J. Sher-e-Bangla Agric. Univ., 2(2): 34-40, July 2008 ISSN 1997-6038

VARIABILITY STUDY IN F_2 PROGENIES OF THE INTER-VARIETAL CROSSES OF *Brassica rapa*

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ABSTRACT

An experiment was carried out by using the F_2 population of 12 inter-varietal crosses, including reciprocals, of the species *Brassica rapa* for estimating the magnitude of variations in characters, heritability and genetic advance. There were significant variations among different F_2 materials used in the experiment. Genetic parameters viz. number of primary branches/plant, number of secondary branches/plant, length of siliqua, number of seeds/siliqua, days to 50% flowering, 1000 seed weight and yield/plant showed least difference between genotypic and phenotypic variance. Plant height, length of siliqua, number of seeds/siliqua and days to 50% flowering showed low genotypic and phenotypic co-efficient of variation. Number of primary branches/plant and secondary branches/plant showed high heritability coupled with high genetic advance and very high genetic advance in percentage of mean. However, the yield/plant, days to maturity and length of siliqua showed low heritability. Based on the variability study, some promising F_2 plants showing high heritability for yield contributing characters were selected from some of the cross combinations of the inter-varietal crosses of *Brassica rapa* for advancing the generations.

Key words: Variability, F_2 progenies, inter-varietal crosses

INTRODUCTION

Brassica oil is the world's third most important sources of edible vegetable oils (Downey, 1990). In Bangladesh, *Brassica* is the most important oilseed crop. The country is facing huge shortage in edible oils. Almost one fourth of the total edible oil consumed annually is imported. The import cost was about 690 million US dollar (BBS, 2004). The average yield of *Brassica* oilseed in Bangladesh is around 733 kg/hectare (FAO, 2003). In Bangladesh, there is limited scope to increase acreage for oil crop due to pressure of other crops and to increase yield due to cultivation of the existing low yielding varieties. In Bangladesh, local cultivars, which are short in duration, of *B. rapa* are widely grown and they give moderate yield but some of the long duration cultivars produce high yield, which are not occupied by the farmers. Short duration variety Tori-7 of *B. rapa* is still popular in Bangladesh because it can fit well into the T. Aman-Mustard-Boro cropping pattern. No improved short duration variety of *B. rapa* is available to replace this short duration variety. There should be an attempt to develop short duration and high yielding varieties of mustard to meet the challenge of edible oils of the country by increasing the production. Therefore, the present experiment was carried out to study the variability in F_2 segregating generations for selecting the desired plant types with short maturing high yielding grey seeded plants and short duration high yielding yellow seeded plants.

MATERIALS AND METHODS

The experiment was undertaken in the experimental farm, Sher-e-Bangla Agricultural University (SAU), Dhaka during November 2005 to March 2006. The experiment was set up in a RCBD design

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with three replications, following 30cm x 10 cm spacing. The unit plot size was 5 m x 25 m and block to block distance was 1.5 m. The plot was fertilized with 250,170, 85, 150, 5 Kg/ha Urea, TSP, MP, Gypsum and Borax, respectively. Standard agronomic practices were carried out to raise healthy crop. Data were recorded on number of primary branches/plant, number of secondary branches/plant, length of siliqua, number of seeds/siliqua, number of siliquae/plant, days to 50% flowering, days to maturity, 1000 seed weight and yield/plant from ten plants selected at random from parental line and 50 plants from F_2 progenies in each replication. The data were analyzed for different components. Phenotypic and genotypic variance was estimated by the formula used by Johnson *et al.* (1955). Heritability and genetic advance were measured using the formula given by Singh and Chaudhary (1985) and Allard (1960). Genotypic and phenotypic co-efficient of variation were calculated by the formula of Burton (1952).

RESULTS AND DISCUSSION

All the F_2 materials varied significantly with each other for all the characters indicating the presence of considerable variations among the materials studied. Among the different F_2 materials, SS75×BARI sarisha-9, BARI sarisha-9×SS75 and BARI sarisha-9×BARI sarisha-6 were taller with the average plant height of more than 95 cm and the shortest plant was found in the progenies obtained from SAUYC × Tori-7 (Table 1).

Table 1. Values of mean, range and CV (%) of seed and related characters of 5 Parents of *Brassica rapa*

Parents	Plant height (cm)	No. of primary branches/plant	No. of secondary branches/ plant	Length of siliqua (cm)	Seeds/ siliqua (no.)	No. of siliquae/ plant	1000 seed weight (g)	Yield/ plant (g)	Days to 50% flowering	Days to maturity
Tori-7										
Mean	80.83	7	9	3.84	14	147	2.24	2.21	33	80
Range	67-95	4-12	4-15	2.92-5.7	8.6-19.8	47-238	1.6-3	0.94-3.81	------	79-85
CV (%)	8.48	35.14	31.41	14.75	27.14	38.73	12.39	25.72	------	2.21
SS-75										
Mean	106.77	10	1	3.59	16	289	2.49	4.64	41	95
Range	92-132	5-16	0-10	2.66-4.72	8.4-26	117-417	2-3.2	2.99-8.35	41-42	93-103
CV (%)	8.77	27.24	149.76	14.50	24.89	22.16	9.02	28.97	-------	4.51
BARI-6										
Mean	105.53	8	1	4.40	22	143	2.47	4.20	43	95
Range	90-121	5-10	0-3	3.54-5.16	5-30.4	104-215	1.9-3.5	1.45-7.43	42-43	85-103
CV (%)	8.31	22.08	180.33	11.24	23.79	17.52	16.13	29.40	-------	6.29
SAUYC										
Mean	95.3	11	5	4.65	18	211	2.24	3.50	30	83
Range	88-100	7-15	0-15	3.04-6.52	10-25	117-319	1.9-3.2	2.06-5.59	29-33	80-87
CV (%)	4.29	24.61	113.55	26.35	31.77	38.42	18.02	32.04	-------	3.14
BARI-9										
Mean	82.1	10	8	3.63	14	206	2.61	2.87	34	85
Range	62-110	5-15	0-20	2.46-4.72	10 -19.8	117-329	1.5-3.2	1.3-5.71	33-35	85-87
CV (%)	13.95	27.66	72.83	10.99	17.01	28.67	14.43	32.10	-------	0.72

BARI sarisha-9 × SAUYC produced maximum number of primary branches/plant and the lowest number of primary branches/plant were observed in the cross BARI sarisha-6 × BARI sarisha-9. The co-efficient of variation was higher for number of primary branches/plant and number of secondary branches/plant in Tori-7 × BARI sarisha-6 and SAUYC × BARI sarisha-9, respectively. The length of siliqua was highest in BARI sarisha-6 × BARI sarisha-9. The F_2 materials of the cross Tori-7 × BARI sarisha-6 had the highest number of siliquae/plant (Fig 1). However, the lowest number of

siliquae/plant was observed in BARI sarisha-9 × SS75 and the CV% (72.85%) was higher in SAUYC × Tori-7. So, selection can be made here for this character. The Tori-7 × SAUYC had the highest 1000 seed weight (2.36g) and the lowest seed weight was observed in SS75 × Tori-7 (1.90g) and in BARI sarisha-6 × BARI sarisha-9 (1.99g).

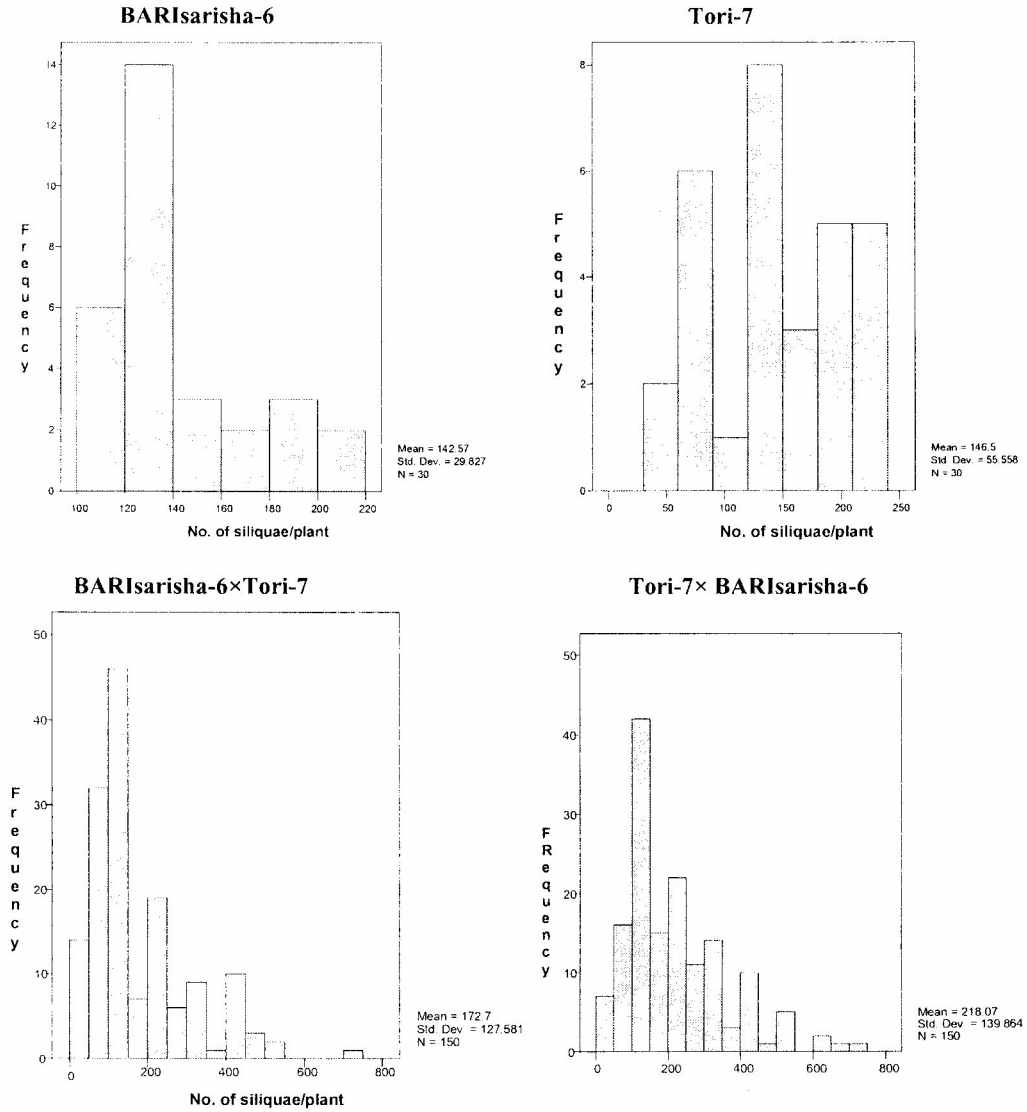

Figure 1. Histogram showing frequency distribution of plants for number of siliquae/plant of parents and F_2 population of the cross BARIsarisha-6×Tori-7 and their reciprocals

The yield was highest in the cross BARI sarisha-6 × BARI sarisha-9, which produced 2.93g of seeds per plant. The cross SAUYC × Tori-7 and SS75 × Tori-7 showed the shortest days (30) to 50% flowering. The plants obtained from the cross Tori-7 × SAUYC showed the shortest maturity period of 83 days. The genes for short duration are

obtained in the plants for these crosses from the parent Tori-7, which could mature within 75 days. The high yielders BARI sarisha-6×BARI sarisha-9 and Tori-7 × SS75 were in the late maturing category having the maturity period of above 86 days. The phenotypic variance of F_2 materials was considerably higher than the genotypic variance for all the characters studied (Table 2).

Table 2.Values of mean, range and CV (%) of seed and related characters of 12 F_2 materials of *Brassica rapa*

Crosses (F_2)	Charecters									
	Plant height (cm)	No. of primary branches/ plant	No. of Secondary branches/ plant	Length of siliqua (cm)	No. of seeds/ siliqua	No. of siliquae/ plant	1000 seed weight (g)	Yield/ plant (g)	Days to 50% flowering	Days to maturity
SS75×Tori-7										
Mean	80.54	8	4	3.61	14	156	1.90	2.06	30	87
Range	55-120	2-23	0-25	2.2-5.28	5.4-25.2	32-412	0.95-3.0	0.51-10.28	------	80-93
CV (%)	15.71	45.71	101.20	17.24	28.89	52.89	20.75	45.76	------	5.15
Tori-7×SS75										
Mean	89.79	5	5	3.43	13	150	2.21	2.86	36	89
Range	52-125	2-13	0-16	2.08-5.06	5.6-23.8	36-427	0.9-3.55	0.48-10.78	33-38	81-103
CV (%)	15.08	47.21	94.59	16.83	26.25	51.75	19.84	50.27	-----	7.90
SS-75× BARI-9										
Mean	96.99	6	3	3.63	14	171	2.04	2.05	33	94
Range	67-130	2-17	0-15	2.32-5.94	4.4-29	50-406	1.1-3.5	0.52-6.03	-----	80-103
CV (%)	13.70	40.56	120.50	17.78	31.23	47.00	20.15	45.68	-----	8.47
BARI-9 × SS-75										
Mean	97.67	6	3	3.89	13	148	2.25	2.21	39	90
Range	55-190	2-13	0-15	2.26-6.98	6.8-25	22-481	0.9-3.95	0.38-7.41	39-40	80-103
CV (%)	18.39	41.75	115.46	18.11	24.96	61.33	22.96	62.69	-----	8.12
Tori-7×BARI-6										
Mean	78.83	8	5	3.59	14	218	1.83	2.46	33	88
Range	43-521	2-26	0-29	2.3-5.92	5-33.4	31-712	1-3.1	0.43-7.89	-----	79-103
CV (%)	36.50	60.34	90.93	15.50	30.20	64.12	20.37	49.85	-----	9.25
BARI-6×Tori-7										
Mean	84.73	7	5	3.53	14	174	2.08	2.20	37	88.03
Range	50-121	2-39	0-43	2.14-7.24	5-75	35-717	0.15-4.4	0.37-8.01	35-38	80-93
CV (%)	18.66	62.71	94.95	16.78	45.20	68.92	30.25	74.23	------	5.75
BARI-6×BARI-9										
Mean	93.26	5	5	3.914	16	177	1.99	2.93	38	87
Range	62-125	2-21	0-14	2.18-6.14	6.8-25.4	47-687	0.21-3.55	0.38-10.23	------	81-93
CV (%)	14.25	54.20	76.94	18.49	27.46	54.28	25.28	57.95	------	5.73
BARI-9×BARI-6										
Mean	99.12	6	3	3.90	14	188	2.105	2.89	40	95
Range	65-119	2-23	0-12	2.26-5.58	7.8-25.2	46-482	0.22-3.25	0.45-9.47	39-41	80-103
CV (%)	12.60	60.17	104.34	17.31	23.89	52.07	21.74	57.38	-----	7.64
SAUYC×Tori-7	75.87									
Mean	50-118	6	6	3.42	12	166	2.18	2.33	30	86
Range	17.41	2-22	0-23	2.2-9.8	6-37	146-567	1.25-3.3	0.69-7.59	-----	79-93
CV (%)		40.93	64.67	21.33	28.78	72.85	17.71	49.13	-----	6.24
Tori-7×SAUYC										
Mean	81.2	7	5	3.69	13	204	2.36	2.57	33	83
Range	55-130	2-25	0-15	2.16-6.82	3-39.6	11-704	0.8-5.1	0.76-7.09	-----	79-85
CV (%)	16.71	56.14	67.99	19.66	30.19	59.37	22.44	43.97	-----	3.02
BARI-9×SAUYC										
Mean	86.93	10	6	3.60	12	209	2.23	2.49	38	89
Range	51-124	2-39	0-43	1.92-5.5	3.8-33.6	31-706	0.18-4.35	0.46-9.68	-----	79-103
CV (%)	14.45	48.12	90.91	16.65	34.62	63.90	24.85	62.58	-----	8.17
SAUYC×BARI-9										
Mean	87.5	7	3	3.56	14	171	2.02	2.08	38	86
Range	10-127	1-26	0-17	2.2-5.44	6.2-24.8	29-517	0.5-3.9	0.31-9.67	38-39	79-103
CV (%)	15.22	51.35	134.02	18.67	27.15	57.36	23.55	66.24	------	8.21

Number of primary branches/plant, number of secondary branches/plant, length of siliqua, number of seeds/siliqua, days to 50% flowering, 1000 seed weight and yield/plant showed minimum difference between genotypic and phenotypic variance which indicated low environmental influence on these characters. Plant height, number of siliqua/plant and days to maturity showed much difference between genotypic and phenotypic variance indicating greater environmental influence in controlling these characters. Plant height, length of siliqua, number of seeds/siliqua and days to 50% flowering showed low genotypic and phenotypic co-efficient of variation. Moderate genotypic and phenotypic co-efficient of variation was observed in number of primary branches/plant, number of secondary branches/plant, number of siliquae/plant, yield/plant, 1000 seed weight and days to maturity. Number of primary branches/plant and number of secondary branches/plant showed high heritability coupled with high genetic advance and very high genetic advance in percentage of mean, where as days to 50% flowering, number of siliquae/plant, plant height, 1000 seed weight and number of seeds/siliqua showed high heritability with moderate genetic advance and genetic advance in percentage of mean that revealed the possibility of predominance of additive gene action in the inheritance of this character, therefore, the characters could be improved through selection process (Table 2).

Yield/plant, days to maturity, length of siliqua showed low heritability with low genetic advance and genetic advance in percentage of mean. As a whole, the low heritability and the consequent low genetic advance indicated the lower possibility of selecting more genotypes for improvement of the crop. Based on the variability study, 18 plants of yellow seeded and 31 plants of grey seeded F_2 materials showing high heritability for yield contributing characters were selected from some of the cross combinations of the inter-varietal crosses of *Brassica rapa* (Table 3 & 4). Overall yellow seeded plants gave lower yield per plant than the grey seeded plants. Only two plants one from the cross BARI sarisha-6 × BARI sarisha-9 and the other one from the cross BARI sarisha-6 × Tori-7 have produced more than 4.5g of yellow seed per plant which showed maturity in 80 days.

Table 3. Estimation of some genetic parameters in respect of 12 F_2 materials of *Brassica rapa*

Parameters	Plant height (cm)	No. of primary branches/ plant(no.)	No. of Secondary branches/ plant	Length of siliqua (cm)	Seeds/ siliqua (no.)	Siliquae/ plant (no.)	1000 seed weight (g)	Yield/ plant (g)	Days to flowering	Days to Maturity
Genotypic Variance	49.46	1.61	1.24	0.01	0.08	517.69	0.08	0.01	9.53	3.65
Phenotypic Variance	84.94	2.03	1.49	0.07	1.55	633.31	0.16	0.22	10.49	31.16
Genotypic co-efficient of variation	8.02	18.54	27.48	2.07	6.51	12.77	13.27	3.99	8.54	2.16
Phenotypic co-efficient of variation	10.51	20.81	25.07	7.43	9.21	14.13	18.94	19.40	8.96	6.32
Heritability %	58.22	79.31	83.22	7.70	49.90	81.74	49.06	4.25	90.78	11.73
Genetic advance	12.61	34.01	47.11	1.18	9.47	23.79	19.14	1.70	16.76	1.53
Genetic advance in percentage of mean	14.38	496.86	1060.56	32.35	70.05	13.35	909.41	70.36	46.38	1.73

Among the grey seeded F_2 variants, most of the selected plants produced more than 4g seed per plant. However, three selected grey seeded plants from the crosses BARI sarisha-6 × BARI sarisha-9 and BARI sarisha-6 × Tori-7 produced more than 6g seed per plant (Table 4). Some of the plants would be grown further to advance the generation for future selection.

Table 4. Performance of selected yellow seeded short duration (80 days) plants from the F_2 materials of different cross combinations of *Brassica rapa*

Cross combinations	Plant no.	Siliquae/ Plant (no.)	1000 seed wt. (g)	Yield/ plant (g)	Type of plant
SS-75×Tori-7 (R-1)	5	32	1.90	2.00	SS-75
Tori-7×SS-75 (R-1)	7	69	2.05	2.01	Tori-7
BARIsar-6×BARIsar-9 (R-3)	9	298	2.75	4.60	BARIsar-6
	23	306	1.85	2.97	BARIsar-6
	24	291	2.85	3.45	BARIsar-6
BARIsar-9×BARIsar-6 (R-1)	4	127	1.90	3.22	BARIsar-9
BARIsar-6×Tori-7 (R-1)	1	419	1.85	5.29	BARIsar-6
	25	126	4.40	3.49	BARIsar-6
Tori-7×SAUYC (R-2)	4	161	1.90	2.36	Tori-7
	23	89	1.25	2.24	Tori-7
	24	76	2.25	2.03	Tori-7
Tori-7×SAUYC (R-3)	8	112	3.40	2.21	Tori-7
	9	114	3.10	2.33	Tori-7
	25	69	3.20	2.30	Tori-7
SAUYC×Tori-7 (R-2)	5	135	2.20	1.90	SAUYC
SAUYC×Tori-7 (R-3)	13	123	2.45	2.24	SAUYC
SAUYC×BARIsar-9 (R-2)	16	135	2.20	2.20	SAUYC
SAUYC×BARIsar-9 (R-3)	5	286	1.25	2.25	SAUYC

Table 5. Performance of selected grey seeded short duration (80 days) plants from the F_2 materials of different cross combinations of *Brassica rapa*

Cross combinations	Plant no.	Siliquae/ Plant (no.)	1000 seed wt. (g)	Yield/ plant (g)	Type of plant
Tori-7×SS-75 (R-2)	1	161	2.05	3.87	Tori-7
Tori-7×SAUYC (R-2)	2	345	1.65	4.33	Tori-7
	14	342	1.00	4.24	Tori-7
SAUYC×Tori-7 (R-1)	7	210	1.75	3.33	SAUYC
	8	210	2.05	3.28	SAUYC
BARIsar-6×BARIsar-9 (R-3)	12	341	2.20	5.60	BARIsar-6
	21	214	2.65	5.38	BARIsar-6
	22	319	1.65	6.28	BARIsar-6
	44	347	1.70	5.14	BARIsar-6
BARIsar-9×BARIsar-6 (R-3)	1	315	2.10	3.91	BARIsar-9
	5	398	1.85	4.77	BARIsar-9
BARIsar-6×Tori-7 (R-1)	19	314	2.65	4.07	BARIsar-6
	32	507	3.10	6.35	BARIsar-6
	34	138	3.00	4.39	BARIsar-6
BARIsar-6×Tori-7 (R-2)	2	417	2.50	7.20	BARIsar-6
	3	192	2.85	5.25	BARIsar-6
	12	497	1.70	4.99	BARIsar-6
BARIsar-6×Tori-7 (R-3)	7	430	1.95	5.32	BARIsar-6
	8	305	1.40	4.04	BARIsar-6
Tori-7×BARIsar-6 (R-1)	6	67	1.45	3.48	Tori-7
	7	297	2.65	5.95	Tori-7
	32	192	2.10	3.46	Tori-7
Tori-7×BARIsar-6 (R-2)	1	507	1.45	4.45	Tori-7
	14	421	2.25	4.90	Tori-7
BARIsar-9×SAUYC (R-3)	25	410	1.80	4.60	BARIsar-9
SAUYC×BARIsar-9 (R-1)	13	201	3.20	3.71	SAUYC
	40	321	3.80	3.61	SAUYC
SAUYC×BARIsar-9 (R-2)	5	315	2.15	5.03	SAUYC
SAUYC×BARIsar-9 (R-3)	10	231	2.55	4.17	SAUYC
	13	301	2.20	5.45	SAUYC
	23	267	2.10	4.25	SAUYC

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