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STUDIES ON F_2 AND FIRST BACKCROSS POPULATION OF INTERSPECIES *BRASSICA* CROSSES

A. BHATTACHARJEE[1], L. RAHMAN[2], A.Z.M.K.A. CHOWDHURY[1], M.M.H. CHOWDHURY[3] AND M.J. HASAN[4]

[1]Plant Breeder, East West Seed (BD) Ltd., Bashon, Gazipur, [2]Professor, Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh, [3]Seed Analyst, Seed Certificate Agency, Gazipur, Bangladesh and [4]Senior Scientific Officer, Hybrid Rice Project, Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh

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ABSTRACT

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An experiment was conducted at the experimental farm of the Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh during rabi season of 1995-1996. This was designed to study the F_2 and first back cross (BC_1) populations of some interspecies crosses of the genus *Brassica*. In this study six parental lines/ varieties, 7 F_2 populations and 7 BC_1 generations from different interspecies crosses were used. Pollen sterility, number of siliquae per plant, siliqua length, number of seeds per siliqua, shattering percentage after 15 days of harvest and yield per plant were studied. The investigation revealed that the pollen sterility of F_2 did not exceed the parentage range. The average number of seeds per siliqua was 13.27 and the percentage of siliqua shattering of F_2 after 15 days of harvest (7.73%) was within the range of parents. The mean seed yield per plant of F_2 was lower when compared the average of both the parents but the co-efficient of variation was very high (143.32%) and the range was 0-31.8g. In F_2, it was observed that more pairs of characters were significantly and positively correlated than that found in their respective parents. Only one negative significant association was observed between pollen sterility and siliqua shattering percentage after 15 days of harvest. The results indicated that the interspecies cross between B. *napus* and B. *campestris* through these two genotypes would result into faster development of improved varieties through better combination effect.

Keywords: F_2 population, BC_1 generation, *Brassica*

INTRODUCTION

The genus *Brassica* includes a large number of economically important oil crops of the world. The species comprising this genus includes many cultivated vegetable and oil seeds. The *Brassica* species can be classified into three groups, Viz; the Cole, the rape seed and the mustard. The coles are consumed as vegetable and the other two are the valuable sources of edible oils and proteins. The mustard groups includes species like *Brassica juncea* Czern and cross, *Brassica nigra* Koch and *Brassica carinata* Barun; while the rape seed groups includes *Brassica campestris* L and *Brassica nap*us L. (Yarnell, 1956). *Brassica* oil is one of the most important edible oil sources of the world after palm and soybean. In Bangladesh, it is the most important oil seed crop. About 15% of world's edible oil supply comes from oil seed *Brassica* (Anonymous, 1985). In a balanced human diet about 20-25% of calories should come from fats and oils. For Bangladeshi diet it comes to about 37g /day. The genome designations of the three elemental species of *Brassica* are "AA" for *B. campestris*, "BB" for *B. nigra* and "CC" for *B. oleracea* having the chromosome number of 10, 8 and 9 at "n" level respectively. The tetraploid species *B. juncea* (AABB), *B. carinata* (BBCC) and *B. napus* (AACC) are amphidiploids and originated from the combinations of the three diploid elemental species (U, 1935). Series of studies on the inheritance of erucic acid and other major fatty acids have been studied in crosses between *B. juncea* and *B. campestris*, *B. napus* and *B. campestris* as well as *B. napus* and *B. juncea* (Rahman, 1972). The recent information on interspecies hybridization in oleiferous *Brassica* group for transfer of earliness to *B. napus* using introgressive hybridization with *B. campestris* (Wahiduzzaman, 1987); for transfer of shattering resistance to *B. napus* with crosses involving *B. campestris* and *B. juncea* (Debi, 1994). All these information clearly showed the possibility of developing varieties of improved yield and quality by interspecific hybridization in *Brassica* oil crop. The present study was designed to cover the following objectives: - to determine the variations obtained in the population of F_2 and BC_1 materials of interspecies crosses and to estimate the relative degree of association between pairs of characters in different types of populations.

MATERIALS AND METHODS

The experiment was conducted at the experimental farm of the Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh during rabi season of 1995-1996. Six parental lines/ varieties, 7 F_2 populations and 7 BC_1 generations from different interspecies crosses were used for the study. The soil of the experimental area belongs to AEZ 9 (The Brahmaputra Alluvial Soil Tract of Bangladesh) with P^H around 6.5. The area was non flooded medium high and soil was sandy loam in texture. Four ploughing and cross ploughing followed by laddering were given during land preparation to ensure good tilth. Fertilizer was applied at a rate of 5000: 200: 160: 70: 140: 5 kg/ha as Cow dung, Urea, TSP, MP, Gypsum and Zinc Sulphate respectively. No specific design was followed due to unequal number of seeds and thus materials were sown in plots of variable sizes.

Intercultural operations such as weeding, application of irrigation, insecticides etc were done uniformly when necessary in order to maintain uniform conditions.

RESULTS AND DISCUSSION

Interspecies crosses of *B. napus* (AACC) and *B. campestris* (AA) have been reported to be easier than that of *B. juncea* (AABB) and *B. campestris*. In interspecies crosses cross ability is the most important trait and the crosses when successful, the patterns of gene combinations dictate the seed setting. The presence of univalent chromosomes in such crosses was found to create major disturbance in fertility of F_2 and onward generations. The specific variability as to selected characters have been shown in Table 1 and 2 and discussed individually. Variety Sambal belongs to the species *B. juncea* and having germination 95% that indicated the selected seeds have performed as per seed standard germination (Table 1). The pollen sterility was better (2.85 of mean and 7.73% CV) than that of two varieties of *B. napus* (Nap-8509 and Nap-3) where the sterility percentage was higher than these varieties (Table 2). The average number of siliqua per plant was 187.80 with a range of 78-270 and the coefficient of variation was 28.59% but produced the lowest size of siliquae 2.84 with lowest number of seeds per siliqua (11.90). Shattering percentage after 15 days of harvest was only 1.26 and produced the lowest 1000 seed weight (2.57g). In case of seed weight per plant it varied from 4-6.30g. Variety Tori-7 belongs to the species *B. campestris* and possessed very high germination percentage. The pollen sterility of the variety Tori-7 was as low as 1.01% with a range of 0-2.10%. Number of siliquae/plant, siliqua length and number of seeds/ siliqua was moderate and it ranged from 27-64, 2.8-4 and 7-17 respectively. The individual plants of variety Tori-7 showed 1.5% shattering after 15 days of harvest. The variation was from 0 to 1.7 % with 14.3% coefficient of variation. The variation was high in Tori-7 than that of Shambol, Sampad and Nap-3. The 1000 seed weight was 2.83g and seed weight per plant was only 2g which was lowest of all the materials used in the interspecies cross program.

Variety Sampad showed very good germination with lowest pollen sterility. Number of siliquae/plant, siliqua length and number of seeds/ siliqua varied from 21-86, 3.6-4.6 and 17-25 respectively. The individual plants showed 1.36% shattering after 15 days of harvest. The range was 1.26-2.30% with coefficient of variation of 8.67%. The variation was the lowest among all the varieties used in the study. The 1000 seed weight was 3g and 3.97g seed yield/plant. Variety Nap-8509 showed good germination but had12.10% pollen sterility. The coefficient of variation was 26.12% (Table 2) and it was the highest variation of all the materials tested. Number of siliquae/plant, siliqua length and number of seeds/ siliqua varied from 180-210, 5-5.60 and 17-25 and showed the lowest percent of coefficient of variation for number of seeds / siliqua. Shattering percentage after 15 days of harvest ranged from 8-16% with coefficient of variation of 20.75%. The 1000 seed weight was 3.93g and seed yield/plant was 9.59g.

Variety Nap-3142 was shown 94% germination with 2.02% pollen sterility. Number of siliqua/plant was 90.60 having a range of 90-110 with coefficient of variation was 11.99%. Siliqua length varied from 4.9-5.70 with coefficient of variation of 4.59%. Number of seeds/siliqua was 17.70. The individual plants showed 8.25% shattering after 15 days of harvest. The 1000 seed weight was 3.80g and seed yield / plant was 11.80g.

Variety Nap-3 showed 94% seed germination with high seedling vigor. The pollen sterility of the variety was 4% with a range of 0-13%. The coefficient of variation was 18.12% and that was close to variety Sampad. The variety produced highest number of siliquae/plant and also showed the highest siliqua length. The range of siliquae production /plant was 79 to 355 with an average number of 221.80 having 42.95% of coefficient of variation. Parental variety Nap-3 produced the highest number of seeds/siliqua it was ranges from 9-26 with very less shattering tendency after 15 days of harvest and also possessed the highest 1000 seed weight (4.10g) and seed yield/plant (12.35g). In all parameters except pollen sterility parental variety Nap-3 was superior.

In case of F_2 population studied average pollen sterility was 9.17% with a range of 3 -12.75% having 11.45% of coefficient of variation (Table 3). In both the parents the sterility was as high as 13% (Nap-3) and 7% (Sampad). The sterility in F_2 population was well with in the highest range of *B. napus* parent. The sterility in F_2 was found to be within the range of the parents indicated that the combination of the "AA" genome set of *B. campestris* was available in both the parents. Sambal "AA", Nap-3 "AACC", have had higher chance to meet each other and pairs for next generation. It has been reported (Debi, 1994; Wahiduzzaman, 1987 and Yamagishi and Takayanagi, 1982) that crosses between *B. napus* (mother plant) and *B. campestris* (pollen donor) are easier and sets variable number of good seeds in F_1. In Nap-3 x Sampad crosses out of 333 F_2 seeds only 85 plants survived. This showed a percentage of germination not more than 25.33. Low germination indicated two possibilities , one that many seeds actually did not have kernels as because in many such interspecies crosses only the seed coat were reported to be developed but not the kernel inside due to embryo abortion (Wahiduzzaman, 1987). Another was harvesting of immature F_2 seeds. The interspecies cross program of Nap-3 x Sampad also involved backcross between F_1 and Sampad. From the

backcross only 2 seeds were germinated and the plant could reach flowering. Therefore, only relevant data of 2 BC_1 plants have been given in Table 3. The low level of success of the cross as well as low seed setting could not be explained other than indicating that the presence of monovalent chromosome sets of "CC" genome in F_1 of the cross *B. napus* (Nap-3) x *B. campestris* (Sampad), when received further dose of "AA" genome from *B. campestris*, the irregulations were more and seed setting was less. However, there were only 4 seeds that were produced in the cross, but only 2 germinated. This might also be due to situations like development of only seed coat but not the kernel as reported by Wahiduzzaman (1987).

The pattern of character association in parents would be different in the offspring due to recombination and linkage breakage. In parent Nap-3, there were 21 values of correlation co-efficients, out of which only the value of pollen sterility (%) and seed yield per plant (0.622*) and number of siliquae per plant with seed yield per plant (0.766**) were significant. It was important to note that with the increase in number of siliquae per plants, the weight of 1000 seed decreased (-0.537), though the relationship was not significant. On the other hand increase siliqua length increased the 1000 seed weight (Table 4). In parent Sampad, number of siliquae per plant was significantly and positively correlated with 1000 seed weight (0.827**) and seed yield per plant 90.845**). Significant positive association was observed between siliqua length and number of seeds per siliqua. The 1000 seed weight and number of seeds per siliqua increased the seed yield positively and significantly (Table 5). In F_2 population of the cross of Nap-3 x Sampad indicated that pollen sterility decreased the shattering percentage at 1% level. Number of siliquae per plant was found to be positively and significantly correlated with siliquae length, number of seeds per siliqua, 1000 seed weight and seed yield per plant. The longer siliqua significantly increased the number of seeds per siliqua and seed yield per plant. Number of seeds per siliqua was highly and positively correlated with seed yield per plant. Similar relationship was found in case of 1000 seed weight and seed yield per plant (Table 6).

Table1: Germination rates of seeds of parents, F_2 and BC_1 populations of the interspecies cross program

Parents & Crosses	Number of seeds sown	Number of seeds germinated	Germination percentage
Parents			
1. Shambal	400	380	95
2. Tori-7	400	384	96
3. Sampad	400	384	96
4. Nap-8509	400	376	94
5. Nap-3142	400	372	93
6. Nap-3	400	376	94
F_2			
1. Nap-3 x Sampad	333	85	25.33
2. Nap-3142 x Sampad	112	10	8.93
3. Nap-8509 x Sampad	41	Failed	00
4. Nap-3 x Tori-7	2	Failed	00
5. Nap-8509 x Tori-7	67	6	8.96
6. Nap-3142 x Tori-7	24	1	4.17
7. Nap-8509 x Shambal	35	1	2.86
BC_1			
1. (Nap-3142 x Sampad) x Sampad	20	3	15.00
2. (Nap-3 x Tori-7) x Tori-7	21	6	28.57
3. (Nap-3 x Sampad) x Sampad	4	2	50.00
4. (Nap-8509 x Sampad) x Sampad	3	1	33.33
5. (Nap-3142 x Tori-7) x Tori-7	30	10	33.33
6. (Nap-8509 x Tori-7) x Tori-7	11	3	27.27
7. (Nap-8509 x Shambal) x Shambal	4	1	25.00

Table 2: Values of mean, range and CV (%) of seed and related characters of six parents of three species *B. juncea, B. campestris and B. napus*

Parents	Pollen sterility (%)	Number of siliquae/ plant	Siliqua length (cm)	Number of seeds/ siliqua	Shattering percentage after 15 days of harvest (%)	1000 seed weight (gm)	Seed yield/ plant
1.Shambal							
Mean	2.85	187.80	2.84	11.90	1.26	2.57	5.63
Range	0-2.85	78-270	2.6-3.20	9-13	1.12-2.00	-	4-6.30
CV (%)	7.73	28.59	8.17	7.36	10.50	-	10.45
2.Tori							
Mean	1.01	46.50	3.33	13.20	1.5	2.83	2.00
Range	0-2.10	27-64	2.8-4.00	7-17	0-1.70	-	0.5-2.10
CV (%)	4.01	28.80	9.84	22.53	14.3	-	22.24
3.Sampad							
Mean	0.77	46	4.10	21.80	1.36	3.00	3.97
Range	0-2.00	21-86	3.6-4.6	17-25	1.26-2.30	-	0.99-4.10
CV (%)	13.16	46.18	6.40	12.19	8.67	-	13.64
4.Nap-8509							
Mean	12.10	204.90	5.56	19.80	15.20	3.93	9.59
Range	3-15.00	180-210	5.00-5.60	17-25	8-16.00	-	8-11.00
CV (%)	26.12	27.66	4.96	6.65	20.75	-	12.62
5.Nap-3142							
Mean	2.02	90.60	5.35	17.70	8.25	3.80	11.80
Range	0-3.75	90-110	4.9-5.70	13-27	2-9.50	-	9-12.00
CV (%)	6.75	11.99	4.59	23.07	10.40	-	16.12
6.Nap-3							
Mean	4.00	221.80	4.25	19.10	10.19	4.10	12.35
Range	0-13	79-355	5.1-5.7	9-26	1.25-2.30	-	5.2-15.00
CV (%)	18.12	42.95	18.84	12.93	9.80	-	18.23

Table 3: Data of Parents, F_2 and BC_1 of involving the cross between *B. napus* (Nap-3) and *B. campestris* (Sampad: Yellow Sarson)

	Characters						
Parents & crosses	Pollen sterility (%)	Number of siliquae/ plant	Siliqua length (cm)	Number of seeds/ siliqua	Shattering percentage after 15 days of harvest (%)	1000 seed weight (gm)	Seed yield/ plant
Parents							
Nap-3							
Mean	4.00	221.80	4.25	19.10	10.19	4.10	12.35
Range	0-13	79-355	5.1-5.7	9-26	1.25-2.30	-	5.2-15.00
CV (%)	18.12	42.95	18.84	12.93	9.80	-	18.23
Sampad							
Mean	0.77	46	4.10	21.80	.36	3.00	3.97
Range	0-2.00	21-86	3.6-4.6	17-25	1.26-2.30	-	0.99-4.10
CV (%)	13.16	46.18	6.40	12.19	8.67	-	13.64
F_2							
Nap-3 x Sampad							
F_2 Population Size	85	85	85	85	85	85	85
F_2 Mean	9.17	102.49	4.08	13.27	7.73	3.29	3.87
F_2 Range	3-12.75	0-519	5.0-5.7	0-30	2.89-12.15	-	0-31.8
F_2 CV (%)	11.45	102.91	22.09	49.51	21.50	-	143.32
BC_1							
(Nap-3 x Sampad) x Sampad							
BC_1 Population Size	2	2	2	2	2	2	2
BC_1 Mean	54.27	32.50	1.5	6	10.93	-	0.15
BC_1 Range	-	-	-	-	-	-	-
BC_1 CV (%)	-	-	-	-	-	-	-

Table 4: Simple correlation co-efficient values between pairs of yield and yield contributing characters in Nap-3 (*B. napus*)

Characters	Number of siliquae/ plant	Siliqua length (cm)	Number of seeds/ siliqua	Shattering percentage after 15 days of harvest (%)	1000 seed weight (gm)	Seed yield/ plant (gm)
Pollen sterility (%)	0.141	-0.258	-0.247	0.287	-0.381	0.622*
Number of siliquae/plant		0.135	0.318	-0.377	-0.537	0.766**
Siliqua length (cm)			0.047	-0.294	0.355	-0.132
Number of seeds/ siliqua				-0.253	0.146	0.201
Shattering percentage after 15 days of harvest (%)					-0.256	-0.088
1000 seed weight (gm)						-0.596

* Significant at 5% Level, ** Significant at 1% Level

Table 5: Simple correlation co-efficient values between pairs of yield and yield contributing characters in Sampad (*B. campestris*)

Characters	Number of siliquae/ plant	Siliqua length (cm)	Number of seeds/ siliqua	Shattering percentage after 15 days of harvest (%)	1000 seed weight (gm)	Seed yield/ plant (gm)
Pollen sterility (%)	0.161	-0.309	0.013	-0.409	0.082	0.318
Number of siliquae/plant		0.294	0.508	0.358	0.827**	0.845**
Siliqua length (cm)			0.741*	0.245	0.184	0.517
Number of seeds/ siliqua				0.036	0.382	0.661*
Shattering percentage after 15 days of harvest (%)					0.662*	0.223
1000 seed weight (gm)						0.696*

* Significant at 5% Level, ** Significant at 1% Level

Table 6: Simple correlation co-efficient values between pairs of yield and yield contributing characters in the F_2 population of the cross Nap-3 x Sampad

Characters	Number of siliquae/ plant	Siliqua length (cm)	Number of seeds/ siliqua	Shattering percentage after 15 days of harvest (%)	1000 seed weight (gm)	Seed yield/ plant (gm)
Pollen sterility (%)	-0.079	-0.177	-0.127	-0.248	-0.012	0.040
Number of siliquae/plant		0.531***	0.548***	-0.161	0.359***	0.918***
Siliqua length (cm)			0.659***	0.025	0.111	0.492***
Number of seeds/ siliqua				-0.067	0.130	0.538***
Shattering percentage after 15 days of harvest (%)					0.051	-0.214
1000 seed weight (gm)						0.355**

* Significant at 5% Level, ** Significant at 1% Level and *** Significant at 0.1% Level

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