Middle-East Journal of Scientific Research 25 (2): 250-259, 2017
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2017.250.259

Mean Performance for 12 Different Characters in 40 Lines of *Brassica napus* L. in Bangladesh

[1]*Elora Pervin,* [2]*Firoz Mahmud,* [2]*Md. Shahidur Rashid Bhuiyan and* [3]*Md. Maksudul Haque*

[1]Department of Genetics and Plant Breeding,
Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
[2]Professor, Department of Genetics and Plant Breeding,
Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
[3]Scientific officer (Golden Rice), Plant Breeding Division,
Bangladesh Rice Research Institute, Gazipur 1701, Bangladesh

Abstract: A field experiment was conducted with 40 genotypes of *Brassica napus* L. at the experimental field of Sher-e-Bangla Agricultural University. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Analysis of variance for each trait showed significance differences among the genotypes. The days to 50% flowering were observed lowest (30.33 days) in Nap-10009 and highest (69.00 days) was observed in Nap-0837. The highest days to maturity was observed in Nap-10009 (82.67 days). The highest plant height was observed in Nap-9901 (136.62 cm) whereas the minimum plant height was observed in BARI-8 (79.57 cm). The number of siliquae per plant was observed highest in Nap-9901 (197.82). Length of siliqua was observed highest in Nap-108(8.69cm) followed by Nap-10020 (8.63 cm). The number of seeds per siliqua was observed highest in Nap-108(26.37). Thousand seed weight was found maximum in BARI-8 (4.19gm). The highest amount of yield per plant was observed in BARI-8 (14.29 gm) followed by Nap-2057 (13.56 gm). Considering group distance and other agronomic performance genotypes G11 (BARI- 8), G35 (Nap-2057), G40 (Nap-108) and G31 (Nap-9901) might be suggested for future hybridization program.

Key words: Mean · Character · *Brassica napus* L.

INTRODUCTION

Brassica napus L. (AACC, 2n = 38) is an important crop species that originated in a limited geographic region through spontaneous interspecific hybridizations of *Brassica rapa* (AA, 2n = 20) and *Brassica oleracea* (CC, 2n = 18), followed by chromosome doubling [1-5]. This species includes oilseed rape, swede or rutabaga, vegetable types and fodder crops [6, 7]. *Brassica napus* is predominantly self-compatible [3, 8] with interplant out-crossing rates varying between 20-45% under field conditions [9-12]. Nowadays, *Brassica napus* is the world's third most important source of vegetable oil after soybean and palm [13]. Plant breeders seek to develop new *Brassica napus* cultivars of nutritionally beneficial high-oleic acid oil to replace harmful saturated palm oil in food applications [14, 15]. Therefore, assessment of genetic diversity and phylogenetic relationships in this important crop is essential for establishing efficient conservation and future breeding practices [2, 13].

Oilseed brassica species (*Brassica napus; B. campestris* and *B. juncea*) are now the 3rd most important source of edible vegetable oil in the world after palm and soybean [16-20]. There issub division of oilseed rape into winter and spring types [21]. Canola-type cultivars having low level of erucic acid (<2%) and glucosinolate (<30µM) of *B. napus* and *B. rapa* [22] are widely grown commercially. Genetic diversity in germplasm isthe base of exploiting and utilizing desirable genes for genetic improvement of open-pollinated varieties and hybrids (having high level of heterosis). For commercial hybrid development, the knowledge of genetic diversity is important [23-26]. Inter specific hybridization can easily be forced in the

Corresponding Author: Scientific officer (Golden Rice), Plant Breeding Division, Bangladesh Rice Research Institute, Gazipur 1701, Bangladesh. Mob: +8801723778056.

family brassicaceae where gene flow is very limited under natural conditions [27]. In addition to biochemical and morphological characterization [28] molecular characterization is essential for identifying genetic relationship as molecular markers can detect high degree of polymorphism and are not sensitive to environmental and developmental variation [23, 29, 30].

The genus Brassica is an important member of the cruciferae family. It comprises of several economically important species which yield edible roots, stems, leaves, buds, flowers and seeds condiment. Most of the species are used as oilseed crop and some as forage. Oilseed Brassica is commonly known as rapeseed and mustard and occupy an important position in the rainfed agriculture of our country. They provide the most concentrated source of energy and also help to absorb vitamins A, D, E and K. In most of the regions of the world, its cultivation has increased dramatically during last decades and, by now; it is the third largest contributor of the world supply of vegetable oil. Rapeseed is one of the most important oil and protein rich annual crops in the world. Seed provides oil both for industrial and culinary purpose. Vegetable oils and fats (lipids) constitute an important component of human diet. Oils as from plant origin are nutritionally superior to that of animal origin. Therefore, vegetable oil has been always considered as a major component for food preparation.

In a plant breeding program, potential genotypes are usually evaluated in different environments before selecting desirable ones for stabilizing yield. It is necessary to identify the stable genotypes suitable for wide range of environments. Stability analysis is a good technique for measuring the adaptability different crop varieties to varying environments. Grain yield in mustard is correlated with different yields contributing traits. These traits are also correlated between themselves. Therefore, the relationship between grain yield and different contributing traits establishes a complex chain. The complex chain of such relationship is further analyzed in more simple way through path coefficient. The path coefficient breaks the correlation coefficient of the yield with its contributing traits into direct and indirect effects. Genetic diversity is the basic for genetic improvement. It is widely accepted that information about germplasm diversity and genetic relatedness among elite breeding material is a fundamental element in plant breeding. Keeping in mind the available genetic diversity and widely practiced breeding programs for developing variety for any trait, the present study was undertaken to achieve the following objectives: the genetic variation in morphological traits of the progeny lines of introgressed and non-introgressed *brassica napus* along with the parents.

MATERIALS AND METHODS

To conduct the experiment 40 selected cultivars were used as lines and these were done among parents in Rabi season. The research work was conducted at the experimental farm of Department of Genetics and Plant Breeding, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, Bangladesh. The experimental site was situated in the subtropical zone. The soil of the experimental site belongs to Agro-ecological region of “Madhupur Tract” (AEZ No. 28). The soil was clay loam in texture and olive gray with common fine to medium distinct dark yellowish brown mottles. The pH was 5.47 to 5.63 and organic carbon content is 0.82%. 40 lines were collected from the Bangladesh Agricultural Research institute, Gazipur-1701. These 40 lines were grown in the experimental farm of Sher-e-Bangla Agricultural University during the winter season of 2013 to 2014 are presented in Table 1.

The seeds of 40 lines were grown in Randomized Complete Block Design (RCBD) with three replications. Each plot consisted of single row of 3 m length spaced 40 cm apart and 10 cm between plants. The seeds were sown at a soil depth of 2.5 cm to 3.5 cm.

Data Recorded

Days to 1st Flowering: Days to 1st flowering was counted when the 1st flowering plants had at least one open flower in each line. Flowering stage was shown in Plate 3.

Days to 50% Flowering: Days to 50% flowering was counted when the 50% plants had at least one open flower in each line. Flowering stage was shown in plate 4.

Days to 80% Flowering: Days to 80% flowering was counted when near about 80% plants had at least one open flower of each lines. Flowering stage was shown in plate 5.

Days to Maturity: Number of days required from sowing to siliquae maturity of 80% plants of each row.

Plant Height: During harvesting the plant height was measured in cm from the ground level of the plant to the top of the plant. It was the longest inflorescence of the tallest raceme.

Table 1: List of the 40 *Brassica napus L.* genotypes used in the experiment with their sources

Genotype No.	Name/Acc No.	Source
G1.	Nap-0717-2	BARI
G2.	Nap-0733-1	BARI
G3.	Nap-0762	BARI
G4.	Nap-08-4	BARI
G5.	Nap-0837	BARI
G6.	Nap-0865	BARI
G7.	Nap-0869	BARI
G8.	Nap-0876	BARI
G9.	Nap-0885	BARI
G10.	Nap-205	BARI
G11.	BARI-8	BARI
G12.	BARI-13	BARI
G13.	Nap-10007	BARI
G14.	Nap-10009	BARI
G15.	Nap-10015	BARI
G16.	Nap-10017	BARI
G17.	Nap-10019	BARI
G18.	Nap-10020	BARI
G19.	Nap-1005	BARI
G20.	Nap-1007	BARI
G21.	Nap-10014	BARI
G22.	Nap-10012	BARI
G23.	Nap-0130	BARI
G24.	Nap-2012	BARI
G25.	Nap-2013	BARI
G26.	Nap-2022	BARI
G27.	Nap-9906	BARI
G28.	Nap-9908	BARI
G29.	Nap-248	BARI
G30.	Nap-2001	BARI
G31.	Nap-9901	BARI
G32.	Nap-9904	BARI
G33.	Nap-9905	BARI
G34.	Nap-2057	BARI
G35.	Nap-2037	BARI
G36.	Nap-206	BARI
G37.	Nap-2066	BARI
G38.	Nap-179	BARI
G39.	Nap-94006	BARI
G40.	Nap-108	BARI

Number of Primary Branches per Plant: Mean numbers of branches originated from the main stem from 10 randomly selected plants from each line at maturity.

Number of Secondary Branches per Plant: Number of branches originated from the primary branch from 10 randomly selected plants from each line at maturity.

Number of Siliquae per Plant: Mean number of siliqua obtained from 10 randomly selected plants from line at maturity.

Length of Siliqua: 10 siliquae was selected at random from every selected plant to measure the length of siliqua. The measurement was in cm. Distance between the end of the peduncle to the starting point of the beak was considered as siliqua length.

Number of Seeds per Siliqua: All siliqua from the sample plants was collected and 10 siliqua was randomly selected. Seeds obtained from them, were counted and average numbers of seeds per siliqua was recorded.

Thousand-Seed Weight (G): Weight in grams of 1000-seed was recorded from 10 randomly selected plants of line.

Seed Yield per Plant (g): Mean seed weight in grams of 10 randomly selected plants from each line after harvest.

Statistical Analyses: Data collected on different parameters under study were statistically analyzed to ascertain the significance of the experimental results using the Statistix 10 computer package program. Mean, range, co-efficient of variation (CV) and correlation was estimated using MSTAT computer program and Excel program.

RESULT AND DISCUSSION

Mean Performance: Mean performance of twelve agronomic and yield related traits of lines are presented in Table 2. In the study significant variations were observed for most of the characters among forty materials of *Brassica napus* L.

Days to 1st Flowering: Considerable variations were observed among forty materials for days to 1st flowering. In case of Days to 1st Flowering for line, it was ranged from 28.33 to 66.33 days. The days to 1st flowering were observed lowest (28.33 days) in Nap-10009 and highest (66.33 days) was observed in Nap-0837 (Table 2). The days to 1st Flowering were observed in varieties 37.33 days in BARI-8 and 39.33 days in BARI-13 (Table 2). The days to 1stflowering was graphically represented in Figure 1. Singh, *et al*. [31] obtained earliness on YSK-S501 × SS-2 in *B. campestris/rapa*. Singh, *et al*. [32] observed earliness in PR-1108 × BJ-1235 in *Brassica juncea* L.

Days to 50% Flowering: Considerable variations were observed among forty materials for days to 50% flowering. In case of days to 50% flowering for line, it was

Table 2: Mean performance for 12 different characters in 40 lines of *Brassica napus* L.

Genotype	Days to 1^{st} Flowering	Days to 50% Flowering	Days to 80% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Number of siliquae per plant	Length of siliqua (cm)	Number of seeds per siliqua	Thousand-seed weight (gm)	Seed yield per plant (gm)
Nap-0717-2	33.33	35.33	38	85.52	86.14	2.95	3.6	97.94	7.21	22.97	3.01	11.23
Nap-0733-1	50.33	52.33	55	96.22	111.33	4.31	4.32	146.44	7.13	21.75	3.4	10.87
Nap-0762	56.33	58.33	61	104.57	120.22	3.84	3.95	138.76	7.79	22.43	2.91	9.51
Nap-08-4	60.33	62.33	65	107.67	104.16	2.91	3.38	128.34	7.31	24.32	3.73	11.83
Nap-0837	66.33	69	72	112.33	99.21	3.67	4.3	124.72	6.93	21.57	2.88	11.35
Nap-0865	30.33	32.33	35	85	96.77	3.19	3.15	164.8	7.76	20.04	3.68	12.75
Nap-0869	31.33	33.33	36	87.52	87.45	3.33	4.97	153.84	7.63	23.95	3.18	12.56
Nap-0876	32.33	34.33	37	86.19	101.03	2.75	3.83	160.48	8.06	21.63	3.71	13.25
Nap-0885	34.33	36.33	39	85.57	82.11	3	3.37	145.93	7.5	21.71	3.46	11.78
Nap-205	36.33	38.33	41	86.86	82.98	2.7	3.2	166.78	6.38	22.36	3.52	13.23
BARI-8	37.33	39.33	42	87.29	79.57	3.28	4.13	172.01	7.68	23.33	4.19	14.29
BARI-13	39.33	41.33	44	90	91.44	3.58	3.71	173.48	6.63	23.98	3.73	12.89
Nap-10007	45.33	47.33	50	95.67	90.53	3.35	3.51	156.48	7.23	24.17	3.29	8.58
Nap-10009	28.33	30.33	33	82.67	89.07	2.71	4.5	166.38	7.52	20.62	2.84	11.76
Nap-10015	29.33	31.33	34	83.33	87.22	3	4.38	145.68	7.29	19.45	3.35	12.21
Nap-10017	35.33	37.33	40	86.33	91.3	3.08	3.71	185.03	7.44	22.58	4.09	13.33
Nap-10019	41.33	43.33	46	90.33	100.93	3.12	3.48	138.72	7.82	23.84	3.72	10.89
Nap-10020	42.33	44.33	47	88.33	100.7	3.03	4.44	187.42	8.63	21	3.38	11.26
Nap-1005	43.33	45.33	48	91	95.85	3.08	4.4	145.47	7.73	24.37	3.47	12.45
Nap-1007	44.33	46.33	49	90.67	93.67	3.18	4	158.69	7.56	22.55	3.19	10.38
Nap-10014	46.33	48.33	51	90.67	94.76	3.08	4.28	165.83	7.99	18.24	3.62	12.19
Nap-10012	38.33	40.33	43	86.67	96.47	3.08	4.25	155.97	7.3	24.36	2.9	11.28
Nap-0130	47.33	49.33	52	93.33	100.69	3.6	5.17	178.04	7.86	21.86	3.55	10.78
Nap-2012	48.33	50.33	53	95	90.33	3.03	4.49	181.25	7.52	25.84	3.63	13.28
Nap-2013	49.33	51.33	54	95.33	103.53	3.03	5.33	148.4	7.95	24.42	3.7	11.53
Nap-2022	61.33	63.33	66	105	106.23	3.05	4.34	167.95	7.02	19.29	3.21	11.9
Nap-9906	40.33	42.33	45	86.67	111.85	3.33	4.25	138.85	7.71	25.91	3.66	11.28
Nap-9908	51.33	53.33	56	97.67	120.99	3.59	5.31	178.63	7.42	23.58	3.81	11.54
Nap-248	52.33	54.33	57	98.67	119.02	3.16	4.48	190.66	6.63	21.81	4.04	12.78
Nap-2001	53.33	55.33	58	97.67	129.16	3.4	4.14	182.87	8.09	23.47	3.22	10.76
Nap-9901	55.33	57.33	60	100.67	136.62	3.19	4.03	197.82	7.37	24.36	3.5	11.58
Nap-9904	57.33	59.33	62	102.67	126.15	3.34	4.13	190.6	7.67	23.18	3.38	11.26
Nap-9905	58.33	60.33	63	104.33	116.83	4	5.21	172.64	7.7	22.91	3.72	12.25
Nap-2057	59.33	61.33	64	106	115.94	3.43	4.28	156.64	7.34	23.12	3.13	13.56
Nap-2037	62.33	64.33	67	108.67	106.69	3.53	4.08	162.41	8.01	22.62	3.77	13.01
Nap-206	54.33	56.33	59	95.67	108.79	3.32	3.83	169.6	7.48	20.73	3.57	11.25
Nap-2066	63.33	66.67	69	110.67	103.61	3.87	6.85	197.25	7.34	24.06	3.62	11.56
Nap-179	64	67	70	110.33	102.84	3.21	4	163.83	7.42	23.68	3.59	12.11
Nap-94006	66	67.33	71.33	111	107.31	3.14	4.04	182.02	6.97	23.08	3.72	10.71
Nap-108	63	64.33	66.67	107.33	130.23	3.91	6.64	165.3	8.69	26.37	3.01	12.89
Mean	47.73	49.77	52.48	95.68	102.99	3.28	4.29	162.60	7.52	22.79	3.48	11.85
Minimum	28.33	30.33	33.00	82.67	79.57	2.70	3.15	97.94	6.38	18.24	2.84	8.58
Maximum	66.33	69.00	72.00	112.33	136.62	4.31	6.85	197.82	8.69	26.37	4.19	14.29
Median	47.83	49.83	52.50	95.17	100.98	3.19	4.20	165.05	7.51	23.03	3.54	11.77
SD	11.54	11.60	11.66	9.10	14.16	0.36	0.78	21.02	0.47	1.79	0.33	1.13
Variance	133.14	134.64	135.97	82.73	200.41	0.13	0.61	441.80	0.22	3.22	0.11	1.28
SE Mean	1.82	1.83	1.84	1.44	2.24	0.06	0.12	3.32	0.07	0.28	0.05	0.18
C.V.	24.18	23.31	22.22	9.51	13.75	10.94	18.29	12.93	6.30	7.87	9.59	9.56

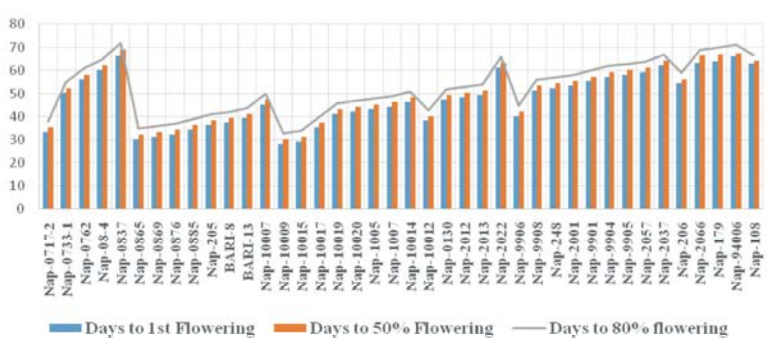

Fig. 1: Graphical representation of Days to 1^{st} Flowering, Days to 50% flowering and Days to 80% Floweringin 40 *B. napus* genotypes

ranged from 30.33 to 69.00 days. The days to 50% flowering were observed lowest (30.33 days) in Nap-10009 and highest (69.00 days) was observed in Nap-0837 (Table 2). The days to days to 50% flowering were observed in varieties 39.33 days in BARI-8 and 41.33 days in BARI-13 (Table 2). The days to 50% flowering was graphically represented in Figure 1. Singh, *et al*. [31] obtained earliness on YSK-S501 × SS-2 in *B. campestris/rapa*. Singh, *et al*. [32] observed earliness in PR-1108 × BJ-1235 in *Brassica juncea* L.

Days to 80% Flowering: Considerable variations were observed among forty materials for days to 80% flowering. In case of days to 80% flowering for parent, it was ranged from 33 to 72 days. The days to 80% flowering were observed lowest (33.00 days) in Nap-10009 and highest (72.00 days) was observed in Nap-0837 (Table 2). The days to days to 50% flowering were observed in varieties 42.00 days in BARI-8 and 44.00 days in BARI-13 (Table 2). The days to 80% flowering was graphically represented in Figure 1. Singh, *et al*. [31] obtained earliness on YSK-S501 × SS-2 in *B. campestris/rapa*. Singh, *et al*. [32] observed earliness in PR-1108 × BJ-1235 in *Brassica juncea* L.

Days to Maturity: Considering earliness, the highest days to maturity was observed in Nap-10009 (82.67 days) and the minimum days (112.33 days) to maturity were observed in Nap-0837 (Table 2). The varieties the days to maturity were observed in 87.29 days in BARI Sharisha8 and 90.00 days in BARISharisha13 (Table 2). Chowdhury, *et al*. [33] observed earliness in M-27 × Din-2 in *Brassica rapa* L. Singh, *et al*. [31] obtained earliness in SS-3 × SS-1 in *Brassica campestris* L. The days to maturity is graphically represented in Figure 2.

Plant Height (cm): In this study the highest plant height was observed in Nap-9901 (136.62 cm) whereas the minimum plant height was observed in BARI-8 (79.57 cm). Plant height observed in the varieties 91.44 cm in BARI-13 (Table 2). Plant height was graphically represented in Figure 2. Chowdhury, *et al*. [33] observed dwarfness in PT-303 × Tori-7 in *Brassica rapa* L. Nair, *et al*. [34] observed significant variance for this trait in *Brassica juncea* L. Tyagi, *et al*. [35] observed highest variation in plant height among parents and their hybrid. These findings are close resemblance to the reports of Chaudhury, *et al*. [36] and Yadava, *et al*. [37].

Number of Primary Branches per Plant: Among the forty materials the highest number of primary branches/plant was observed in Nap-0733-1(4.31) where as the minimum number of primary branches/plant was observed in Nap-205 (2.7) (Table 2). No. of primary branches per plant observed in the varieties 3.28 in BARI-8 and 3.58 in BARI-13 (Table 2). Number of primary branches per plant showed little differences. The value indicating the apparent variation not only due to genotypes but also due to the large influence of environment (Table 2). Chowdhury, *et al*. [33] found more primary branches in Sampad× Tori-7 in *Brassica rapa* L. Singh, *et al*. [31] obtained maximum number of primary branches per plant in YSK-8501 × SS-1 in *Brassica campestris* L. The number of primary branches per plant is graphically represented in Figure 3. Chaudhury, *et al*. [36] found significant differences for number of primary branches per plant. Similar results were obtained by Afroz, *et al*. [38]; Rashid [39]; Siddikee [40] and Kumar, *et al*. [41]. Negative associations were found by Varshney, *et al*. [42].

Number of Secondary Branches per Plant: For the number of secondary branches per plant, parents showed at a range from 3.15 to 6.85. However, the parent Nap-0865 (3.15) flowered with the lowest t ime but the parent Nap-2066 (6.85) took the highest duration (Table 2). No. of secondary branches per plant observed in the varieties 4.13 in BARI-8 and 3.71 in BARI-13 (Table 2). Chowdhury, *et al*. [33] found maximum secondary branches in Sampad× Din-2 in *Brassica rapa* L. Singh and Murty [43] observed more secondary branches per plant in YSC-68×SS-2 in *Brassica campestris* L. Number of secondary branches per plant is graphically represented in Figure 3. These findings are closing similar to the reports of Chaudhury, *et al*. [36] and Mahmud [44].

Number of Siliquae per Plant: Number of siliquae per plant were varied from 97.94 to 197.82.The number of siliquae per plant was observed highest in Nap-9901 (197.82) followed by Nap-2066(197.25). Whereas the minimum number of siliquae per plant was observed in Nap-0717-2 (97.94) (Table 2). Number of siliquae per plant observed in the varieties 172.01 in BARI-8 and 173.48 in BARI-13 (Table 2). These combinations could be selected for the future breeding programme to obtain desirable higher number of siliquae per plant. Chowdhury, *et al*. [33] found the maximum siliquae in

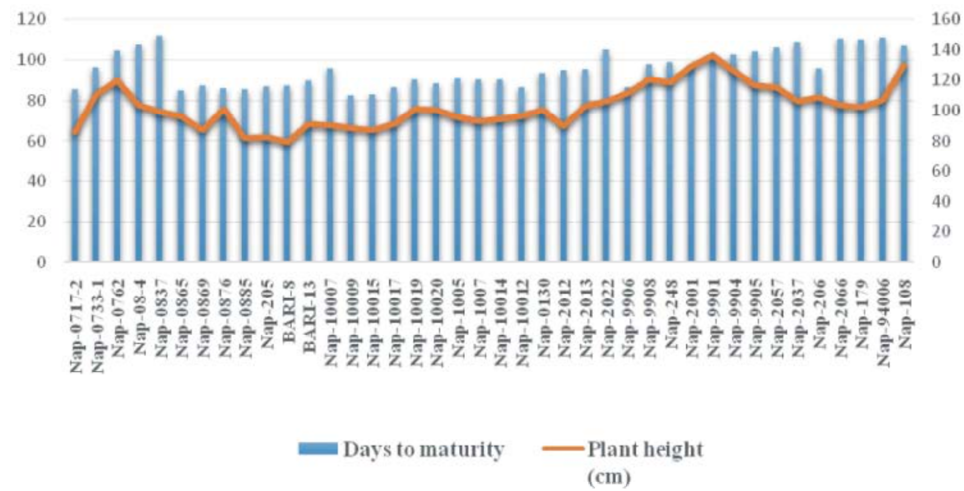

Fig. 2: Graphical representation of Days to maturity and Plant height (cm) in 40 *B. napus* genotypes

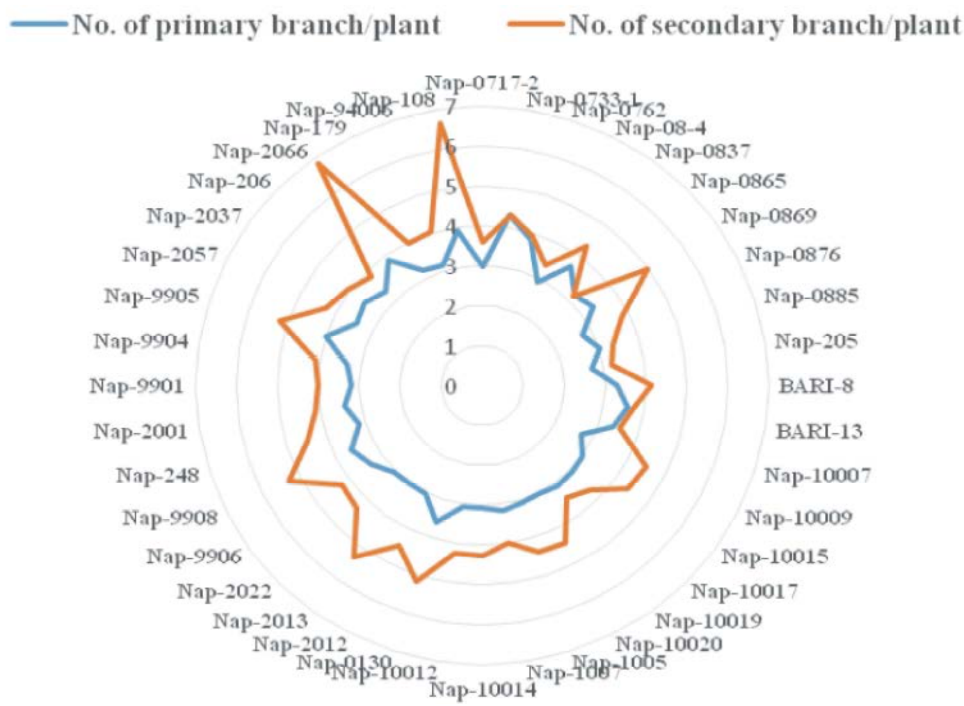

Fig. 3: Graphical representation of Number of primary branches per plant and Number of secondary branches per plant in 40 *B. napus* genotypes

Sampad× Din-2 in *Brassica rapa* L. Singh and Murty [43] observed more siliquae per plant in YSP-842 × SS-3 in *Brassica campestris* L. Number of siliquae per plant is graphically represented in Figure 4.

Length of Siliqua (cm): Siliqua length of parent was ranged from 6.38 to 8.69 cm. Length of siliqua was observed highest in Nap-108(8.69cm) followed by Nap-10020 (8.63 cm) whereas the minimum length of pod was observed in Nap-205 (6.38cm) (Table 2). The varieties length of siliqua was observed 6.63 cm in BARI-13 and 7.68 cm in BARI-8 (Table 2). Huq [45] showed BINAsar-6 × Tori 7 was not good for improving the trait in *Brassica rapa* L. Length of siliqua is graphically represented in Figure 4. Lebowitz [46] studied *Brassica campestris* population for pod length and observed high genetic variation on this trait. Olson [47] found high genetic variability for this trait.

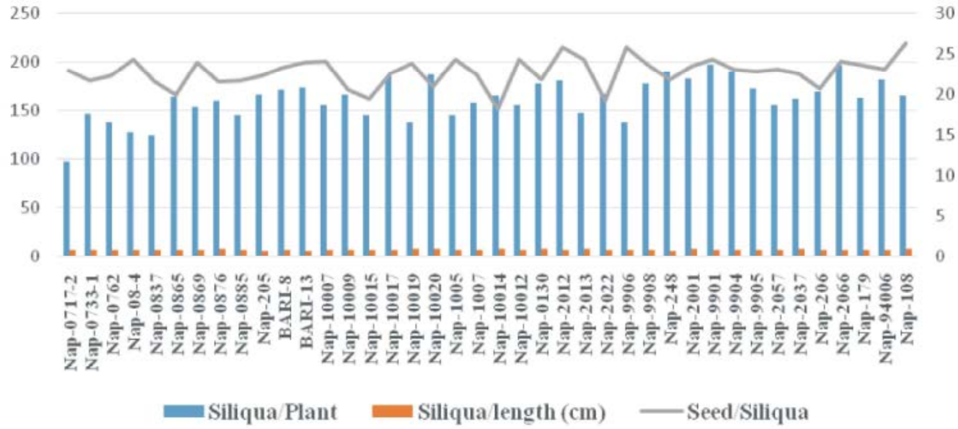

Fig. 4: Graphical representation of Number of siliqua eper plant, Length of siliqua (cm)and Number of seeds per siliquain 40 *B. napus* genotypes

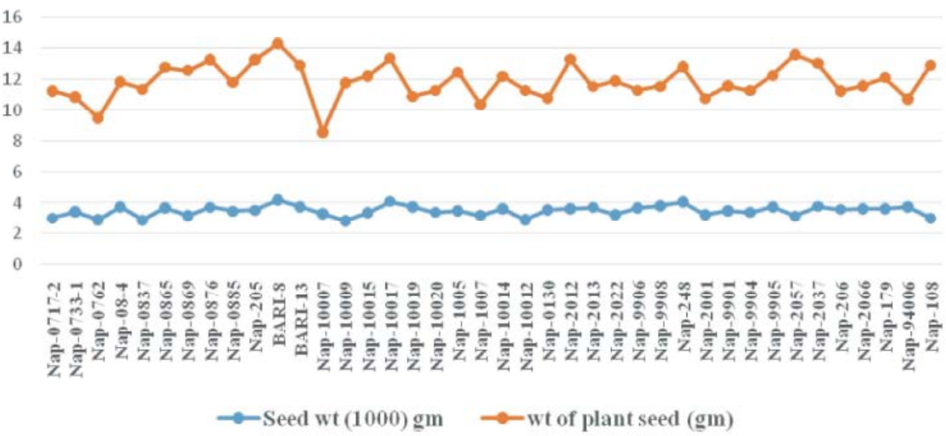

Fig. 5: Graphical representation of Thousand seed weight (gm) and Seed yield per plant (gm) in 40 *B. napus* genotypes L

Number of Seeds per Siliqua: Number of seeds per siliqua was varied from 18.24 to 26.37. The number of seeds per siliqua was observed highest in Nap-108(26.37). Nap-9906 (25.91) was found the second highest for number of seeds per siliqua. Whereas the minimum number of seeds per siliqua was observed in Nap-10014 (18.24) (Table 2). The number of seeds per siliqua observed 23.33 in BARI-8 and 23.98 in BARI-13 (Table 2). Chowdhury, *et al*. [33] found the highest seeds per siliqua in Dhali×Sampad in *Brassica rapa* L. Singh, *et al*. [31] obtained more seeds per siliqua in YSP-842 × YSK-8501 in *Brassica campestris* L. Number of seeds per siliqua is graphically represented in Figure 4.

Thousand Seed Weight (gm): Thousand seed weight in *B. napus* varied with some extent i.e. from 2.84 to 4.19gm in line. Thousand seed weight was found maximum in BARI-8 (4.19gm) where as the minimum thousand seed weight was found in Nap-10009 (2.84gm) (Table 2). Thousand seed weight observed in the varieties 3.73g in BARI-13 (Table 2). Singh, *et al*. [31] observed more seed weight per plant in YSC-68 × SS-2 in *Brassica campestris* L. Chowdhury, et al. [33] obtained the highest seed weight in Dhali×Sampad in *Brassica rapa* L. Thousand seed weight is graphically represented in Figure 5.

Seed Yield per Plant (gm): Seed yield per plant was found at diversely in different genotypes including lines. Seed yield of the genotypes varied from 8.58 to 14.29gm in lines. Yield is the most outstanding character and all the research work and objectives are dependent on yield. The highest amount of yield per plant was observed in BARI-8 (14.29 gm) followed by Nap-2057 (13.56 gm). Whereas the minimum yield per plant was observed in Nap-10007 (8.58 gm) (Table 2).The yield per plant of the varieties were12.89 in BARI-13. Huq [45] obtained the highest seed yield in Agroni× Tori 7, Agroni×BARIsar-6 and Shafal×BARIsar-6 in *Brassica rapa* L. Chowdhury, *et al*. [33] obtained the highest seed yield in M-27 × Din-2 in *Brassica rapa*L. Singh, *et al*. [31] observed more seed yield per plant in YSP-842 × YSK-8501 in *Brassica campestris* L. Seed yield per plant is graphically represented in Figure 5.

CONCLUSION

Results of the present studies indicated significant variation among the genotypes for all the characters studied. Considering diversity pattern and other agronomic performance lines G11 (BARI- 8), G35 (Nap-2057), G40 (Nap-108) and G31 (Nap-9901) could be considered suitable genotypes for efficient hybridization in future. Involving of such diverse. So, divergent genotypes are recommended to use as parents in future hybridization program.

REFERENCES

1. UN, 1935. Genome-analysis in Brassica with special reference to the experimental formation of B. napus and peculiar mode of fertilization, Jpn. J. Bot., 7: 389-452.
2. Hasan, M., F. Seyis, A.G. Badani, J. Pons-Kuhnemann, W. Friedt, W. Luhs and R.J. Snowdon, 2006. Analysis of genetic diversity in the Brassica napus L. gene pool using SSR markers, Genetic Resources and Crop Evolution, 53: 793-802.
3. Fu, Y.B. and R.K. Gugel, 2010. Genetic diversity of Canadian elite summer rape (*Brassica napus* L.) cultivars from the pre- to post-canola quality era, Canadian Journal of Plant Science, 90: 23-33.
4. El-Esawi, M.A., 2015. Taxonomic relationships and biochemical genetic characterization of brassica resources: Towards a recent platform for germplasm improvement and utilization, Annu. Res. Rev. Biol., pp: 8.
5. El-Esawi, M., P. Bourke, K. Germaine and R. Malone, Assessment of morphological variation in Irish Brassica oleracea species, JAS, 4: 20-34.
6. Snowdon, R., W. Lühs and W. Friedt, 2007. Oilseed rape. In: Genome mapping and molecular breeding in plants, (Kole C. Ed.) vol. 2. Berlin Heidelberg: Oilseeds, Springer, 2007.
7. Wu, J., F. Li, K. Xu, G. Gao, B. Chen, G. Yan, N. Wang, J. Qiao, J. Li, H. Li, T. Zhang, W. Song and X. Wu, 2014. Assessing and broadening genetic diversity of a rapeseed germplasm collection, Breed. Sci., 64: 321-330.
8. McNaughton, I.H., 1995. Swedes and rapes. In: Evolution of crop plants. (Smartt J, Simmonds NW. Eds.). Harlow, UK: Longman Scientific & Technical.
9. Olsson, G., 1960. Self-incompatibility and outcrossing in rape and white mustard, Hereditas, 46: 241-252.
10. Rakow, G. and D. Woods, 1987. Outcrossing in rape and mustard in Saskatchewan prairie conditions, Canadian Journal of Plant Science, 67: 147-151.
11. Becker, H.C., C. Damgaard and B. Karlsson, 1992. Environmental variation for outcrossing rate in rapeseed (Brassica Napus), Theoretical and Applied Genetics, 84: 303-306.
12. Damgaard, C. and V. Loeschcke, 1994. Genetic variation for selfing rate and the dependence of selfing rate on mating history in Brassica napus (Rape Seed), Heredity, 72: 570-573.
13. Moghaieb, R.E., E.H. Mohammed and S.S. Youssief, 2014. Genetic diversity among some canola cultivars as revealed by RAPD, SSR and AFLP analyses, 3 Biotech, 4: 403-410.
14. Spector, A.A., 1999. Essentiality of fatty acids, Lipids, 34: S1-3.
15. Stoutjesdijk, P.A., C. Hurlestone, S.P. Singh and A.G. Green, 2000. Higholeic acid Australian Brassica napus and B. juncea varieties produced by co-suppression of endogenous Delta 12-desaturase, Biochem. Soc. Trans., 28: 938-940.
16. Zhang, G. and W. Zhou, 2006. Genetic analyses of agronomic and seed quality traits of synthetic oilseed Brassica napus produced from inter specific hybridization of Brassica campestris and Brassica olearacea, J. Genet., 85: 45-51.
17. Turi, N.A., R.M.A. Farhatullah and Z.K. Shinwari, 2012. Genetic diversity in the locally collected Brassica species of Pakistan based on microsatellite markers, Pak. J. Bot., 44: 1029-1035.
18. Ali, F.Y., H. Rahman, A. Nasim, S.M. Azam and A. Khan, 2013. Heritability and correlation analysis for morphological and biochemical traits in brassica carinata, Sarhad Journal of Agriculture, 29: 359-369.
19. Zada, M., N. Zakir, M.A. Rabbani and Z.K. Shinwari, 2013. Assessment of genetic variation in Ethiopian mustard (Brassica Carinata A. Braun) germplasm using multivariate techniques, Pak. J. Bot., 45:583-593.

20. Zada, M., Z.K. Shinwari, Z. Nahida and M.A. Rabbani, 2013a. Study of total seed storage proteins in Ethiopian mustard (Brassica Carinata A. Braun) germplasm, Pak. J. Bot., 45: 443-448.
21. Bus, A., N. Korber, R.J. Snowdon and B. Stich, 2011. Patterns of molecular variation in a species-wide germplasm set of Brassica napus, Theoretical and Applied Genetics, 123: 1413-1423.
22. Downey, R.K. and S.R. Rimmer, 1993. Agronomic improvement in oilseed, Brassicas Advances in Agronomy, 50: 1-66.
23. Ahmad, R., C.F. Farhatullah, R.H. Quiros and Z.A. Swati, Genetic diversity analyses of Brassica napus accessions using SRAP molecular markers, Plant Genetic Resources, 12: 14-21.
24. Shinwari, S., F. Akbar, M.A. Rabbani, A.S. Mumtaz and Z.K. Shinwari, 2013. Evaluation of genetic diversity in different genotypes of Eruca sativa from Pakistan by SDS-page analysis, Pak. J. Bot., 45: 1235-1240.
25. Shinwari, S., A.S. Mumtaz, M.A. Rabbani, F. Akbar and Z.K. Shinwari, 2013a. Genetic divergence in Taramira (*Eruca sativa* L.) germplasm based on quantitative and qualitative characters, Pak. J. Bot., 45: 375-381.
26. Sultan, M., N. Zakir, M.A. Rabbani, Z.K. Shinwari and M.S. Masood, 2013. Genetic diversity of guar (*Cyamopsis Tetragonoloba* L.) landraces from Pakistan based on RAPD markers, Pak. J. Bot., 45: 865-870.
27. Sandhu, S.K. and V.P. Gupta, 2000. Interspecific hybridization among digenomic species of Brassica, Crop Improvement-India, 27: 195-197.
28. Azam, S.M., A. Farhatullah, S.S. Nasim and S. Iqbal, 2013. Correlation studies for some agronomic and quality traits in *Brassica napus* L, Sarhad Journal of Agriculture, 29: 547-550.
29. Rabbani, M.A., M.S. Masood, Z.K. Shinwari and K.Y. Shinozaki, Genetic analysis of basmati and nonbasmati Pakistani rice (*Oryza sativa* L.) cultivars using microsatellite markers, Pak. J. Bot., 42: 2551-2564
30. Zeb, A., Z.K. Shinwari and T. Mahmood, 2011. Molecular markers assisted genetic characterization of some selected Wild Poaceae species, Pak. J. Bot., 43: 2285-2288.
31. Singh, M., S.P. Singh and S. Dhirendra, 2000. Genetic analysis for seed yield and its genotypes in yellow sarson (*Brassica compestris* L.), Indian J. Agril. Sci., 70: 624-626.
32. Singh, J.N., Y. Maheshc and I.A. Sheikh, 1996. Genetical studies for yield and oil content in *Brassica juncea* L, Indian Journal of Genetics and Plant Breeding, 56: 299-304.
33. Chowdhury, M.A.Z., M.A.K. Mian, M.A. Akbar and M.Z. Alam, 2004. Combining ability for seed yield and yield contributing characters in turnip rape (*Brassica rapa* L), Bangladesh. J. Pl. Breed. Genet., 17: 17-24.
34. Nair, B., V. Kalamkar and S. Bansod, 2005. Heterosis studies in mustard, Journal of Phytological Research, 18: 231-233.
35. Tyagi, M.K., J.S. Chauhan, P.R. Kumar and K.H. Singh, 2001. Estimaiton of heterosis in Indian mustard [*Brassica juncea* (L.) Czren and Coss], Annl. Agril. Bio. Res., 6: 193-200.
36. Chaudhury, B.D., P. Singh, D.P. Singh and R.K. Pannu, 1993. Functional relationship among morphological characters in Brassica, Haryana J. Agron., 9: 161-166.
37. Yadava, T.P., A.K. Yadav and H. Singh, 1978. A concept of plant ideotype in Indian mustard (*B. juncea* L. Czern and Coss), presented at the 5th International Rapeseed Conf, 1978.
38. Afroz, R., M.S.H. Sharif and L. Rahman, 2004. Genetic variability, correlation and path analysis in mustard and rape (*Brassica* Spp.), Bangladesh J. Pl. Breed. Genet., 17: 59-63.
39. Rashid, M.H., 2007. Characterization and diversity analysis of the oleiferous Brassica species, MS Thesis, Dept. of Genetics and Plant Breeding, SAU, Dhaka, 2007.
40. Siddikee, M.A., 2006. Heterosis inter genotypic variability, correlation and path analysis of quantitative characters of oleiferous *Brassica campestris* L., MS Thesis, Dept. of Genetics and Plant Breeding, SAU, Dhaka, 2006.
41. Kumar, C.H.M.V., V. Arunachalam and P.S.K. Rao, 1996. Ideotype and relationship between morpho-physiological characters and yield in Indian mustard (B. Juncea), Indian Journal of Agricultural Sciences, 66: 14-17.
42. Varshney, S.K., B. Rai and B. Singh, 1986. Component analysis of harvest index in Brassica oilseeds, Indian J. Agric. Res., 20: 129-134.
43. Singh, J.N. and B.R. Murty, 1980. Combining ability and maternal effects in *Brassica campestris* L. var. Yellow sarson, Theor. Appl. Genet., 56: 265-272.
44. Mahmud, M.A.A., 2008. Intergenotypic variability stusy in advanced lines of Brassica rapa, MS Thesis, Dept. of Genetics and Plant Breeding, SAU, Dhaka, 2008.

45. Huq, K.M.E., 2006. Heterosis and combining ability in rapseed (*Brassica rapa* L.) derivatives, MS. Thesis, SAU, Dhaka, 2006.
46. Lebowitz, R.J., 1989. Image analysis measurements and repeatability estimates of siliqua morphological traits in *B. campestris* L, Euphytica, 43: 113-116.
47. Olson, G., 1990. Rape yield-production components, Sversk Fortidning, 59: 194-197.