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IMPACT OF DIFFERENT MATING APPROACHES IN GENERATING VARIABILITY IN WHEAT (*T. AESTIVUM* L. EM THELL)

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ABSTRACT

Comparison of mating systems indicated the significance of biparental mating within F_2 and intermating between individuals of two different F_2 populations for elevating the population mean and initial genetic variation for grain yield and its component traits in wheat. Correlation studies also demonstrated the usefulness of intermating. Positive and significant correlations were established between tillers/plant and grains/ear in BIPS and F_2 intermated populations also showed positive and significant correlation between 1000-grain weight and grains/ear. Double-cross F_2 populations showed little significance.

Key words: Wheat, mating systems, BIPS, F_2 intermating, double cross.

Success of selection in plant breeding depends on the choice of initial genetic variation which may result in high expected genetic gain. Autogamous species place a restriction on genetic combination because selfing leads to rapid fixation of linked genes, precludes free exchange of favourable genes and greatly prevents the emergence of desirable gene constellations, thereby limits genetic variability. To overcome this limitation, many plant breeders [1–4] favoured the intermating approach to elevate population mean and genetic variability in wheat. Both inter- and intrapopulation improvement methods may be adopted to release useful variability. Keeping this in view, a comparison has been made to know the relative efficiency of some mating systems in generating genetic variability for grain yield and its component traits in wheat.

MATERIALS AND METHODS

The study was conducted with two wheat crosses, namely, HD 2009 (HD) × Sonalika (Son) and Kalyan sona (KS) × Sonalika (Son) during 1982–1988. The varieties involved in crosses are highly diverse for different yield components. The F_1 and F_2 of both crosses were grown at Plant Breeding Research Farm, Haryana Agricultural University, Hisar, during 1983–1984 and seed for the following six populations was generated.

F_3(I)	:	by selfing of F_2 plants of cross HD × Son
BIPS(I)	:	seeds of 36 BIPS developed by using NC I mating design in F_2 population of cross HD × Son

Double cross F_2 population	:	about 500 seeds obtained by crossing between F_1 (HD × Son) × F_1 (KS × Son)
F_2 inter-mated population	:	by paired crossing between randomly selected 56 F_2 plants of the crosses
F_3 (II)	:	by selfing F_2 of cross KS × Son
BIPS (II)	:	seeds of 36 BIPS obtained by using NC I mating design in F_2 population of cross KS × Son

The seeds of double cross were raised at Lahual Spiti in off-season of 1984 and 155 plants were harvested randomly to get seed for double-cross F_2 population.

The six populations along with check variety HD 2009 were evaluated during 1984-85 in randomised complete block design with three replications. Each population had 25 plots per replication, whereas two plots for the check variety HD 2009 were maintained in each replication. The plot size was single row of 2 m length. The distance between plots (rows) was 25 cm and between plants 15 cm. Data for five quantitative characters (Table 1) were recorded on five random plants per plot in each replication, and the populations were compared on the basis of analysis of variance, mean, range, genotypic and phenotypic coefficients of variation (GCV and PCV), heritability (h^2), and genetic advance (GA) for each character calculated by the standard statistical procedures. The nature and extent of association between grain yield/plant and its components were examined by computing simple correlations in different populations.

RESULTS AND DISCUSSION

Analysis of variance for six populations and one check indicated significant differences among populations. The BIPS differed significantly from their respective F_3 selfed progenies in both crosses for grain yield/plant and at least for one or more yield components. Double-cross and F_2 intermated populations showed significant differences between themselves for all the traits, except biological yield/plant. The comparison of F_2 intermated population with BIPS of the two crosses also showed significant difference for all the traits, except grain yield/plant. Mean squares for HD 2009 v. six experimental populations were significant for all the traits. Thus, each mating system had different impact in generating variability for grain yield and its components.

The comparison of mean and range (Table 1) for different traits indicated that **BIPS (I) and BIPS (II) are significantly superior to F_3 (I) and F_3 (II), respectively,** for yield/plant. The higher mean and range for grain yield/plant and some of its component traits in BIPS populations than their respective selfed generation (F_3) established the superiority of biparental mating approach. Superior performance of BIPS could be attributed to accumulation of favourable genes spread over the population [5, 6] and release of cryptic genetic variability by breaking undesirable linkages. The better performance of BIPS over F_3 (selfed) progenies is also expected when major portion of genetic variation is of additive and additive × additive types.

Table 1. Mean and range of various traits in different populations of wheat

Character	Parameter	HD 2009 × Sonalika		Intercrossed		Kalyan Sona × Sonalika		Check HD 2009	LSD
		F_3(I)	BIPS(I)	double cross F_2	F_2 intermated	F_3(II)	BIPS (II)		
Tillers/plant	Mean	10.0	12.7	7.2	14.9	19.2	15.3	11.1	3.7
	Range	4-35	7-37	2-26	9-49	7-28	6-35	8-12	
Grains/ear	Mean	45.0	53.8	46.5	79.1	60.2	65.8	42.1	8.0
	Range	20-70	26-69	25-63	30-76	27-93	31-96	35-48	
1000-grain weight (g)	Mean	36.8	48.5	50.2	45.8	41.9	45.2	38.5	3.7
	Range	25.2-48.7	30.8-51.9	27.6-55.1	33.1-55.3	26.4-59.7	24.8-53.1	32.1-39.4	
Biological yield/plant(g)	Mean	78.3	70.6	96.4	100.0	81.6	94.2	71.1	6.5
	Range	35.1-197.2	35.6-200.0	25.3-300.0	37.2-219.2	60.1-190.6	30.4-225.1	55.4 80.3	
Grain yield per plant(g)	Mean	26.3	33.6	23.1	38.0	27.7	35.0	24.6	6.9
	Range	10.5-60.3	12.0-72.3	12.3-51.7	8.1-90.2	15.4-70.8	13.7-81.3	18.1-30.6	

The usefulness of biparental approach in improving mean and variance of wheat populations has also been reported earlier [4, 7–9].

The GCV and PCV (Table 2) were higher in the BIPS populations than the corresponding F_3 populations of both crosses for majority of traits. Interestingly, the higher CV for all the traits except grains/ear in BIPS(I), and tillers number, biological yield, and grain yield/plant in BIPS (II) were associated with high heritability and GA. Similar observations were reported earlier [8, 10 11] for grain yield and tillers/plant in wheat, which can be attributed to the predominance of repulsion phase linkage for these traits [3]. The high CV was not associated with high heritability for grains/ear in BIPS(I) and BIPS (II), and for 1000-grain weight in BIPS(II), although GA in BIP(I) and BIPS(II) was higher than in F_3(I) and F_3(II), respectively, for these traits. Inconsistencies in the magnitude of heritability and GA for these traits may be attributed to low or high phenotypic standard deviation. High phenotypic standard deviation along with high variability tends to increase the expected genetic gain. Thus, the variability in base populations would be more useful than the magnitude of heritability alone for selecting better genotypes [12]. The present comparison of mating systems shows that BIPS offers better opportunities than selfing for isolating superior types, releasing hidden genetic variation, and precluding early fixation of genes in homozygous lines.

A comparison among BIPS(I), BIPS(II), double-cross F_2 and F_2 intermated populations showed that the mean performance of F_2 intermated population was significantly higher than that of double-cross F_2 population for grains/ear, and tiller number and grain yield/plant. Double cross F_2 population showed significantly higher

Table 2. Genotypic and phenotypic coefficients of variation, heritability and genetic advance in six wheat populations for various traits

Character	Parameter	HD 2009 × Sonalika		Intercrossed		Kalyan Sona × Sonalika	
		F_3(I)	BIPS(I)	double cross F_2	F_2 inter-mated	F_3(II)	BIPS(II)
Tillers/plant	GCV	25.6	30.9	40.9	31.4	24.1	25.4
	PCV	36.7	42.5	82.4	47.8	27.3	29.0
	h^2	50.0	53.1	24.6	42.8	78.0	74.9
	GA	37.6	46.5	20.8	42.4	38.8	14.8
Grains/ear	GCV	5.7	7.2	7.9	10.8	5.1	8.4
	PCV	6.6	9.9	10.3	14.3	6.7	10.3
	h^2	75.7	51.9	59.2	58.1	79.6	66.6
	GA	10.3	10.6	12.5	13.9	9.4	14.1
1000-grain weight	GCV	8.7	9.0	7.8	11.7	8.1	12.2
	PCV	10.5	10.3	8.2	12.9	8.2	15.0
	h^2	68.9	76.5	89.9	89.8	87.8	66.3
	GA	14.9	16.3	15.2	22.6	16.4	20.5
Biological yield per plant	GCV	6.7	7.9	6.4	7.5	6.0	15.9
	PCV	10.8	11.6	10.9	11.7	10.1	24.4
	h^2	39.0	46.7	34.4	40.7	35.1	41.9
	GA	8.7	11.2	7.7	9.8	7.8	21.2
Grain yield/plant	GCV	17.6	18.3	20.4	26.3	22.3	25.4
	PCV	27.6	28.3	34.9	34.3	33.5	34.0
	h^2	40.2	51.6	33.9	59.9	44.2	55.8
	GA	22.9	27.1	24.5	41.6	30.5	38.8

mean than BIPS (II) only for 1000-grain weight. The range, CV, heritability and GA were highest for grain yield/plant in F_2 intermated population in comparison to the other three populations. For other traits, this population exhibited comparable variability and GA with BIPS (I) and BIPS (II). This suggested that the gain from selection would be higher in F_2 intermated population. The double-cross F_2 population did not exhibit superiority over other populations in terms of mean, CV and GA for grain yield/plant and most of its component traits. This may be due to considerably lower frequency of favourable alleles in the double-cross F_2 than single-cross F_2 population. The double-cross F_2 population did not generate high yielding segregants (as was also reported in sorghum [13]), although the variability in population was considerably high. Thus, multiple crosses at F_1 level did not perform more favourably in releasing useful genetic variability [14].

Correlation studies (Table 3) also confirmed the significance of intermating approach. BIPS(I) and BIPS(II) and F_2 intermated populations exhibited some shift in character associations. Significant positive correlations were established between tillers/plant and grains/ear in these populations, but in double-cross F_2 population, this correlation became significantly negative. BIPS(II) and F_2 intermated populations showed significant positive correlation between 1000-grain weight and grains/ear.

Table 3. Correlation coefficients among yield components in six wheat populations

Character	Population	Grains per ear	1000-grain weight	Yield per plant	Biological yield per plant
Tillers/plant	F_3 (I)	−0.12	−0.03	0.43*	0.23*
	BIPS(I)	0.62*	0.13	0.52*	0.24*
	F_3(II)	0.03	0.12	0.63*	0.33*
	BIPS(II)	0.39*	0.42*	0.46*	0.26*
	Double cross F_2	−0.44*	−0.54*	0.14	0.51*
	F_2 intermated	0.55*	0.13	0.65*	0.61*
Grains/ear	F_3(I)		−0.08	0.44*	0.13
	BIPS(I)		0.14	0.46*	0.11
	F_3(II)		0.04	0.24*	0.07
	BIPS(II)		0.21*	0.07	0.22
	Double cross F_2		−0.35*	−0.02	0.44
	F_2 intermated		0.46*	−0.44*	0.56*
1000-grain wt.	F_3(I)			0.05	0.15
	BIPS(I)			0.64*	0.11
	F_3(II)			0.04	0.13
	BIPS(II)			0.12	0.13
	Double cross F_2			−0.21*	−0.45*
	F_2 intermated			0.43*	−0.29*
Grain yield/plant	F_3(I)				0.18
	BIPS(I)				0.49*
	F_3(II)				0.56*
	BIPS(II)				0.51*
	Double cross F_2				0.10
	F_2 intermated				0.49*

*Significant at 5% level.

Shift in correlations has also been reported earlier [4, 7, 8, 15]. The double-cross F_2 population exhibited weak or negative correlations between yield components. This again supported the observations of [13] that multiple-cross approach does not always give favourable result because of disruption of adaptive gene complex. Therefore, introgression of desirable genes in self-pollinated crops should be made cautiously and selectively. The present study indicates that intermating within or between F_2 populations generates more desirable genetic variability and dissipates negative correlations between yield and its components.

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