Indian J. Genet., **55** (3): 273–278 (1995)

RELATIVE EFFICIENCY OF DIFFERENT METHODS OF GENERATING VARIABILITY IN *TRITICUM DURUM*

S. K. SETHI, R. B. SRIVASTAVA, M. YUNUS AND B. YADAV

Department of Plant Breeding, Haryana Agricultural University
Hisar 125004

(Received: October 10, 1990; accepted: June 11, 1995)

ABSTRACT

Comparison among randomly selected F_3 progenies, F_2 biparental progenies and F_4M_2 progenies was made to understand the impact on generating variability for yield, harvest index and another traits in *durum* wheat. It was observed that biparental mating in F_2 generation is able to provide greater variability for selection of plants of high yielding efficiency with high harvest index. Correlation studies also exhibited that biparental mating had generated strong character associations with grain yield. Improvement in increasing the number of tillers per plant was found to be difficult. Increase in harvest index and yield per plant in this study might be due to the elevation in mean of other component traits as a result of accumulation of desirable genes through biparental mating. Mutation breeding offered little chances to generate desirable variability for yield.

Key words: *Triticum durum*, biparental mating, heritability irradiation, variability.

Pedigree selection from F_2 generation and onward in *durum* wheat has proved little usefulness during 13 years of researches at Haryana Agricultural University, Hisar (India). It might be that the single cross F_2 generation was not able to generate desired base population to carry out selection of promising types. Useful initial genetic variation results in high selection gains. Intermating approach has been favoured to elevate the population mean and genetic variability in oat, barley and breadwheat [1–3]. Mutation breeding approach has also been suggested for similar purpose [4]. Keeping this in view, a comparison was made among progenies generated through visual selection, biparental mating and irradiation in F_2 generation to know the impact on mean and variance for grain yield and other traits in *durum* wheat.

MATERIALS AND METHODS

The study was conducted with three *durum* wheat crosses Qfn. x Capeity (Cross I), Qfn. x BD 2030 (Cross II) and BD 2030 x Jori 69 (Cross III) during 1985–90 at Deptt. of Plant

Breeding, HAU, Hisar. The varieties involved in crosses are highly diverse for yield and yield components traits. F_2 generation of three crosses were grown during the crop season of 1987–88. Three populations of each cross were developed by using random selection, biparental mating and irradiation in F_2. Randomly selected plants were used for making 24 BIPS for each cross using NCI mating design in F_2 population. Spikes of selected plants were also selfed to get F_3 progenies. Half of the selfed seed was also irradiated with 25 kR of gamma rays to get F_3M_1 (during 1988–89) and it was further advanced to F_4M_2 generation. Finally three populations of each cross namely (i) randomly selected F_3 progenies, (ii) F_2 biparental progenies and (iii) F_4M_2 progenies were evaluated separately using randomized block design with three replications during 1989–90. Each population had 20 plots per replication. The plot size was single row of 3 m length. The distance between plots (rows) was 25 cm and between plants 15 cm.

Data for effective tillers per plant, biological yield per plant, harvest index per plant and grain yield per plant were recorded on five randomly selected plants per plot in each replication. To compare the populations, the analysis of variance, mean, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and genetic advance (GA) were calculated for each character in each population of the three crosses by using standard statistical procedures. The nature and extent of association between grain yield and other traits were examined by computing out of simple correlations in different populations.

RESULTS AND DISCUSSION

The analysis of variance for nine populations generated from three crosses by using random selection, biparental crosses and F_4M_2 progenies indicated the significant differences among the populations for all the four traits under study. The analysis of variance for three different populations of an individual cross also showed wide differences among the populations for all the traits except for effective tillers per plant in Cross II and Cross III. It emphasised that random selection series, biparental mating and F_4M_2 progenies had different impact on generating the variability for all the four traits in the present *durum* wheat material.

Mean of the biparental progenies (BIPS) was significantly superior over both the F_3 progenies developed through random selection and the F_4M_2 progenies for grain yield per plant and harvest index in all the three crosses (Table 1). The three populations of each cross were not differed significantly for effective tillers per plant. F_4M_2 progenies showed significantly higher mean for biological yield per plant over the other populations of each cross. Effectiveness of biparental mating approach in generating population of high mean and variance in breadwheat has been observed while comparing against F_3 and F_4M_2

progenies. The superior performance of biparental progenies could be attributed to the accumulation of favourable genes of low frequency spread over the population, dominance deviation and epistatic interaction in BIPS [3, 5, 6]. The release of concealed genetic variability by breaking undesirable linkages might be another reason for increasing mean and variability of biparental population.

Genotypic and phenotypic coefficients of variation (Table 1) in BIPs were higher than in corresponding F_3 random selections and F_4M_2 progenies for most of the traits in all the three crosses. It might be due to breakage of undesirable linkages and appearance of new gene combinations [3, 4]. Higher GCV and PCV of biparental progenies for different traits were associated with higher heritability and genetic advance, as also reported earlier in breadwheat [3, 5, 7, 8]. It suggested the predominance of repulsion phase linkages for these traits [9]. The present comparison of methods of creating variability in *durum* wheat showed that BIPs offer better opportunities than random selection series and irradiated population for isolating superior types, releasing concealed genetic

Table 1. Mean, coefficients of variation, heritability and genetic advance in *durum* wheat populations

Populations and parameter	Effective tillers per plant	Biological yield per plant (g)	Harvest index per plant (%)	Grain yield per plant (g)
Qfn. x Capeity (Cross I)				
Randomly selected F_3 progenies				
Mean	9.53	54.73	40.29	21.67
GCV	11.47	16.87	18.08	13.54
PCV	16.95	19.31	21.99	17.48
Heritability	45.83	76.29	67.65	60.01
Genetic advance	1.52	16.61	12.34	4.68
F_2 biparental progenies				
Mean	7.21	51.11	51.57	28.48
GCV	16.91	18.10	23.15	16.11
PCV	22.39	22.36	26.95	19.90
Heritability	57.05	65.68	73.75	65.51
Genetic advance	1.92	12.42	21.12	5.50
F_4M_2 progenies				
Mean	9.11	60.33	35.66	18.23
GCV	0.00	0.00	15.92	12.72
PCV	2.37	13.44	21.35	13.62
Heritability	− 34.52	− 11.91	55.60	87.14
Genetic advance	− 0.15	− 1.99	8.72	5.19
Qfn. x BD 2030 (Cross II)				
Randomly selected F_3 progenies				
Mean	8.73	45.84	43.61	19.78
GCV	14.07	19.45	19.96	17.85
PCV	18.45	21.84	23.95	20.73
Heritability	58.15	79.26	69.47	74.09
Genetic advance	1.87	17.26	16.10	7.03
F_2 biparental progenies				
Mean	8.47	48.40	46.97	22.24
GCV	18.00	26.06	21.21	19.97
PCV	21.39	27.68	25.86	21.56
Heritability	70.80	88.66	67.28	85.74
Genetic advance	2.72	23.18	17.07	7.92

(Contd.)

variation and precluding early fixation of genes in homozygous lines [3, 4]. Higher phenotypic standard deviation along with high variability tend to increase the expected genetic gain. Thus, the genetic variability in base populations would be more useful than the magnitude of heritability alone for selecting the better genotypes [10].

The irradiation in F_2 failed to generate desirable high mean and genetic variability. It might be attributed to the fact that cummulative nature of the mutants might be dependent on many factors such as genetic architecture of quantitative traits, the efficiency of mutagen, the population size studied and the extent of diversity of parents used in the cross. The low heritable variation induced by gamma rays might be the result of predominantly cryptic chromosomal changes and other induced events of nonfixable nature. Further, the genetic variability induced by radiation was not always of cummulative in nature [4].

Table 1 (contd.)

Populations	Effective tillers per plant	Biological yield per plant (g)	Harvest index per plant (%)	Grain yield per plant (g)
F_4M_2 progenies				
Mean	9.14	60.77	37.25	17.23
GCV	0.01	0.01	0.01	12.72
PCV	1.89	12.33	24.46	13.62
Heritability	– 48.14	– 10.78	– 35.54	87.14
Genetic advance	– 0.17	– 1.66	– 6.67	5.19
BD 2030 X Jori 69 (Cross II)				
Randomly selected F_3 progenies				
Mean	8.01	47.50	40.46	20.96
GCV	17.48	17.75	15.48	18.08
PCV	21.92	23.71	22.23	20.06
Heritability	63.57	56.08	48.53	81.21
Genetic advance	2.45	14.04	10.14	7.66
F_2 biparental progenies				
Mean	8.54	51.23	45.61	22.84
GCV	21.94	27.08	15.90	22.68
PCV	25.65	29.42	20.55	24.71
Heritability	73.16	84.72	59.91	84.26
Genetic advance	3.16	24.39	11.53	8.99
F_2M_2 progenies				
Mean	8.54	56.05	35.06	19.40
GCV	3.80	20.68	13.07	14.39
PCV	10.53	21.10	14.67	16.23
Heritability	13.53	96.07	79.31	78.53
Genetic advance	0.24	23.41	8.40	5.09

Correlation studies (Table 2) also demonstrated the significanc of biparental mating approach as BIPS populations exhibited strong character association between yield and other characters [3, 5, 6]. New positive and significant correlations appeared between harvest index and tillers per plant in BIPS progenies of cross I and II. Except for grain yield/plant and harvest index, irradiated populations showed either negative or no correlation with other traits under study [4]. Thus the improvement in yield, harvest index and related traits in *durum* wheat may be possible by generating desirable variability

Table 2. Genotypic (G) and Phenotypic (P) correlations in different *durum* wheat populations

Population/trait		Effective tillers per plant			Harvest Index per plant			Grain yield per plant		
		CI	CII	CIII	CI	CII	CIII	CI	CII	CIII
Biological yield per plant										
Randomly selected	G	0.40	0.52	0.39	-0.43	-0.59	0.45	-0.07	0.07	0.78
F3 progenies	P	0.37*	0.47*	0.44*	-0.60*	-0.54*	-0.58*	-0.33*	0.09	0.58*
F2 biparental	G	0.70	0.42	0.72	-0.61	-0.51	-0.62	0.37	0.53	0.72
progenies	P	0.56*	0.39*	0.64*	-0.58*	-0.49*	-0.56*	0.33*	0.47*	0.66*
F4M2 progenies	G	0.90	0.17	-0.73	0.00	-0.90	-0.73	0.00	0.00	-0.37
	P	-0.14	0.08	-0.62*	-0.82*	-0.84*	-0.68*	-0.41*	-0.36*	-0.33*
Effective tillers per plant										
Randomly selected	G				-0.22	-0.06	0.24	0.17	0.15	0.63
F3 progenies	P				-0.17	-0.14	0.03	0.19	0.15	0.51*
F2 biparental	G				0.40	0.33	0.63	0.31	0.69	0.31
progenies	P				0.33*	0.23	0.66*	0.20	0.54*	0.21
F4M2 progenies	G				0.00	0.23	-0.56	0.00	0.00	0.28
	P				-0.20	-0.27	-0.45*	-0.43*	-0.20	0.25
Harvest index per plant										
Randomly selected	G							0.45	0.34	0.17
F3 progenies	P							0.52*	0.27	0.24
F2 biparental	G							0.50	0.45	0.84
progenies	P							0.52*	0.50*	0.82*
F4M2 progenies	G							0.60	0.00	0.31
	P							0.54*	0.22	0.38*

*Significant at 5% level, C—Cross.

through biparental mating and subsequent selections. It also suggests that mutation breeding for the improvement in yield has shown little promise in this material. However, the mutation breeding may be used for individual character improvement. In the present study mutated progenies had shown improvement for biological yield in all the three crosses. The variability of BIPS populations may be used for further selections of economic value after advancing the generation through SSD method [11].

REFERENCES

1. A. B. Joshi and N. L. Dhawan. 1966. Genetic improvement in yield with special reference to self-fertilizing crops. Indian J. Genet., 39: 567–578.

2. N. F. Jensen. 1970. A diallel selective mating system in cereal breeding. Crop Sci., **10**: 622–626.

3. R. B. Srivastava, R. S. Paroda, S. C. Sharma and M. Yunus. 1989. Impact of different mating approaches in generating variability in wheat. (*T. aestivum* L. em. Thell). Indian J. Genet., **49**(3): 38–43.

4. S. R. Verma. 1989. Studies on Methods of Creating Variability and Genetic Analysis of Yield and Its Component Traits in Breadwheat (*T. aestivum* L. em. Thell). Ph. D. Thesis. H.A.U., Hisar.

5. M. Yunus and R. S. Paroda. 1982. Impact of biparental mating on correlation coefficients in breadwheat. Theor. Appl. Genet., **62**: 337–343.

6. S. Chander. 1992. A Comparative Study of First and Second Cycle of Intermating with Basic Population in Wheat. M. Sc. Thesis. H.A.U., Hisar.

7. M. A. Islam. 1976. Genotypic and phenotypic variability in yield and other quantitative characters in common wheat. Pak. J. Sci. Res., **28**: 41–45.

8. G. Singh, G. S. Bhullar and K. S. Gill. 1986. Comparison of variability generated following biparental mating and selfing in wheat. Crop Improv., **13**: 24–28.

9. A. S. Randhawa and K. S. Gill. 1978. Effectiveness of selection under different mating systems for improvement of protein content in wheat. Theor. Appl. Genet., **53**: 129–139.

10. H. W. Johanson, H. F. Robinson and R. E. Comstock. 1955. Estimation of genetic and environmental variability in soybean. Agron. J., **47**: 314–318.

11. R. B. Srivastava, R. S. Paroda, S. C. Sharma and M. Yunus. 1989. Genetic variability and advance under four selection procedures in wheat pedigree breeding programme. Theor. Appl. Genet., **77**: 516–520.