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Genetic variability created through biparental mating in early segregating generation of scented rice

N R Koli , R S Narolia, S S Punia and Chandra Prakash
Agricultural Research Station, Ummedganj, Kota -324001
(Maharana Pratap University of Agriculture and Technology- Udaipur) Rajasthan

ABSTRACT

Biparental mating was attempted in the F_2 of P-1460 x P-1121 of scented rice (Oryza sativa L.). The biparental population (BIP) had higher mean performance than the F3 self's for all the characters under study. The lower limit of range was, in general smaller for all the characters in the biparental population. The upper limit has also increased in the desired direction for all the characters. Sufficient high genetic variations as maintained in the BIP, for most of the characters. Biparental population also exhibited improved estimates of heritability and genetic advance. The unity of biparental mating in early segregating generation in scented rice is emphasized.

Key words: *biparental mating, scented rice genotype, heritability, genetic advance*

Genetic variability is the most important pre-requisites for any successful crop improvement programme. It has been aurged that one of the reasons for failure to achieve a major breakthrough in productivity of self pollinated crops like rice is the lack of sufficient variability. The presence of large linkage blocks and inverse relations among the correlated characters are most common. Under such circumstances, conventional breeding methods such as pedigree, bulk and back cross methods again impose restriction on the chance of better recombination are also associated with the weakness of causing rapid homozygosity and low genetic variability (Cleggy *et al.* 1972). On the other hand biparental mating is expected to break linkage blocks and provide better opportunities for recombination's than the selfing series (Gill *et al.* 1973). It is also a useful system of mating for generation of increase variability and may appropriately be applied where lack of desired variation is the immediate need in the breeding programme.

Though sharply differing views have been expressed on the effectiveness of biparental mating approach in self pollinated crops, it has been successfully employed in some self pollinated crops like wheat and safflower. However, no report on the effectiveness of biparental mating population is available in basmati rice. The present investigation was therefore, planned to compare the performance of biparental progenies with selfed ones with respect to creating genetic variability for yield and its contributing traits.

MATERIALS AND METHODS

Two basmati genotypes P-1460 and P-1121 were selected on the basis of their contrasting characteristics for productivity related features as well as reaction to blast and bacterial blight. The F_2 generation of the cross between these two lines was thus an ideal material to effect biparental mating and hence about 200 F_2 plants were selected for selective intermating on the visual basis of vigour, plant type, earliness and resistant to blast and bacterial blight. These F_2 plants used in biparental intermating were also selfed to generate F_3 progenies. The experiment was conducted at the Experimental Field of Agricultural Research Station, Kota, during wet season, 2009. The biparental population (BIP) and their corresponding F_3 population were sown in 10 rows each in 5 meter length with 20 cm. spacing between rows and 10 cm between plants within the rows. The data were recorded on all the plants in BIP and F_3 for days to 50 % flowering, plant height (cm.), no. of panicles m^{-2}, spikelets $panicle^{-1}$, panicle length (cm.), days to maturity, 1000 seed weight

(g) and yields plant^{-1} (g). The mean, range and various components of variance were worked out in the biparental as well as F_3 progenies. The phenotypic and genetic coefficients of variances were computed considering the variances of non-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 substracing mean variance of non-segregating generations from the variance of F_2. The phenotypic and genotypic co-efficient of variation (Burton and Devane 1953), heritability in broad sense (Hanson *et al*. 1956) and genetic advance (Eobinson *et al.* 1949) were also computed.

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 which influencing the characters. In BIP, which provide a better scope for the reshuffling of the alleles concerned would certainly help in the better exploitation of the non additive gene effect and hence results in the increase in mean performance. It is also attributed to the creation of more genetic variability by breakage of undesirable linkage which otherwise conceal the genetic variation in the small size F_2 generations (*Gill et al.* 1973).The results of the present investigation are in agreement with the earlier reports on wheat (Yunus and Paroda 1983; Namatullah and Jha 1993) and chick pea (Nagaraj *et al* 2002 and Narendra singh, 2004).

Table 1. Mean and Range of expression in respect of various quantitative traits in intermated (BIP) and selfed (F_3) population of basmati rice

Characters	Mean ± SE		Range	
	F_3	Biparental population	F_3	Biparental population
Days to 50%flowering	104 ±1.89	106 ± 2.01	99-112	96-114
Plant height (cm.)	107.21 ± 4.56	110.68 ± 4.02	98.33-115.0	95.33-118.67
Panicles m^{-2}	245.72 ± 9.53	275.40 ± 8.23	201-279.67	197.0-324.67
No. of spikelets panicle^{-1}	115.17 ± 5.84	130.45 ± 5.56	90.0-145.67	84.67-156.33
Panicle length (cm)	28.19 ± 0.44	29.10 ± 0.65	24.87-30.40	24.30-32.03
Days to maturity	136 ± 0.93	139 ± 1.01	134-139	133-142
1000 grain weight (g)	19.84 ± 0.30	21.54 ± 0.32	17.40-22.93	17.0-24.1
Grain yield (g) plant^{-1}	14.65 ± 0.78	17.62 ± 0.93	9.75-20.64	8.70-22.07

RESULTS AND DISCUSSION

The results indicated that the mean and range values of biparental progenies for all the traits were found higher than the F_3 population (Table 1). 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 expecting breakage of linkage blocks. It may also be due to accumulation of favourable genes as BIP progenies were developed by crossing between the segregants selected on the basis of better performance. The general shifts in the value of range of expression of characters by biparental approach were also reported in chick pea by Nagaraj *et al.* (2002) and Narendra Singh (2004). It is also interesting to note that the mean performance improved considerably in respect of panicle m^{-2}, spikelets panicle^{-1} and seed yield plant^{-1}.

In general, the variability parameters are higher for biparental progenies than the F3 population in respect of all the traits studied (Table 2). Higher GCV and PCV in the BIP as compared to F_3 were also reported in wheat by Nanda *et al* (1990) and in Chickpea by Narendra Singh (2004) and Nagarajan *et al* (2002). The phenotypic coefficient of variation (PCV) was the maximum for grain yield (34.61 and 35.21) followed by no. of spikelets panicle^{-1} (22.44 and 23.26) and panicles m^{-2} (13.82 and 16.62) for F3 and BIP population, respectively. On the other hand, 1000 grain weight, plant height, and panicle length had moderate estimates of PCV for both the populations. Similar trends were observed for genotypic coefficient of variation (GCV) for almost all the traits, though they were slightly low

Table 2. Estimates of genetic variability parameters of eight quantitative traits in F_3 and BIP population of basmati rice

Characters	Population	GCV (%)	PCV (%)	h^2 (bs) (%)	GA (% as mean)	Genetic gain as % of mean
Days to 50% flowering	F_3	5.50	6.34	75.26	13.12	11.38
	BIP	7.08	7.81	82.20	17.98	16.30
Plant height (cm.)	F_3	7.04	10.19	47.78	13.78	9.53
	BIP	9.15	11.12	67.82	22.03	18.14
Panicles m^{-2}	F_3	12.08	13.82	76.35	68.47	59.83
	BIP	15.79	16.62	90.28	109.14	103.28
No. of spikelets panicle^{-1}	F_3	20.64	22.44	86.19	62.02	57.58
	BIP	22.05	23.26	89.89	72.01	68.28
Panicle length (cm)	F_3	9.11	9.51	87.63	6.49	6.21
	BIP	10.41	11.12	91.63	7.48	7.00
Days to maturity	F_3	1.77	2.13	68.79	5.28	4.38
	BIP	2.03	2.39	72.16	6.35	5.39
1000 grain weight (g)	F_3	12.92	13.19	96.04	6.63	6.50
	BIP	15.42	15.65	97.14	8.64	8.52
Grain yield (g) plant^{-1}	F_3	33.40	34.61	92.80	12.42	11.97
	BIP	34.00	35.21	93.12	15.25	14.72

compared to PCV. Similar finding also reported in cauliflower (Kanwar and Korla 2002). The higher magnitude of GCV and PCV in BIP populations indicating more scope for selecting better segregants for the traits like grain yield, No. of spikelets panicle^{-1} and panicles m^{-2}. The heritability estimates was the highest for 1000 grain weight (96.04 and 97.14), followed by grain yield plant^{-1} (92.80 and 93.12), Panicle length (87.63 and 91.63), No. of spikelets panicle^{-1} (86.19 and 89.89) and panicles m^{-2} (76.35 and 90.28) for F3 and BIP population, respectively. 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 bread wheat by Nanda *et al* (1990) and in Chickpea by Narendra singh (2004) and Nagarajan *et al* (2002).

Among the characters studied, panicles m^{-2} and spikelets plant^{-1} (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. This is further supported by the wider range of expression and that too in the desirable direction in BIP as mentioned earlier. High heritability accompanied with low genetic gain was found for panicle length and days to maturity, indicating that, these traits is 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.

The comparison of biparental mating and selfing shows that, additional variability realized with biparental mating in the early segregating generation is probably brought about by rare recombination between linked loci. 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. 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.

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