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Research Note

Effect of intermating on genetic variability and character association in aromatic Rice (*Oryza sativa L.*)

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Abstract
Biparental mating (BIP) attempted in the F_2 of a cross of P-1460 × P-1121 revealed that, the biparental progenies had better mean performance as compared to F_3 progenies for all the characters studied. In general, the lower limits of the range decreased for all the characters in the biparental progenies widening the variability. The variation created on account of biparental mating was found to be heritable as seen from increase in heritability estimates and genetic advance as per cent of mean. Highest value of genetic and phenotypic coefficient of variation were recorded for yield / plant (34.00 and 35.21) followed by No. of spikelet's / panicle (22.05 and 23.26). Test weight (g) and panicles / m^2 exhibited high heritability and genetic advance (% as mean). The correlation co-efficient in biparental progenies are generally of higher magnitude than in F_3 populations. Traits like, panicles/m^2, Spikelet's/ panicle, panicle length, test weight (g) and days to maturity showed significant correlation with yield / plant in biparental progenies. It was also observed that, the non-significant negative association between panicles/m^2 with yield / plant (g) in F_3 changed to positive and significant in BIP population. Similarly, non-significant positive association between days to 50% flowering, spikelet's / panicle, panicle length (g) and test weight with yield / plant in F_3 got changed to positive and significant in BIP populations. These results indicated that intermating in F_2 was quite effective to break undesirable linkage.

Key words
Aromatic rice (*O. sativa* L.)., Genetic variability, heritability, genetic advance, biparental mating, correlation co-efficient

Rice (*Oryza sativa* L., 2n = 24) is the second most important cereal crop and stable food for more than one third of the world's population." Rice is life" was the theme of International year of rice 2004 denoting its overwhelming importance as an item of food and commerce. For any successful breeding programme, knowledge of genetic variability parameters and character association among different traits in base population are pre-requisite to initiate and execute proper selection for yield. In self pollinated crop like rice, the conventional methods of handling segregating populations like pedigree or bulk methods do not provide any opportunity for rearrangement of genes. Hence, any unfavourable associations observed in early segregating generation like in F_2 are likely to persist through the filial generations. Whereas, biparental mating in early segregating generations like F_2 helps in breaking unfavourable associations (Yunus and Paroda 1983, Parameshwarappa *et al.* 1997). Keeping this in view, the present investigation was planned to compute and compare the nature and magnitude of genetic variability and correlations among the various characters in the biparental progenies and the corresponding selfed generation *viz*., F_3 in aromatic rice.

Two basmati genotypes, P-1460 and P-1121 were selected on the basis of their peculiar contrasting characteristic productivity related features as well as reaction to blast and bacterial blight. Intermating of selected plants in F_2 generation of the cross between these two lines was attempted and the plants involved in the crosses were also selfed to generate F_3 progenies. The biparental progenies (BIPs) and its corresponding F_3 populations were planted in 10 rows each in 5 meter length with 20 cm. spacing between rows and 10 cm between plants within the rows in complete randomized block design at Agricultural Research Station, Ummedganj, Kota, during *kharif* 2009. The data were recorded on days to 50 % flowering, plant height (cm.), number of panicles / m^2, spikelet's / panicle, panicle length (cm.), days to maturity, test weight (g) and yield / plant (g) on 400 plants in biparental progenies and on 200 plants in F_3

populations. Data on days to 50% flowering and days to maturity were recorded on plot basis in both the populations (F_3 and BIP). The mean, range and various components of variance were worked out in the biparental as well as F_3 progenies on the individual plant data basis. The phenotypic and genetic coefficients of variances were computed considering the variances of segregating generations to be an indicative of environmental variance (V_e). Assuming the variance in segregating population (V_p) to be equal to the sum of variance due to genotype (V_g) and variance due to environment (V_e), the parameter V_g was computed by subtracting mean variance of non-segregating generations from the variance of $F_{2.}$ The phenotypic and genotypic co-efficient of variation (GCV &P CV), heritability in broad sense, genetic advance and correlation coefficient were computed as per standard methods.

Variability analysis:

The estimates of various genetic variability parameters for different yield attributing characters of BIP and their corresponding F_3 populations are presented in Table-1. Data indicated that, all the variability parameters have higher values in biparental progenies than F_3 populations for all the characters studied. Upper limit of range was especially higher in BIP than the F_3 populations indicating that, the intermating has helped in releasing more variability than selfing generations by expected breakage of linkage blocks (Amudha and Arumugachamy, 2008). Superior mean performance of biparental progenies appeared to be due to better exploitation of additive and non-additive gene effects. The non-additive gene effects contributing to the expression of characters is a function of an interaction of alleles influencing the characters. In BIP, which provide a better scope for the reshuffling of the alleles concerned and results in the increase in mean performance. Similar results were earlier reported by Koli *et al.* (2012), Nayak (2008) in aromatic rice, Naik *et al.* (2009) in safflower and in chick pea by Kampli *et al.* (2002) and Singh (2004). Higher value of genetic and phenotypic coefficient of variation were recorded for grain yield (34.00 and 35.21) followed by number of spikelet's/ panicle (22.05 and 23.26). Whereas, heritability estimates was the highest for test weight (96.04 and 97.14), followed by grain yield / plant (92.80 and 93.12), panicle length (87.63 and 91.63), number of spikelet's / panicle (86.19 and 89.89) and panicles / m^2 (76.35 and 90.28) for F_3 and BIP population respectively. Days to 50% flowering and days to maturity had lower values in F_3 as compared to BIP progenies in the present study. Similar finding was also reported in rice by Naik *et al.* (2009), in cauliflower (Kanwar and Korla 2002) and in fenugreek (Gangopadhyay, 2009). The higher magnitude of GCV and PCV in BIP populations indicated more scope for selecting better segregants for the traits like grain yield, number of spikelet's / panicle and panicles / m^2. This suggested that the variation due to environment played a relatively limited role in influencing the inheritance of these characters and thus the expected response to selection is higher in BIP. High heritability in case of BIP over F_3 has also been reported in rice by Naik *et al.* (2009), Koli *et al.* (2012), Nath and Talukdar (1997) and Amudha *et al.* (2007), in Chickpea by Singh (2004) and Campli *et al.* (2002). In the present study, traits like, panicles / m^2 and spikelet's / panicle (109.14 and 72.01 respectively) showed higher genetic advance, indicating that, the gain from selection based on these two traits would be higher in biparental progenies than in their corresponding selfed progenies (F_3). High heritability accompanied with low genetic gain was found for panicle length, days to 50% flowering and days to maturity indicating that, these traits are more likely under the control on non-additive gene action and selection for these traits would be less effective. Rest of the traits had moderate to high heritability with low genetic gain, indicating the influence of environment on these traits. In addition to this, it is also expected to help in maintaining a greater variability for selection to be effective for longer period in crops like rice where lack of variability has been implicated as one of the important causes for limited progress (Koli *et al* 2012 and Nayak 2008). Hence, the use of biparental mating in early segregating generation (F_2) of an appropriate cross could be of much use in widening variability and consequently in making considerable gains in improving productivity.

Correlation Co-efficient:

A comparison of correlation co-efficient among characters studied within BIP with those within F_3 populations (Table-2) revealed that, correlation co-efficient in biparental progenies are generally of higher magnitude than in F_3 populations. The increase in magnitude of correlation co-efficient would be expected if linkages were in repulsion phase (Nanda *et al.* 1990). However, in BIP populations, associations of number of spikelet's / panicle, panicle length (cm) with test weight (g) were high and positively significant. This clearly indicated that, these traits are the most important yield contributing characters. In the present study traits like, panicles / $m^{2,}$ spikelet's/ panicle, panicle length (g) and test weight showed significant correlation with yield / plant in biparental progenies. Days to 50% flowering showed significant correlation for panicles / m^2 and days to maturity. Whereas, days to maturity has significant correlation for yield / plant in both F_3 and BIP populations indicated that, it is a most desirable trait for described maturity groups i.e. early, mid and late for any crop. It was also observed that, the non-significant negative association between panicles / m^2 with yield / plant (g) in F_3 population changed to positive and significant in BIP population. Similarly, non-significant positive association between days to 50% flowering, spikelet's / panicle, panicle length (g) and test weight with yield / plant in F_3 population changed to positive and significant in BIP populations. These results indicated that intermating in F_2 was quite effective to break undesirable linkage. It was thus evident that the reshuffling of genes responsible for correlation amongst some characters resulted in newer recombinants which, presumably were due to changes from a coupling phase to repulsion phase. Linkage shift in correlations have also been reported in rice by Nayak (2008), Nath and Talukdar (1997), in wheat by Yunus & Paroda (1982), Nanda *et al* (1990) and in chickpea by Campli *et al.* (2002).

The present study on the effect of intermating on association in aromatic rice has clearly brought out its importance in altering the association pattern involving some important components of yield to the breeder's advantages enabling him to increase the efficiency of selection for improving productivity.

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Table:-1 Estimates of genetic variability parameters in respect of eight quantitative traits in F_3 (selfed progenies) and BIP progenies in aromatic rice.

Characters	Population	Range	Mean ± SE	Coefficient of variation		Heritability (bs) %	Genetic advance as % of mean	Genetic gain as % of mean
				Phenotypic coefficient of variation (GCV) %	Genotypic coefficient of variation (PCV) %			
Days to 50% flowering	F_3	99-112	104 ±1.89	5.50	6.34	75.26	13.12	11.38
	BIP	96-114	106 ± 2.01	7.08	7.81	82.20	17.98	16.30
Plant height (cm.)	F_3	98.33-115.0	107.21 ± 4.56	7.04	10.19	47.78	13.78	9.53
	BIP	95.33-118.67	110.68 ± 4.02	9.15	11.12	67.82	22.03	18.14
Panicles/m^2 (No.)	F_3	201-279.67	245.72 ± 9.53	12.08	13.82	76.35	68.47	59.83
	BIP	197.0-324.67	275.40 ± 8.23	15.79	16.62	90.28	109.14	103.28
Spikelet's/panicle (No.)	F_3	90.0-145.67	115.17 ± 5.84	20.64	22.44	86.19	62.02	57.58
	BIP	84.67-156.33	130.45 ± 5.56	22.05	23.26	89.89	72.01	68.28
Panicle length	F_3	24.87-30.40	28.19 ± 0.44	9.11	9.51	87.63	6.49	6.21
(cm)	BIP	24.30-32.03	29.10 ± 0.65	10.41	11.12	91.63	7.48	7.00
Days to maturity	F_3	134-139	136 ± 0.93	1.77	2.13	68.79	5.28	4.38
	BIP	133-142	139 ± 1.01	2.03	2.39	72.16	6.35	5.39
Test weight (g)	F_3	17.40-22.93	19.84 ± 0.30	12.92	13.19	96.04	6.63	6.50
	BIP	17.0-24.1	21.54 ± 0.32	15.42	15.65	97.14	8.64	8.52
Yield per plant (g)	F_3	9.75-20.64	14.65 ± 0.78	33.40	34.61	92.80	12.42	11.97
	BIP	8.70-22.07	17.62 ± 0.93	34.00	35.21	93.12	15.25	14.72

Table 2:- Correlation co-efficient among different characters in biparental and selfed progenies (F_3) in aromatic rice.

Characters	Population	Plant height (cm.)	Panicles /m2	Spikelet's/ panicle	Panicle length (cm)	Test weight (g)	Days to maturity	Yield / plant (g)
Days to 50% flowering	F_3	0.045	0.217*	0.060	-0.113	-0.193*	0.244**	0.129
	BIP	0.045	-0.165*	-0.004	-0.136	0.023	-0.615**	0.017
Plant height (cm.)	F_3		-0.083	0.197*	0.046	0.035	-0.006	-0.470**
	BIP		0.309**	-0.241**	0.018	-0.235*	-0.102	-0.123
Panicles/m^2	F_3			-0.294**	-0.076	0.237*	0.256**	-0.111
	BIP			-0.096	-0.096	-0.054	0.097	0.364**
Spikelet's/panicle (No.)	F_3				0.331**	0.269**	0.006	0.075
	BIP				0.166*	0.400**	0.175*	0.269**
Panicle length(cm)	F_3					0.257**	0.137	0.006
	BIP					0.373**	-0.211*	0.252**
Test weight (g)	F_3						0.215*	0.085
	BIP						0.162*	0.223**
Days to maturity	F_3							-0.242**
	BIP							0.223**

*, ** significant at P= 0.05 and 0.01 respectively.