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Utilization of selection parameters for seed yield and its contributed traits in Indian mustard (*Brassica juncea* L. Czern & Coss)

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Abstract
High heritability observe for plant height, days of maturity, number of siliquae per plant. Higher genetic advance shows length of main raceme, plant height, number of siliquae per plant, days to maturity, harvest index, seed yield and oil content, number of seed size, number of secondary branch, days to flowering, number of seeds per siliqua, biological yield and 1000-seed weight. These characters should be considered in making selection of genotypes for crop improvement. Seed yield per plant have positively correlated with number of primary branches per plant, number of secondary branches per plant, days to maturity, plant height, length of main raceme, number of seeds per siliquae, biological yield, harvest index, 1000-seed weight and oil content.

Keywords: *brassica Juncea*, Indian Mustard, quantitative traits, selection parameters (correlation, genetic advance and heritability) and diallel dating design

1. Introduction
The oleiferous *Brassica* species, commonly known as rapeseed-mustard, are one of the economically important agricultural commodities. Rapeseed-mustard comprising eight different species viz. Indian mustard, toria, yellow sarson, brown sarson, gobhi sarson, karan rai, black mustard and taramira, are being cultivated in 53 countries spreading all over the globe. The oil obtained from different forms of rapeseed mustard show slight variation in percentage of oil. The oil content varied from 37 to 49 per cent. Mustard oil contains about 70% mono-unsaturated fatty acid (MUFA) of which 42% is erusic acid and 12% oleic acid. The seed and oil are used as condiments in the preparation of pickle and for flavour carrying out vegetables. The oil is utilized for human consumption throughout northern India in cooking and frying purposes. The oil cake is used as a cattle feed and manure. Green stems and leaves are a good source of green fodder for cattle.

2. Materials & Methods
The present investigation was carried out at Oil Seed Research Farm, Kalyanpur of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, during rabi season 2013-15. The experiment was conducted in Randomized Block Design (RBD) with three replications. 7 parents/strains (Varuna, RK-9101, Pusa jagannath, RH-9801, Pusa bahar, Rohini & Kanti) were crossed in diallel mating design (excluding reciprocal crosses). 28 genotypes (21 F_1 + 7 parents) were evaluated for 13 characters viz. Days to flowering, Number of primary branches, Number of secondary branches, Days to maturity, Plant height, Number of siliquae per plant, Length of main raceme, Number of seeds per siliqua, Biological yield per plant (g), Harvest index (%), 1000-Seed weight (g), Oil content (%) and seed yield per plant (g). The parents and F_1s were growing in single row of five meter length spaced 45 cm apart. The distance of 15 cm between the plants in a row maintained by thinning. All the recommended agronomic practices were followed for raising the good crop. The components of variance in diallel cross were computed by the use of formula suggested by Hayman (1954a) [8]. Heritability (in narrow sense) in F_1 generation was calculated by the formula suggested by Crumpacker and Allard (1962) [6]. Heritability in F_2 generation was calculated according to the methodology given by Verhalen and Murray (1969) [16]. The genetic advance was worked out using following formula suggested by Robinson *et al.* (1949) [13]. The formulla were used for calculating the genotypic and phenotypic coefficients of correlation as suggested by Al-jibouri *et al.* (1958) [3]. Oil content was estimated with the help of NMR.

3. Results & Discussion

The estimate of heritability (narrow sense) and genetic advance for nine characters in F_1 are presented in Table-1. The estimates of heritability (narrow sense) were observed high for the characters varied from -0.35 per cent for harvest index to 126.02 per cent for plant height. As per classification high heritability were recorded for plant height (126.02) Days of maturity (52.08), number of Siliqua per plant (31.19) medium long was recorded for length of main receame (15.98) and low he used to covered for days to flower (6.92), number of primary branch (9.22), number of secondary branch (6.95), number of seed per siliqua (7.17), biological yield (7.72), harvest index (-0.03), 1000 seed rate (0.29), oil content (2.03) and seed yield (7.61). The genetic advance in percent over mean was estimated for all the 13 characters which ranged from 0.71 to 32.46 per cent. The high values were found of length of main recame (32.46), plant height (20.08), number of siliqua per plant (15.95), days to maturity (15.64), harvest index (4.98), seed yield (3.38), oil content (2.76), number of seed size (1.83), number of secondary branch (1.73), days to flowering (1.63), number of seed per siliquae (1.62), biological yield (1.91) and 1000 seed rate (0.71). Similar findings were also observed by Badrsa *et al.* (2001), Ghosh *et al.* (2001) [7], Mahia *et al.* (2003) [10], Kardam *et al.* (2005) [9], Patra *et al.* (2006) [11], Chakravarty *et al.* (2006) [5], Akbar *et al.* (2007) [2], Acharya *et al.* (2008) [1], Singh *et al.* (2011) [14], Priyamedha *et al.* (2013) [12] and Singh *et al.* (2013) [12].

Table 1: Grand mean, heritability and genetic gain in percent over mean in 13 characters in F_1's diallel generation of Indian mustard.

Character	$\overline{X}$	$\hat{h}^2$ (%)	GA	GA in percent over mean
Days to flowering	71.44	6.92	1.63	2.27
No. of primary branches/ plant	10.32	4.22	1.62	16.17
No.of secondary branchs/plant	24.06	6.95	1.73	7.29
Days to maturity	120.87	52.08	15.64	12.83
Plant height (cm)	178.22	126.02	20.08	11.38
Length of main raceme (cm)	74.21	15.98	32.46	43.82
No. of siliquaes/plant	373.68	31.19	15.95	4.32
No. of seeds /siliqua	16.02	7.17	1.83	11.73
Biological yield/plant (g)	83.19	7.72	0.91	1.10
Harvest index (%)	32.98	-.35	4.98	15.06
1000-seed weight (g)	5.74	0.29	0.71	12.48
Oil content (%)	39.48	2.03	2.76	7.01
Seed yield / plant (g)	28.11	7.61	3.38	12.20

$\overline{X}$ = Grand mean of the character,

$\hat{h}^2$ (%) = Heritability estimates in percent (narrow sense)

GA = Genetic advance,

GA (%) = Genetic advance in percent over mean of the character

Estimates of genotypic and phenotypic correlation coefficient between all possible pairs of characters involving thirteen traits in first filial generation were computed. The results are presented in Table-2. At genotypic level of correlation coefficient, days to flowering have positive significant associations with number of primary branches per plant, days to maturity, length of main raceme, number of siliquae per plant and harvest index; number of primary branches per plant have positive correlation with day to flowering, number of secondary branches, days to maturity, plant height, length of main raceam, number of siliquae per plant, number of seeds per siliquae, biological yield, harvest index, 1000 seed weight and seed yield per plant; number of secondary branches per plant have positive associations with days to flowering, number of primary branches, days to maturity, plant height, length of main raceme, number of siliquae per plant and number of seeds per siliquae, biological yield, harvest index, 1000 seed weight and seed yield per plant; days to maturity have positive correlated with days to flowering, number of primary branches, number of secondary branches, plant height, length of main raceme, number of siliquae per plant, harvest index and seed yield per plant; plant height have positive associations with number of primary branches, number of secondary branches, days to maturity, length of main raceme, number of siliquae per plant and number of seeds per siliquae, biological yield, harvest index, 1000 seed weight, oil content and seed yield per plant; length of main raceme have positive associations with days to flowering, number of primary branches, number of secondary branches, days to maturity, plant height, number of siliquae per plant and number of seeds per siliquae, harvest index, oil content and seed yield per plant; number of siliquae per plant have positive correlation with days to flowering, number of primary branches, number of secondary branches, days to maturity, plant height, length of main raceme, number of seeds per siliquae, biological yield, harvest index and 1000 seed weight; number of seeds per siliquae have positive associations with number of primary branches, number of secondary branches, plant height, length of main raceme, number of siliquae per plant, biological yield, harvest index, 1000 seed weight, oil content and seed yield per plant; biological yield have positive correlation with number of primary branches, number of secondary branches, plant height, number of siliquae per plant and number of seeds per siliquae, 1000 seed weight, oil content and seed yield per plant; harvest index have positive association with days to flowering, number of primary branches, number of secondary branches, days to maturity, plant height, length of main raceme, number of seeds per siliquae, oil content and seed yield per plant; 1000-seed weight have positive correlation with number of primary branches, number of secondary branches, plant height, number of siliquae per plant and number of seeds per siliquae, biological yield, oil content and seed yield per plant; oil content have positive association with plant height, length of main raceme, number of seeds per siliquae, biological yield, harvest index, 1000 seed weight and seed yield per plant and seed yield per plant have positive correlation with number of primary branches per plant, number of secondary branches per plant, days to maturity, plant height, length of main raceme, number of seeds per siliquae, biological yield, harvest index, 1000 seed weight and oil content. At phenotypic level of correlation coefficient, days to flowering have positive significant associations with number of primary branches per plant, number of secondary branches per plant, days to maturity, length of main raceme, number of siliquae per plant and harvest index; number of primary branches per plant had positive correlation with day to flowering, number of secondary branches, days to maturity, plant height, length of main raceme, number of siliquae per plant, number of seeds per siliquae, biological yield, harvest index, 1000 seed weight and seed yield per plant; number of secondary branches per plant have positive associations with number of primary branches, days to maturity, plant height, length of main raceme, number of siliquae per plant and number of seeds per siliquae, biological yield, harvest index, 1000 seed weight and seed yield per plant; days to maturity have positive correlation with days to flowering, number of primary branches, number of secondary branches, plant height, length of main raceme, number of siliquae per plant, harvest index and seed yield per plant; plant height have positive associations with number of primary branches, number of secondary branches, days to maturity, length of main raceme, number of siliquae per plant, number of seeds per siliquae, biological yield, harvest index, 1000 seed weight, oil content and seed yield per plant; length of main raceme have positive association with days to flowering, number of primary branches, number of secondary branches, days to maturity, plant height, number of siliquae per plant and number of seeds per siliquae, harvest index, oil content and seed yield per plant; number of siliquae per plant have positive correlation with days to flowering, number of primary branches, number of secondary branches, days to maturity, plant height, length of main raceme, number of seeds per siliquae, biological yield and 1000 seed weight; number of seeds per siliquae have positive association with number of primary branches, number of secondary branches, plant height, length of main raceme, number of siliquae per plant, biological yield, harvest index, 1000 seed weight, oil content and seed yield per plant; biological yield have positive correlation with number of primary branches, number of secondary branches, plant height, number of siliquae per plant and number of seeds per siliquae, 1000 seed weight, oil content and seed yield per plant; harvest index have positive association with days to flowering, number of primary branches, number of secondary branches, days to maturity, plant height, length of main raceme, number of seeds per siliquae, oil content and seed yield per plant; 1000-seed weight have positive correlation with number of primary branches, number of secondary branches, plant height, number of siliquae per plant and number of seeds per siliqua, biological yield, oil content and seed yield per plant; oil content have positive association with plant height, length of main raceme, number of seeds per siliquae, biological yield, harvest index, 1000 seed weight and seed yield per plant and seed yield per plant have positive correlation with number of primary branches per plant, number of secondary branches per plant, days to maturity, plant height, length of main raceme, number of seeds per siliquae, biological yield, harvest index, 1000 seed weight and oil content. Similar findings were also observed by Badrsa *et al.* (2001), Ghosh *et al.* (2001) [7], Mahia *et al.* (2003) [10], Kardam *et al.* (2005) [9], Patra *et al.* (2006) [11], Chakravarty *et al.* (2006) [5], Akbar *et al.* (2007) [2], Acharya *et al.* (2008) [1], Singh *et al.* (2011) [14], Priyamedha *et al.* (2013) [12] and Singh *et al.* (2013) [12].

Table 2: Genotypic (upper diagonal) and phenotypic (lower diagonal) correlation coefficient among 13 attributes in 7 x 7 parental & F_1 of a diallel cross in Indian mustard.

Characters	Days to flowering	No. of primary branches/ plant	No. of secondary branches/ plantt	Day to Maturity	Plant height (cm)	Length of main raceme (cm)	No. of siliquae /plant	No. of seeds /siliquae	Biological yield/plant (g)	Harvest index %)	1000-seed weight (g)	Oil content (%)	Seed yield/ plant (g)
Days to flowering	ph^{r}g	0.04**	0.04**	0.75**	-0.18	0.073**	0.14**	-0.28	-0.57	0.40**	-0.34	-0.61	-0.03
No. of primary branches/ plant	0.07**	ph^{r}g	0.90**	0.40**	0.46**	0.57**	0.49**	0.98**	0.47**	0.63**	0.55**	-0.13	0.77**
No. of secondary branches/plant	-0.06	0.78**	ph^{r}g	0.63**	0.44**	0.47**	0.90**	0.55**	0.64**	0.34**	0.24**	-0.17	0.54**
Days to maturity	4.34**	1.92**	4.42**	ph^{r}g	0.24**	0.38**	0.63**	-0.03	-0.07	0.51**	-0.03	-0.37	0.22**
Plant height (cm)	-0.15	3.40**	5.60**	15.22**	ph^{r}g	0.66**	0.38**	0.43**	0.19**	0.56**	0.09**	0.23**	0.70**
Length of main raceme (cm)	0.91**	6.21**	7.12**	28.59**	82.00**	ph^{r}g	0.44**	0.60**	-0.42	0.83**	-0.00	0.03**	0.58**
No. of siliquae/plant	0.87**	3.92**	6.73**	25.20**	22.37**	37.69**	ph^{r}g	0.25**	0.21**	0.00	0.22**	-0.43	-0.07
No. of seeds /siliqua	-0.55	1.15**	0.73**	-0.08	1.57**	8.07**	2.88**	ph^{r}g	0.48**	0.58**	0.46**	0.23**	0.80**
Biological yield/plant (g)	-0.32	0.50**	0.58**	-0.60	2.24**	-3.33	2.03**	0.39**	ph^{r}g	-0.36	0.62**	0.35**	0.45**
Harvest index (g)	1.02**	1.39**	1.27**	7.18**	15.81**	25.11**	1.83**	1.61**	-0.99	ph^{r}g	-0.14	0.20**	0.78**
1000-seed weight (g)	-0.09	0.13**	0.07**	-0.04	0.24**	-0.00	0.40**	0.13**	0.12**	-0.09	ph^{r}g	0.10**	0.13**
Oil content (%)	-0.55	-0.14	-0.13	-2.47	3.02**	0.50**	-3.25	0.16**	0.40**	0.66**	0.03**	ph^{r}g	0.42**
Seed yield / plant (g)	-0.23	1.30**	1.01**	2.03**	12.50**	12.25**	-0.00	1.38**	0.82**	5.16**	0.06**	0.83**	ph^{r}g

Significant at P = 0.05; **Significant at P = 0.01

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