	97.77	94.65	24.33	21.57
Grain yield per plant (g)	15.32±0.63	18.66±0.71	4.2	38.3	2.3	47.2	46.58	70.45	40.62	64.36	76.07	83.46	97.11	87.46

h^2 = Heritability; GA = Genetic advance; Cross I – BPT 5204 × JBT 36/14, Cross II – KMP 148 × JBT 36/14

Table 2: Phenotypic correlation coefficients among grain yield and its components in F_2 generation of the cross I (BPT 5204 × JBT 36/14) and Cross II (KMP 148 × JBT 36/14)

Characters	Crosses	X_2	X_3	X_4	X_5	X_6	X_7	X_8
X_1	**Cross I**	0.09	-0.35**	-0.12	-0.38	-0.091	-0.05	-0.56**
	Cross II	0	-0.18	-0.11	-0.57**	0.27	0.06	-0.50**
X_2	**Cross I**		0.04	0.57**	-0.09	0.27*	0.54**	0.055
	Cross II		0.40**	0.63**	0.07	0.59**	0.53**	0.38**
X_3	**Cross I**			0.05	-0.05	0.38**	0.16	0.77**
	Cross II			0.37**	0.16	0.52**	0.30**	0.72**
X_4	**Cross I**				0.04	0.13	0.48	0.121
	Cross II				0.15	0.34**	0.32**	0.36**
X_5	**Cross I**					-0.09	-0.13	0.30**
	Cross II					-0.24	0.09	0.69**
X_6	**Cross I**						0.3	0.38**
	Cross II						0.33**	0.22*
X_7	**Cross I**							0.30**
	Cross II							0.34**

***, **. Significant at P= 0.05 and P=0.0 1**

X_1	Days to first flowering	X_4	Panicle length(cm)	X_7	1000 seed weight (g)
X_2	Plant height (cm)	X_5	Filled grain per panicle	X_8	Grain yield per plant (g)
X_3	Productive tillers	X_6	Straw yield per plant(g)		

Table 3: Genotypic direct (diagonal) and indirect effects of different quantitative traits in F_2 generation of cross I (BPT 5204 × JBT 36 / 14) of rice (*Oryza sativa* L .).

Characters	**X_1**	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**	**r'** with yield
X_1	**-0.052**	0.005	0.005	-0.205	0.012	0.234	0.055
X_2	0.000	**0.754**	0.000	-0.055	0.023	0.057	0.772**
X_3	-0.033	0.040	**0.009**	-0.081	0.011	0.173	0.121
X_4	0.018	-0.072	-0.001	**0.582**	-0.003	-0.105	0.303**
X_5	-0.015	0.413	0.002	-0.042	**0.041**	0.131	0.379**
X_6	-0.034	0.118	0.004	-0.170	0.015	**0.361**	0.297**

Residual Effect=0 .172; *, **. Significant at P= 0.05 and P=0.0 1

X_1	Plant height (cm)	X_6	1000 seed weight (g)
X_2	Productive tillers	X_4	Filled grain per panicle
X_3	Panicle length(cm)	X_5	Straw yield per plant(g)

Table 4: Genotypic direct (diagonal) and indirect effects of different quantitative traits in F_2 generation of cross II (KMP-148 × JBT 36/14) of rice (*Oryza sativa* L.).

Characters	X_1	X_2	X_3	X_4	X_5	X_6	**r**' with yield
X_1	**0.063**	0.218	0.002	0.035	0.027	0.041	0.382**
X_2	0.026	**0.540**	0.001	0.080	0.026	0.023	0.718**
X_3	0.040	0.197	**0.004**	0.079	0.015	0.024	0.362**
X_4	0.004	0.084	0.001	**0.519**	-0.009	0.007	0.687**
X_5	0.036	0.307	0.001	-0.102	**0.047**	0.028	0.224*
X_6	0.034	0.163	0.001	0.045	0.017	**0.076**	0.344**

Residual Effect=0 .353;*, **. Significant at P= 0.05 and P=0.0 1

X_1	Plant height (cm)	X_6	1000 seed weight (g)
X_2	Productive tillers	X_4	Filled grain per panicle
X_3	Panicle length(cm)	X_5	Straw yield per plant(g)