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# GENETIC VARIABILITY, CORRELATION AND PATH COEFFICIENT ANALYSIS IN NINETEEN *Brassica rapa* GERMPLASM

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## ABSTRACT

Nineteen genotypes of *Brassica rapa* were evaluated in order to find out genetic variability, correlation and path coefficient analysis of yield and yield contributing traits. All the genotypes showed highly significant variation for all the characters studied. High heritability together with high to moderate genetic advance in percentage of mean was observed for plant height, number of primary branches/plant, number of secondary branches/plant, number of siliquae/plant, 1000 seed weight and yield/plant. Correlation and path coefficient analysis suggested that during selection more emphasis should be given on plant height, number of primary branches/plant, number of seeds/siliqua, number of siliqua/plant and 1000 seed weight.

**Key words:** Genetic variability, correlation coefficient, path coefficient, *Brassica rapa*, germplasm

## INTRODUCTION

In Bangladesh mustard and rape seed is the leading oil crop. It is most important sources of edible oil in Bangladesh. The three major cultivated species of *Brassica* in the country are *B .rapa*, *B. napus* and *B. juncea*. The per capita consumption of edible oil in the country is 8g/day as compared to a need of 40g/day (Kaul and Das, 1978). There are only a few popular varieties of *B. rapa* except Tori-7 in Bangladesh. Thus to fulfill our demand we should develop varieties with short life span and higher seed yield. The seed yield of mustard and rape seed varieties ranged from 600-3000 kg/ha while the variation in oil content was found to be 30-45%. These variations depend upon the species, the varieties and the climatic conditions under which they are grown (Varshney *et al.*, 1986). Seed yield in mustard and rape seed is a complex and highly variable character and is being associated with a number of component characters. Information related to genetic variability and character association is a prerequisite for initiating a successful breeding program aiming to develop high yielding and short duration varieties. Correlation and path coefficient are used to assess the relative contribution of different components (Sachan and Sharma, 1971 and Jatasra and Paroda, 1978). The understanding of association of characters is of prime importance in developing an efficient breeding programme. The correlation studies provide information about the relationship between any two characters. The path coefficient analysis has been found to give more specific information on the direct and indirect influence of each of the component characters upon seed yield (Behl *et al.*, 1992). Thus, the present study was undertaken to find out and establish suitable selection criteria for higher seed yield through study of genetic variability, heritability, genetic advance, correlation among different characters and the direct and indirect effect of these characters towards seed yield..

## MATERIALS AND METHODS

The experiment was undertaken in the experimental farm, Sher-e-Bangla Agricultural University (SAU), Dhaka during November 2005-March 2006. The experiment was set up in a RCBD design with three replications, following 30cm x 10cm spacing. The unit plot size was 5m×25m and block to block distance was 1.5m. Nineteen germplasms were used in this experiment. The germplasms were collected from the Germplasm Centre of Bangladesh Agricultural Research Institute, Gazipur. The plot was

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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 plant height, 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 each line in each replication. The collected data were analyzed according to Johnson *et al.* (1955); Burton (1952), Singh and Chaudhary (1985), Allard (1960), Comstock and Robinson (1952) and Dewey and Lu (1959).

## RESULTS AND DISCUSSION

Among 19 genotypes used in the study, the genotype SAUYC was the tallest plant and had the highest number of primary branches/plant, longest siliqua length, highest number of siliqua/plant, maximum number of seeds/siliqua and yield/plant (Table 1). Highest number of secondary branches/plant was recorded in BD-9062 while BD-6956 had no secondary branches/plant at all. Lowest length of siliqua as well as lowest number of siliqua/plant was found in BD-9075. Days to 50% flowering were late in BD-6956 and early in BD-9083. Late and early maturing type genotypes were observed in BD-9075 and BD-9085, respectively. Thousand seed weight was recorded highest in BD-9068 while lowest thousand seed weight as well as yield/plant was in BD-9080. Yield/plant was recorded highest (3.4 g) in SAUYC and the lowest yield/plant was recorded in BD-9080 (0.58 g).

**Table1. Mean performance of 10 important characters in respect of *Brassica rapa***

| Genotype | Plant height (cm) | Primary branches/ plant (no.) | Secondary branches/ plant (no.) | Length of siliqua (cm) | Seeds/ siliqua (no.) | Siliquae/ plant (no.) | 1000 seed weight (g) | Yield/ plant (g) | Days to 50% flowering | Days to maturity |
|---|---|---|---|---|---|---|---|---|---|---|
| BD-9062 | 66.60cd | 6.20cd | 9.20a | 4.09ab | 15.88ab | 138.30ab | 2.27cdef | 1.62ef | 30.00b | 73.67ef |
| BD-9063 | 67.10cd | 7.17b | 5.10cd | 3.63cde | 14.02bcde | 134.30abcd | 3.14ab | 2.78abc | 29.67b | 75.67cdef |
| BD-9064 | 66.33cd | 5.87def | 2.70fgh | 3.33ef | 12.13def | 117.40abcde | 2.56bcde | 2.73abc | 30.67b | 76.00bcdef |
| BD-9067 | 61.76de | 6.83bc | 7.06b | 3.47de | 13.17bcdef | 126.90abcd | 3.06ab | 2.55bcd | 26.33b | 77.33bcde |
| BD-9068 | 50.63fgh | 4.57hi | 2.93fgh | 3.47de | 12.39def | 53.87fgh | 3.21a | 1.53efg | 27.00b | 74.67def |
| BD-9071 | 63.46cde | 5.17efghi | 3.53efg | 3.29a | 14.55bcd | 106.87bcdef | 2.65abcde | 3.10ab | 29.00b | 78.33abcd |
| BD-9073 | 57.38def | 5.60defg | 4.17def | 3.83bc | 13.71bcde | 137.37abc | 2.74abcd | 2.15cde | 26.67b | 77.00bcde |
| BD-9074 | 58.13def | 5.07fghi | 1.87h | 2.97gh | 12.94cdef | 79.58bcdefgh | 2.22cdef | 0.82fghi | 28.00b | 78.67abcd |
| BD-9075 | 45.15h | 4.296i | 2.44gh | 2.38i | 10.674f | 26.26h | 1.56g | 1.00fghi | 30.67b | 82.00a |
| BD-9079 | 51.17fgh | 4.93ghi | 2.40gh | 2.72h | 10.37f | 75.27defgh | 2.08efg | 1.06fghi | 28.33b | 79.00abc |
| BD-9080 | 57.20def | 5.53defg | 2.20gh | 3.51cde | 11.27ef | 78.03cdefgh | 1.19h | 0.58i | 29.00b | 80.00ab |
| BD-9081 | 56.77def | 6.03cde | 4.70 de | 3.47de | 13.05bcdef | 89.56bcdefg | 1.29h | 1.59ef | 28.33b | 78.67abcd |
| BD-9082 | 55.74efg | 6.78bc | 6.44bc | 3.54cde | 15.49abc | 118.67abcde | 2.28cdef | 1.50efgh | 27.33b | 78.67abcd |
| BD-9083 | 46.90gh | 5.13fghi | 2.40gh | 3.39def | 11.91def | 46.30gh | 1.86fg | 0.61ghi | 26.00b | 74.67def |
| BD-9084 | 72.07bc | 6.27cd | 2.47gh | 3.45de | 13.83bcde | 107.73bcdef | 1.85fg | 2.53cde | 27.33b | 74.00ef |
| BD-9085 | 58.17def | 4.33i | 2.17gh | 3.46de | 12.33de | 43.60gh | 2.41cdef | 1.73def | 25.67b | 72.67f |
| BD-9087 | 62.92cde | 5.67defg | 3.03 fgh | 3.68cd | 3.85bcde | 83.47bcdefgh | 2.20cdef | 1.35efghi | 30.00b | 78.67abcd |
| BD-6956 | 79.57b | 5.27efgh | 0.00i | 3.09fg | 15.87 ab | 67.00efgh | 2.83abc | 1.49efgh | 40.00a | 79.33abc |
| SAUYC | 100.89a | 10.83a | 5.17cd | 3.35a | 17.34a | 167.71a | 2.22cdef | 3.49a | 30.00b | 78.67abcd |
| L.SIG | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| Lsd.05 | 8.83 | 0.77 | 1.37 | 0.29 | 2.46 | 50.65 | 0.54 | 0.81 | 4.32 | 3.55 |
| Sx/ sd | 3.08 | 0.27 | 0.48 | 0.10 | 0.86 | 17.66 | 0.19 | 0.28 | 1.51 | 1.24 |
| CV(%) | 8.60 | 7.89 | 16.43 | 5.09 | 11.08 | 32.32 | 14.25 | 18.95 | 9.01 | 2.78 |

**Table 2. Estimation of some genetic parameters in respect of *Brassica rapa***

| Character | Plant height (cm) | Primary branches /plant (no.) | Secondary branches/ plant (no.) | Days to 50% flowering | Days to maturity | Length of siliqua (cm) | Seeds/ siliqua (no.) | Siliquae/ Plant (no.) | 1000 seed weight (g) | Yield/ plant (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Genotypic variance** | 151.10 | 2.04 | 4.47 | 0.22 | 2.70 | 1142.22 | 0.40 | 0.70 | 7.40 | 4.61 |
| **Phenotypic variance** | 179.50 | 2.26 | 5.16 | 0.25 | 4.91 | 2077.82 | 0.51 | 0.94 | 14.21 | 9.22 |
| **Genotypic co-efficient of variation** | 19.83 | 24.35 | 61.65 | 13.54 | 12.26 | 35.71 | 27.60 | 49.36 | 9.40 | 2.78 |
| **Phenotypic co-efficient of variation** | 21.61 | 25.59 | 57.42 | 14.46 | 16.53 | 48.17 | 31.07 | 57.23 | 13.02 | 3.93 |
| **Heretability%** | 84.18 | 90.52 | 86.75 | 87.75 | 55.03 | 54.97 | 78.94 | 74.39 | 52.09 | 50.03 |
| **Genetic advance** | 37.47 | 47.72 | 110.17 | 26.13 | 18.73 | 54.54 | 50.52 | 87.70 | 13.97 | 4.05 |
| **Genetic advance in percentage of mean** | 60.44 | 812.73 | 2991.24 | 750.76 | 139.71 | 57.63 | 2202.38 | 5174.05 | 48.27 | 5.24 |

Number of seeds/siliqua, days to 50% flowering and days to maturity showed low heritability with low genetic advance and low genetic advance in percentage of mean which indicated the characters were highly influenced by environmental effects and selection for these characters would be ineffective. Length of siliqua showed high heritability with low genetic advance and low genetic advance in percentage of mean which indicated the preponderance of non-additive gene action. The high heritability for these traits was due to favorable influence of environment rather than genotype and selection for such traits might not be rewarding. Plant height, number of primary branches/plant, number of secondary branches/plant, number of siliquae/plant, 1000 seed weight and yield/plant showed high heritability with high genetic advance and high genetic advance in percentage of mean which revealed the predominance of additive gene effects and selection might be effective.

**Table 3. Correlation co-efficient among different characters of the *Brassica rapa***

| Character | Plant height (cm) | Primary branches/ plant (no.) | Secondary branches/ plant (no.) | Days to 50% flowering | Days to maturity | Length of siliqua (cm) | Seeds/ siliqua (no.) | Siliquae/ plant (no.) | 1000 seed weight (g) | Yield/ plant (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | **1.000** | 0.751 ** | 0.098 | 0.378** | -0.012 | 0.497** | 0.622** | 0.457** | 0.163 | 0.459** |
| Primary branches/ plant (no.) | | **1.000** | 0.460** | 0.055 | 0.044 | 0.570** | 0.563** | 0.624** | 0.034 | 0.510** |
| Secondary branches/plant (no.) | | | **1.000** | -0.214 | -0.151 | 0.484** | 0.365** | 0.518** | 0.056 | 0.336** |
| Days to 50% flowering | | | | **1.000** | 0.504** | -0.073 | 0.184 | -0.027 | 0.145 | 0.008 |
| Days to maturity | | | | | **1.000** | | -0.209 | -0.118 | -0.141 | -0.124 |
| Length of siliqua (cm) | | | | | | **1.000** | 0.580** | 0.544** | 0.194 | 0.514** |
| Seeds/siliqua (no.) | | | | | | | **1.000** | 0.533** | 0.165 | 0.461** |
| Siliquae/ plant (no.) | | | | | | | | **1.000** | 0.145 | 0.507** |
| 1000 seed weight (g) | | | | | | | | | **1.000** | 0.333** |

****, Significant at the 0.01 level; *, Significant at the 0.05 level**

Plant height showed highly significant positive association with number of primary branches/plant, days to 50% flowering, length of siliqua, number of seeds/siliqua, number of siliquae/plant and yield/plant. The results revealed that the tallest plant initiated with early flowering and with an increase of plant height, number of primary branches/plant, length of siliqua, number of seeds/siliqua and number of siliquae/plant. Ultimately the yield/plant would increase. On the other hand, plant height had non significant negative association with days to maturity and non significant positive correlation with number of secondary branches/plant and 1000 seed weight. Number of primary branches/plant had highly significant positive correlation with number of secondary branches/plant, length of siliqua, number of seeds/siliqua, number of siliquae/plant and yield/plant which indicated that more primary branches producing genotype produce more number of seeds/siliqua and more secondary branches/plant. As a result, the yield would increase.

Number of secondary branches/plant showed highly significant positive correlation with length of siliqua, number of seeds/siliqua, number of siliquae/plant and yield/plant. The results revealed that number of secondary branches/plant might be considered for the selection of number of siliquae/plant. Days to 50% flowering showed highly significant positive association with days to maturity. But days to maturity showed non significant negative correlation with length of siliqua, number of seeds/siliqua, number of siliquae/plant, 1000 seed weight and yield/plant. Positive association of days maturity with siliqua length, number of siliquae/plant and 1000 seed weight had been reported by Chaudhury *et al.* (1987). Highly significant positive association of length of siliqua was found with number of seeds/siliqua, number of siliquae/plant and yield/plant (Table 3). Chaudhury *et al.* (1993) found that seed yield was positively correlated with siliqua length which is agreed with this experimental result.

**Table 4. Partitioning of genotypic correlation with seed yield/plant into direct and indirect components of *Brassica rapa***

| Characters | Plant height (cm) | Primary branches/ plant (no.) | Secondary branches/ plant (no.) | Days to 50% flowering | Days to maturity | Length of siliqua (cm) | Seeds/ siliqua (no.) | Siliquae/ plant (no.) | 1000 seed weight (g) | Yield/ plant (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | **0.130** | 0.109 | 2.613 | -0.038 | -4.884 | 8.055 | 5.399 | 7.938 | 4.151 | 0.459 |
| Primary branches/ plant (no.) | 9.779 | **0.145** | 0.012 | -5.522 | 1.790 | 9.238 | 4.887 | 0.108 | 8.659 | 0.51 |
| Secondary branches/ plant (no.) | 1.276 | 1.365 | **2.666** | 2.149 | -6.146 | 7.844 | 0.032 | 8.997 | 1.426 | 0.336 |
| Days to 50% flowering | 4.922 | 7.996 | -5.706 | **-0.100** | 2.051 | -1.183 | 1.597 | -4.689 | 3.693 | 8.00 |
| Days to maturity | -1.563 | 6.397 | -4.026 | -0.051 | **4.609** | -4.036 | -1.814 | -2.049 | -3.591 | -0.124 |
| Length of siliqua (cm) | 6.471 | 8.287 | 1.290 | 7.329 | -1.013 | **0.162** | 5.035 | 9.449 | 4.941 | 0.514 |
| Seeds/siliqua (no.) | 8.099 | 8.185 | 9.731 | -1.847 | -8.506 | 9.400 | **8.680** | 9.258 | 4.202 | 0.461 |
| Siliquae plant (no.) | 5.951 | 9.072 | 1.381 | 2.711 | -4.803 | 8.817 | 4.627 | **0.174** | 3.693 | 0.507 |
| 1000 seed weight (g) | 2.123 | 4.943 | 1.493 | -1.456 | -5.739 | 3.144 | 1.432 | 2.519 | **0.255** | 0.333 |

**Residual effect: 0.566; Bold figures indicate direct effects**

Correlation co-efficient might not provide an exact picture of the relative importance of direct and indirect influence of each of yield components on seed yield per plant. As a matter of fact, in order to find out a clear picture of the interrelationship between seed yield per plant and other yield attributes, direct and indirect effects were worked out using path analysis which also measured the relative importance of each component. The results of path co-efficient analysis of *Brassica rapa* are presented in Table 4.

Plant height, number of primary branches/plant, number of secondary branches/plant, length of siliqua, days to 50% flowering, number of seeds/siliqua, number of siliquae/plant and 1000 seed weight showed positive direct effects and days to maturity showed negative direct effect on yield/plant. Han (1990) working with *Brassica napus*, observed negative direct effect of number of siliquae/plant and positive direct effect of number of seeds/siliqua and plant height on seed yield. Plant height showed positive indirect effects on number of primary branches/plant, number of secondary branches/plant, length of siliqua, number of seeds/siliqua, number of siliquae/plant and 1000 seed weight. Number of primary branches/plant showed positive indirect effect on plant height, number of secondary branches/plant, days to maturity, length of siliqua, number of seeds/siliqua, number of siliquae/plant and 1000 seed weight. Number of secondary branches/plant had positive indirect effects on plant height, number of primary branches/plant, days to 50% flowering, length of siliqua, number of seeds/siliqua, number of siliquae/plant and 1000 seed weight (Table 4). It was found that days to 50% flowering had positive indirect effects on plant height, number of primary branches/plant, days to maturity, number of seeds/siliqua and 1000 seed weight. On the other hand, days to maturity had positive indirect effect on number of primary branches/plant. Chauhan and Singh (1985) observed positive direct effect on days to 50% flowering, plant height, primary branching, number of siliquae/plant, number of seeds/siliqua on yield. Length of siliqua had positive indirect effect on plant height, number of primary branches/plant, number of secondary branches/plant, days to 50% flowering, number of seeds/siliqua, number of siliquae/plant and 1000 seed weight. Chen *et al.* (1983) found negative effect in plant height, days to maturity and siliqua length. Number of seeds/siliqua had positive indirect effect on plant height, number of primary branches/plant, number of secondary branches/plant, length of siliqua, number of siliquae/plant and 1000 seed weight. Chen *et al.* (1983), Chauhan and Singh (1985) and Han (1990) found substantial direct effect of number of seeds/siliqua on seed yield. Number of siliquae/plant had positive direct effect on plant height, number of primary branches/plant, number of secondary branches/plant, days to 50% flowering, length of siliqua, number of seeds/siliqua and 1000 seed weight. The result of path analysis showed that 1000 seed weight had positive indirect effect on plant height, number of primary branches/plant, number of secondary branches/plant, length of siliqua, number of seeds/siliqua and number of siliquae/plant. Varshney *et al.* (1986) working with several strains of *B. rapa* found the negative direct effect of plant height, number of siliquae/plant, number of seeds/siliqua and 1000 seed weight on yield.

Here, the correlation coefficient is positive but the direct effect is negative. Therefore, the indirect effects seem to be the cause of correlation. In such situation the indirect causal factors are to be considered simultaneously. When correlation coefficient is negative and the direct effect is positive and high, a restricted simultaneous selection model is to be followed, i.e. restrictions are to be imposed to nullify the undesirable indirect effects in order to make use of the direct effect (Singh and Kakar, 1977). Residual effects (0.566) indicated that the characters which were selected in this study contributed 44% to the yield. It is suggested that more emphasis should be given on the above characters for selecting rape seed genotypes with higher yield and other traits.

The result of the study indicated high heritability together with high to moderate genetic advance in percentage of mean for plant height, number of primary branches/plant, number of secondary branches/plant, number of siliquae/plant, 1000 seed weight and yield/plant. Therefore, selection through the above characters would be effective for the improvement of *Brassica rapa*. Correlation and path coefficient analysis suggested that during selection more emphasis should be given on plant height, number of primary branches/plant, number of seeds/siliqua, number of siliqua/plant and 1000 seed weight.

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