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EFFICIENCY OF INTERMATING IN F_2 GENERATION OF AN INTERVARIETAL CROSS IN BREADWHEAT

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ABSTRACT

The North Carolina design I was attempted in F_2 generation of a wheat cross. The plants involved in the crosses were also selfed simultaneously to obtain F_3 progenies. The effectiveness of biparental mating was compared with conventional breeding method. The biparental progenies had superior mean performance than the F_3 for yield/plant, tillers/plant, grains/spike, grain weight, harvest index, spike length and spikelets/spike. Plant height was reduced on intermating. The range, variance, heritability and genetic advance were higher in BIPs for all the characters studied except plant height. Additive genetic variance was significant for all the characters, whereas dominance variance was significant for spikelets/spike only. Altered correlations indicated that linkages were broken on intermating. The utility of biparental matings in early segregating generations in wheat is emphasized.

Key words: Intermating, wheat.

The pedigree method of breeding is the most common in the improvement of self-pollinated crops, including wheat. However, this method has certain limitations. The rate of homozygosity is very high, which reduces chances of recombination. This also retains tight and undesirable linkages and utilises only fixable effects. Since, the routine pedigree method of breeding was considered inadequate to exploit the useful genetic variability for complex characters like yield [1], intermating in early segregating generations was suggested to pool the desirable genes from the selected plants in self-pollinated crops [2,3]. There are reports, however, which emphasize that intermating in early segregating generations in wheat is not always useful [4,5]. The present study aims to evaluate the efficiency of intermating in F_2 generation of a cross in effecting improvement and to compare it with the pedigree method of breeding.

MATERIALS AND METHODS

Two genetically diverse varieties of breadwheat, 9D and HD 2009, were used in crossing programme. The cv. 9D is tall and was at one time recommended for rainfed areas. Cv. HD

2009 is a semidwarf, suitable for high-fertility irrigated conditions. In F_2 generation of this cross, North Carolina design I of Comstock and Robinson [6] was applied. In each set, four male plants were selected at random and individually crossed to four randomly selected female plants. No female plant was used in more than one cross. Six sets were generated (each with 16 BIPs and 20 F_3) which constituted 96 BIPs and 120 F_3 progenies. The BIPs and their corresponding F_3 were planted in single-row plots of 1 m each in randomized block design with three replications in 1982-83. The rows and plants were spaced at 30 and 10 cm, respectively. The sets and progenies within sets were randomized separately. The data were recorded on five random plants per row for eight characters: grain yield/plant, tillers/plant, grains/spike, 100-grain weight, harvest index, spike length, spikelets/spike, and plant height. The variances, phenotypic and genotypic coefficients of variation (PCV, GCV) and broad sense heritability were determined as per [7]. The estimates of genetic components of variances were obtained as outlined by [6] along with correlation coefficients.

RESULTS AND DISCUSSION

The mean performance of BIPs was superior of F_3s for yield/plant, tillers/plant, grains/spike, grain weight, harvest index, spike length, spikelets/spike (Table 1). In addition, the higher mean performance for grain yield and its component characters was accompanied by lower plant height, which may provide an opportunity for selecting dwarf segregates with higher performance of component characters (Table 1). Higher mean

Table 1. Comparison of means, variability, heritability and genetic advance between F_3 and BIPs of wheat

Character	Generation	Mean	Range	Variances $\sigma^2 p$	Variances $\sigma^2 g$	PCV	GCV	h^2, %	GA, of mean
Grain yield/plant, g	BIPs	25.8*	17.5–34.7	58.1	42.2	29.5	25.2	72.6	44.2
	F_3	20.3	14.2–27.3	27.1	16.3	25.6	19.9	60.1	31.7
Tillers/plant	BIPs	14.4*	8.4–21.3	6.9	4.2	18.2	14.2	60.9	22.9
	F_3	11.2	5.2–16.8	5.8	3.2	21.5	15.9	55.2	21.4
Grains/spike	BIPs	64.8*	54.9–72.1	22.1	13.6	7.2	5.7	61.5	9.2
	F_3	60.2	52.3–69.6	20.8	11.7	7.5	5.7	56.2	8.7
100-grain weight, g	BIPs	4.1*	3.4–5.1	1.8	1.1	32.7	25.6	61.1	41.2
	F_3	3.7	3.1–5.0	1.6	0.9	32.4	24.3	56.3	37.6
Harvest index, %	BIPs	38.4*	31.4–45.8	7.7	4.4	7.2	5.5	57.1	8.5
	F_3	35.7	28.2–42.7	6.3	3.1	7.0	4.9	49.2	7.1
Spike length, cm	BIPs	13.2*	10.1–14.3	1.2	0.7	8.3	7.1	58.3	9.9
	F_3	11.9	9.2–13.6	1.1	0.5	8.8	5.9	45.5	8.3
Spikelets/spike	BIPs	21.4*	18.9–25.5	4.8	2.9	10.2	7.9	60.4	12.7
	F_3	20.1	17.8–24.6	3.6	2.1	9.4	7.2	58.3	11.3
Plant height, cm	BIPs	105.9	98.2–119.8	171.2	77.3	12.4	8.3	45.2	11.5
	F_3	114.4*	101.2–124.5	209.4	134.8	12.6	10.1	64.3	16.8

*, **Significant at 5 and 1% levels, respectively.

performance of BIPs may be because of the brekage of undesirable linkages which otherwise conceal genetic variation in small populations. The character ranges were higher in BIPs than in F3. The changes in the BIPs were in the desired direction due to increased proportion of the desirable segregates. These results suggest that repulsion-phase linkages were predominant in the parents for yield/plant, tillers/plant, grains/spike, grain weight, harvest index, spike length, and spikelets/spike, and coupling-phase linkage in case of plant height.

The BIPs in comparison to F3s had greater variance, PCV, GCV, heritability and genetic advance (% of mean) in respect of all the characters except plant height. Higher variances in the BIPs as compared to F3 were also reported in oats [8]. Singh and Dwivedi [9] reported higher variances of the F3 over the BIPs, whereas the mean values were higher in the latter. The higher heritability for yield and component characters in BIPs is of particular interest to the breeder as it increases response to selection. High heritability in BIPs over that of F3 has also been reported [10,11]. The maximum genetic advance (44.2% of mean) was observed for grain yield per plant, indicating the utility of intermating for improving the yield potential.

The estimates of components of genetic variances additive and dominance are presented in Table 2. Additive genetic variance was significant for all the eight characters, whereas dominance genetic variance was significant for spikelets/spike. When additive genetic variance is predominant, intermating in the early segregating generations accumulates the desirable alleles and improves the mean performance of the biparental progenies, making selection more effective in BIPs than in the selfed series.

Table 2. Estimates of genetic components of variance for different characters in wheat

Component	Yield per plant	Tillers per plant	Grains per spike	100-grain weight	Harvest index	Spike length	Spikelets per spike	Plant height
σ^2_m	15.1*	1.9**	6.1**	0.95*	1.75*	0.39**	0.81*	32.3**
	±7.0	±0.3	±2.3	±0.32	±0.78	±0.12	±0.32	±10.1
σ^2_f	28.0*	1.3	7.3	1.13*	2.12	0.36	2.18**	37.9*
	±12.1	±0.9	±5.0	±0.53	±1.32	±0.21	±0.28	±16.2
σ^2_A	60.5*	7.8**	24.5**	3.80*	7.00*	1.56**	3.24*	129.4*
	±28.0	±1.3	±9.3	±1.28	±3.12	±0.48	±1.28	±40.5
σ^2_D	51.3	-2.5	4.9	0.72	1.48	-0.12	5.48**	22.1
	±55.9	±4.0	±22.0	±2.47	±6.13	±0.96	±1.70	±76.5
σ^2_D/σ^2_A	1.3	—	0.6	0.62	0.42	—	1.8	0.3

*,**Significant at 5 and 1 percent level.

Intermatings are quite effective under undesirable linkages. The study of correlation coefficients indicated that as a result of intermating the number of nonsignificant and undesirable correlations changed to desirable ones. In BIPs, the correlation coefficients between yield/plant and grains/spike, yield/plant and spike length, tiller No. and grains/spike, grain yield and spike length, tiller No. and grains/spike, tiller No. and spike length, and tiller No. and spikelets/spike turned positively significant from nonsignificant in the selfed series (Table 3). The significant negative association of grain yield with plant height in BIPs indicates that highly potential genotypes with dwarf height was possible. The correlation studies amongst the components of grain yield indicated that seed size incresed at the cost of tiller and spikelet No. per spike. The intermating rendered these correlations to nonsignificant level. So, selection in the biparental populations for grain weight, tillers/plant, and spikelets/spike would improve the level of grain yield. A comparison of correlation coefficients in the BIPs and F_3 revealed that as many as eight correlations turned favourable on intermatings. The magnitude of correlation coefficients is expected to increase if linkage was in a predominantly repulsion phase. Intermating preserves genetic variability in the population and reduces the chances of genetic drift and unfavourable correlated response.

Thus it is appropriate to follow biparental approach in the early segregating generations, as it is very difficult to grow the theoretically required plant population in F_2.

Table 3. Phenotypic correlations among different characters in BIPs and F_3 families of wheat

Characters	Generation	Tillers per plant	Grains per spike	100–grain weight	Harvest index	Spike length	Spikelets per spike	Plant height
Grain yield/plant	BIPs	0.32**	0.28**	0.22**	0.45**	0.21*	0.24*	–0.21*
	F3	0.28**	0.16	0.19*	0.39**	0.16	0.19*	–0.14
Tillers/plant	BIPs		0.21**	0.11	0.29**	0.22*	0.24*	0.12
	F3		0.17	–0.18*	0.26**	0.15	0.13	0.13
Grains/spike	BIPs			0.16	0.27**	0.32**	0.31**	0.11
	F3			0.1	0.28**	0.29**	0.34**	0.13
100-grain weight	BIPs				0.38**	0.17	0.15	0.11
	F3				0.34**	0.15	–0.19*	0.14
Harvest index	BIPs					0.22*	0.24*	–0.20
	F3					0.19*	0.20*	–0.17
Spike length	BIPs						0.32**	0.14
	F3						0.29**	0.16
Spikelets/spike	BIPs							0.13
	F3							0.15

*,**Significant at 5 and 1% levels, respectively.

Early generation intermatings would be ideal to preserve the genetic variability and, thus, may result in rapid and superior response to selection for longer period and avoid early fixation of genes in the homozygous forms.

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