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Response to selection in F_2, in the F_5 generation in Indian mustard [*Brassica juncea* (L.) Czern & Coss.]

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Abstract

Response of selection in F_2 generation for main shoot length, seeds per siliqua, seed mass and seed yield was studied in F_5 generation. Observations were recorded on individual plant basis in F_2 generation of 3 crosses of Indian mustard (*B. juncea* L.) for each trait. Five plants with high and five with low values were selected for each trait. On the other hand a bulk was constituted by taking one seed from each plant in each cross. These selected plants as well as the constructed bulks were raised to advance from F_3 to F_4 generation. In F_5 generation, comparisons were made between high and low selections for each trait as well as between high selection and bulk. It was observed that differences between high and low selection were non-significant for all traits except seed mass. On the other hand mean values under bulk were comparable to that of high selection group for each trait. Bulk was advised to be followed in early generation. Transgressive segregants were more frequent for main shoot length; seeds per siliqua and seed yield than for seed mass. The change in relationship between seed mass and seeds per siliqua from F_2 to F_5 turned to be negative.

Key words: Indian mustard, early generation selection, realized heritability, intergeneration correlation

Introduction

F_2 generation provides an active breeding material from which desirable plants may be selected. There have been varying reports about the reliability of early generation selection [1-3]. Though it is desirable due to high probability of selecting desirable plants in F_2 generation than subsequent generations [4]. The present investigation was undertaken to study the response of F_2 selection in a subsequent generation (F_5) as well as to compare individual plant selection with random bulk for yield and its components.

Materials and methods

Population from three crosses *viz.* QM19 × BIO 902 (Cross 1), PBCM 11565 × Varuna (Cross 2) and NRC 3 × Pusa Bold (Cross 3) were grown during 1997-98 at National Research Center on Rapeseed-Mustard, Bharatpur in plots of 5 m length. Row to row and plant-to-plant spacing were 30 cm and 10 cm, respectively. Observations were recorded on individual plants for main shoot length (cm), seeds per siliqua, 200-seed mass (g) and seed yield per plant (g) on 216 plants in cross 1, 140 pants from cross 2 and 96 plants from cross 3. The number varied because observations were recorded on competitive plants, the plants which were surrounded by other plants at specified row to row and plant to plant spacings, to minimize the environmental effect. On the basis of individual plant observations, 5 superior most and 5 lowest ranking plants were selected for each trait in each cross. The mean values for 4 traits under different selection groups are presented in Table 1 .There were 11 overlaps in cross 1 and 6 each in cross 2 and cross 3. As a result a total of 29 plants were selected from cross 1 and 34 plants were selected from cross 2 and 3 each. In addition a bulk was also constituted for each cross by taking one seed from each plant of the cross. Selected plants were raised in two rows each of 5 m length during 1998-99. In case of overlaps, seed was divided to raise the F_3 progenies. Hence each selection group comprised of 10 rows of F_3 progenies of the selected F_2 plants. In addition 10 rows of 5 m length were grown from single seed bulk. Seed of one selection group was harvested and bulked to raise F_4 generation without practicing any selection. In F_4, 10 rows from each of selection group were raised and harvested and bulked. Open pollination was allowed in both the years assuming predominantly self-pollination in *B. juncea* L.

In F_5, selected plants and single seed bulk were evaluated in split plot design keeping crosses as main plots and selection groups alongwith parents as sub plots in plots of 5 rows of 3m length. In case of overlaps, seed was divided to sow under different selection groups. Observations were recorded on 50 randomly selected plants in each selection group/parents in each population for main shoot length (cm), seeds per siliqua, 200 seed mass (g) while, seed yield (g) was recorded on plot basis from five rows. Response of selection was studied on the basis of four parameters.

1. Comparison between the progenies of high and low selection group in F_5 generation.

2. Inter-generation (F_2/F_5) correlation coefficients estimated between the mean value under different selection groups in F_2 generation and that of their progenies in F_5 generation.

3. Realized heritability estimates (F_2 to F_5) [5].

4. Range depicting transgressive segregation for each trait in F_5 generation.

Correlation coefficients were also estimated among four traits in F_2 and F_5 generation separately on the basis of single plant observations, irrespective of selection groups, to study the changes occurred from F_2 to F_5 generation. Significance of correlation coefficients was tested following 't' test.

Results and discussion

The crosses had significant differences for 200-seed mass and yield per plot and non-significant differences for main shoot length and seeds per siliqua (Table 2). Selection groups exhibited significant responses for main shoot length, 200-seed mass and yield per plot but non-significant response for seeds per siliqua. Interactions between cross and selection group were significant for main shoot length, 200 seed mass and seed yield per plot indicating thereby that response to selection varied from cross to cross.

Differences for seed mass between the progenies of high and low selection groups for seed mass were significant in cross 2 and 3 (Table 3). In cross 1 though, the differences were non-significant, however, progenies of high selection group had bolder seeds than that of low selection group. It indicates that selection for seed mass in F_2 generation was effective. Early generation selection for seed mass has been reported to be effective in wheat also [6]. But low estimates of realized heritability and non-significant correlation coefficients (Table 4) between F_2 and F_5 generation suggested poor response of selection in F_2 generation. For the remaining traits *viz.*, main shoot length, seeds per siliqua and seed yield per plot, no response of selection was observed as the differences between progenies of high and low selection groups for these traits were non- significant accompanied with low realized heritability estimates and non-significant inter-generation (F_2 to F_5) correlation coefficients.

Effectiveness of selection was also studied on the basis of ranges for different traits in F_5 with that of parents. A perusal of the Table 6 depicting ranges for different traits revealed that segregants could surpass the high valued parent for main shoot length, seeds per siliqua and seed yield in all 3 crosses but for seed-mass only in cross 3. Comparison between mean values under different selection groups (Table 1) and high valued parent also support the success in obtaining desirable transgressive segregants for seeds per siliqua and seed yield but failure for seed mass in all 3 crosses however response for main shoot length varied

Table 1. Mean values for four traits under different selection groups in F_2 and F_5 generations of 3 crosses in Indian mustard

Selection group	Cross 1				Cross 2				Cross 3			
	MSL*	S/S	SM	Seed yield	MSL	S/S	SM	Seed yield	MSL	S/S	SM	Seed yield
						F_2						
MSL (H)	63.0	11.3	0.66	8.0	82.2	10.8	0.67	7.7	73.0	13.2	0.86	11.1
MSL (L)	20.7	10.2	0.48	3.6	29.4	10.9	0.58	3.5	26.0	13.4	1.1	8.8
S/S (H)	45.0	16.0	0.61	5.1	52.4	16.0	0.68	6.6	55.6	16.5	0.75	7.7
S/S (L)	32.1	4.0	0.66	3.8	43.0	5.4	0.67	3.7	44.2	10.3	0.82	5.9
SM (H)	41.8	11.8	0.84	4.3	64.6	12.8	0.95	7.3	50.0	12.7	1.07	6.9
SM (L)	33.0	10.3	0.33	3.3	61.3	14.1	0.39	3.8	61.9	12.9	0.5	5.2
Yield (H)	51.7	10.3	0.62	11.5	51.4	12.4	0.71	11.8	47.6	14.5	0.77	16.7
Yield (L)	25.1	9.3	0.41	2.8	47.4	10.2	0.47	2.5	39.4	12.1	0.6	4.3
						F_5						
MSL (H)	56.1	11.2	0.8	0.8	61.9	13.8	0.86	0.76	52.8	14.2	1.1	0.94
MSL (L)	54.7	12.4	0.8	0.82	62.4	15.6	0.86	0.77	56.2	12.0	0.82	0.89
S/S (H)	58.6	11.2	0.77	0.83	61.5	14.0	0.90	0.73	55.6	13.2	0.92	0.92
S/S (L)	54.2	12.0	0.83	0.94	62.7	12.3	0.99	0.71	61.6	12.1	1.1	0.86
SM (H)	51.3	13.3	0.83	0.79	61.3	13.0	0.97	0.78	61.9	14.4	1.02	0.90
SM (L)	53.6	13.2	0.77	0.75	61.3	15.1	0.89	0.85	60.4	13.9	0.94	0.86
Yield (H)	48.9	13.5	0.77	0.79	72.5	13.5	0.93	0.71	58.6	13.7	0.82	0.76
Yield (L)	52.3	12.8	0.78	0.8	67.0	13.1	0.90	0.76	61.4	12.6	0.97	0.76

*MSL = Main shoot length; S/S = Seeds per siliqua; SM = Seed mass; H = High; L = Low

Table 2. Mean sum of squares for different traits in Indian mustard

Source of variation	df	Main shoot length	Seeds/ siliqua	200-seed mass	Yield
Cross	2	208.5	10.7	0.09**	0.17*
Error (A)	4	190.8	12.1	0.0027	0.04
Selection groups	10	151.2**	2.3	0.13**	0.04**
Cross × Selection groups	20	122.0**	4.1	0.019**	0.02*
Error (B)	60	29.3	3.0	0.007	0.01

from cross to cross. Thus these findings suggest that selection in F_2 for highly heritable traits like seed mass is effective in sustaining the differences in F_5 while non-responsive for main shoot length, seeds per siliqua and seed yield; suggesting thereby that though transgressive segregants occurred as a result of hybridization but selecting plants in F_2 generation merely, may be misleading because grouping of plants in high and low categories on the basis of F_2 observation was not effective in sustaining the differences in F_5 generation. Ineffective response of selection in F_2 generation might have occurred because of prevalence of genotype and environment interaction. Further, it might had been possible to identify superior genotypes in F_2 generation but genetic constellation of such genotypes changed in F_3 and F_4 generation as no selection was practiced in these generations. Ineffectiveness of selection in F_2 generation for quantitative traits has earlier been reported [1, 2, 4 and 6-8]. On the contrary transgressive segregants were more frequent for main shoot length; seeds per siliqua and seed yield, suggesting the need of continuous selection throughout segregating generations to sustain the superiority of selected plants. Since the mean values of progenies of high selection group were comparable with that of single seed bulk for all traits (Table 3), the generation advancement from F_2 to F_5 through bulk would be desirable. This finding is in agreement with earlier reports in wheat [9] and in soybean [10].

Correlation coefficients among four traits were estimated in all 3 crosses on the basis of single plant observation in F_2 and F_5 generations separately, to study the changes occurred from F_2 to F_5 due to segregation accompanied with selection (Table 6). Seed yield showed consistent positive and significant correlation with all 3 traits in all crosses in both F_2 and F_5 generations except in cross 1 the relationship

Table 3. Mean values of selected plants under different selection groups in 3 F_5 populations of Indian mustard

Cross	MSL (cm)			Seeds/siliqua			200-seed mass (g)			Yield/plot (kg)		
	H	L	Bulk	H	L	Bulk	H	L	Bulk	H	L	Bulk
1	56.1	54.7	53.5	11.2	12.0	12.1	0.83	0.77	0.83	0.79	0.80	0.77
2	61.9	62.4	63.1	14.0	12.3	14.8	0.97*	0.89	0.91	0.71	0.76	0.65
3	62.8*	56.2	57.1	13.2	12.1	12.8	1.02*	0.94	0.98	0.76	0.76	0.87
Mean	60.3	57.8	57.9	12.8	12.1	13.2	0.94*	0.86	0.91	0.75	0.77	0.76
CD 2		5.1			1.6			0.0447			0.096	
CD 3		8.8			2.8			0.083			0.166	

*Indicate superiority over corresponding low selection groups

Table 4. Intergeneration (F_2-F_5) correlation (r) and realized heritability (RH) estimates in F_5 generation of three crosses in Indian mustard

Traits	Crosses	r	RH
Main shoot length	1	0.060	0.03
	2	–0.146	–0.009
	3	0.678	0.14
Seeds/siliqua	1	–0.218	–0.06
	2	0.494	0.16
	3	0.292	0.17
200-seed mass	1	0.477	0.12
	2	0.535	0.14
	3	0.334	0.14
Seed yield	1	–0.173	–0.02
	2	–0.396	–0.11
	3	–0.203	0.00

Table 5. Range for four traits in F_5 generation of 3 crosses in Indian mustard

Cross	Generation	Trait							
		Main shoot length (cm)		Seeds per siliqua		200-seed mass (g)		Seed yield per plot (g)	
		Low	High	Low	High	Low	High	Low	High
1	F_5	38.0	71.6	8.4	17.2	0.64	1.06	750.0	938.7
	P_1/P_2	59.6	68.7	11.5	12.1	0.70	1.25	637.7	767.3
2	F_5	44.0	91.8	7.2	18.6	0.52	1.1	708.7	853.0
	P_1/P_2	34.5	64.6	11.0	11.5	0.61	1.28	350.3	675.7
3	F_5	42.0	68.4	7.8	17.8	0.72	1.34	645.7	939.7
	P_1/P_2	53.7	66.7	13.5	13.7	0.7	1.02	740.3	782.3

Table 6. Correlation coefficients among different traits in F_2 and F_5 generation of Indian mustard

Trait	Generation	Cross 1			Cross 2			Cross 3		
		Seeds/ siliqua	200-seed mass	Yield	Seeds/ siliqua	200-seed mass	Yield	Seeds/ siliqua	200-seed mass	Yield
MSL	F_2	0.22*	0.15*	0.48*	0.00	0.17*	0.52**	0.22*	0.15	0.46**
	F_5	–0.08	0.12*	0.40**	0.08	0.18**	0.43**	0.33*	–0.01	0.45**
S/S	F_2		0.04	0.19**		0.02	0.31**		–0.13	0.43**
	F_5		–0.42**	–0.09		–0.23**	0.21**		–0.01	0.12*
TW	F_2			0.32**			0.38**			0.22**
	F_5			0.27**			–0.13*			0.32**

with seeds per siliqua turned to be non-significant and in cross 2 with 200-seed mass the correlation became negative. The major change in the relationship from F_2 to F_5, however, occurred between 200 seed mass and seeds per siliqua, which was non-significant in F_2 in all 3 crosses and turned, to be significant but negative in cross 1 and 2 in F_5. This indicates that the linkage between more number of seeds per siliqua and high seed mass could be broken in F_2 generation, providing an opportunity to exercise the selection.

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