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# RELATIONSHIP AMONG YIELD COMPONENTS AND SELECTION CRITERIA FOR YIELD IMPROVEMENT IN WINTER RAPESEED (*BRASSICA NAPUS* L.)

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**Abstract**

Twenty-five winter type rapeseed varieties introduced from diverse sources of the world were studied for variability, heritability, genetic advance, correlation and path analysis of seed yield and yield components. Significant differences among genotypes for most of the traits indicated that there is sufficient variability available to have an effective selection. Genotypic and phenotypic variances were highest for pods/plant followed by plant height, whereas the maximum genotypic and phenotypic coefficients of variability were found in seed yield/plant and pods/plant, respectively. Broad sense heritability estimates ranged from very low to high. Maximum heritability of 0.903 was obtained for days to maturity followed by flower duration (0.662), seed weight (0.548) and seed yield (0.477). High heritability for flower duration, seed weight and seed yield coupled with high genetic advance indicated that these traits could be improved through mass selection. Positive and significant correlation was found between seed yield and harvest index, seed weight and flower duration. Significant and positive correlation of seed weight with harvest index, flower duration and seed yield indicated that improvement in seed weight will give higher harvest index ultimately resulting high seed yield. Harvest index, seed weight and pods/plant have shown a considerable direct positive effect on seed yield. Positive direct effect of seed weight and harvest index associated with significant and positive correlation with seed yield suggested that these yield components may be a good selection criteria to improve seed yield of winter type rapeseeds.

## Introduction

Oilseed rape (*Brassica napus* L.) is now the third most important oil crop in the world. Its total acreage is expanding very fast especially in areas with moderate climatic conditions. In Pakistan, rapeseed and mustard is planted on an area of 300,000 ha and contributes 19.6% share to local edible oil production, whereas in Iran it is a new crop and is planted only on 40,000 ha. Average yield of rapeseed is very low compared to its genetic potential. To increase the yield, study of direct and indirect effects of yield components provides the basis for its successful breeding programme and hence the problem of yield increase can be more effectively tackled on the basis of performance of yield components and selection for closely related characters (Choudhry *et al.,* 1986).

Various researchers studied genetic parameters to determine the selection criteria for yield improvement in rapeseed and mustard.. Labana *et al*., (1980) and Ali (1985) reported high genotypic and phenotypic variances for plant height and pods per plant in mustard. High heritability estimates associated with high genetic advance for plant height, pods per plant and seed yield were reported by Singh & Singh (1997). They also reported greatest positive direct effect of pods per plant, seeds per plant and seed weight on seed yield. Sheikh *et al*., (1999) found high heritability estimates coupled with high

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genetic advance for seed yield/plant, primary and secondary branches, pods per plant and seed weight in rapeseed (*B. campestris*) genotypes. They also reported positive correlation of all the yield components with seed yield. Use of simple correlation analysis could not fully explain the relationships among the characters. Therefore, the path coefficient analysis has been used by many researchers for a more and complete determination of impact of independent variable on dependent one. The path coefficient analysis helps the breeder(s) to explain direct and indirect effects and hence has extensively been used in breeding work in different crop species by various researchers (Green, 1980; Marinkovic, 1992; Punia & Gill, 1994, Shalini *et al.*, 2000 and Ali *et al.*, 2002). The objectives of this study were to estimate the heritable variation, relationship among yield components and the best selection criteria for yield improvement in winter type rapeseed.

## Materials and Methods

Twenty-five selected lines of rapeseed were evaluated for genetic parameters at the Seed and Plant Improvement Institute (SPII), Karaj, Iran. The experiment was arranged in a randomized complete block design with 4 replications. Four rows of five meter length and 30 cm apart were planted for each genotype in each replication. The experiment received all the agronomic and cultural treatments throughout the season. At maturity the data for 9 different characters, including flowering duration, days to maturity, plant height, branches per plant, pods per plant, seeds per pod, seed weight, harvest index and seed yield per plant were recorded from 10 randomly selected plants. Data thus collected were subjected to estimation of genetic parameters like genotypic and phenotypic variances, genotypic and phenotypic coefficients of variability, heritability and genetic advance according to Burton & Devane (1953). Correlation coefficients and the path coefficient analysis was conducted following the procedure developed by Wright (1921) and applied by Dewey & Lu (1959). Yield per plant was kept as resultant variable and all other component characters as causal variables.

## Results and Discussion

The genotypes differed significantly ($P<0.01$) for all the traits indicating the presence of sufficient genetic variability for effective selection to identify the superior genotypes (Table 1). Among these genotypes, seed yield ranged from 3.71 to 6.77 g/plant and the highest yield (6.77 g/plant) was obtained from the genotype (Regent x Cobra) with the highest seed weight (4.01 g). Maximum plant height of 175.75 cm and seeds /pod (30.90) was recorded in genotype Orkan. The genotype (PF-7045/91) produced maximum number of branches per plant (6.43) and took minimum number of days (246) to mature. Maximum harvest index was noted in Alice (26.86%), whereas, SYN-1 took maximum days (32.25) to complete flowering but it matured in less number of days (246). Maximum days to maturity (253) were taken by Licord and SLM-046.

Genotypic and phenotypic variances were high for pods per plant (147.262 and 1085.820) followed by plant height with values of 64.369 and 241.197, respectively (Table 1). Phenotypic variances were larger as compared to genotypic variances for all the traits indicating the influence of environmental effect.

**Table 1. Genetic parameters of yield and yield components of winter rapeseed (*Brassica napus*).**

| Trait | Range | Mean square | Genotypic variance | Phenotypic variance | GCV+ | PCV++ | Broad-sense heretability | Genetic advance (% of mean) |
|---|---|---|---|---|---|---|---|---|
| Flowering Duration (Days) | 21.00-32.25 | 35.606** | 7.895 | 11.923 | 10.959 | 13.467 | 0.662 | 18.37 |
| Days to Maturity | 246.00 -253.00 | 13.667** | 3.327 | 3.685 | 0.732 | 0.770 | 0.903 | 1.43 |
| Plant Height (cm) | 138.00-175.75 | 434.302** | 64.369 | 241.197 | 4.955 | 9.591 | 0.267 | 5.27 |
| Branches/plant | 3.80-6.43 | 1.560 | 0.119 | 1.203 | 6.417 | 20.402 | 0.099 | 4.16 |
| Pods/plant | 88.75-165.75 | 1527.604 | 147.262 | 1085.820 | 9.906 | 26.899 | 0.136 | 7.51 |
| Seeds/pod | 21.70-30.90 | 14.726* | 1.558 | 10.054 | 4.857 | 12.339 | 0.155 | 3.94 |
| Seed Wt. (mg) | 2.73-4.01 | 0.322** | 0.067 | 0.122 | 7.778 | 10.503 | 0.548 | 11.86 |
| Harvest Index (%) | 19.14-26.86 | 20.465** | 2.920 | 11.705 | 7.522 | 15.060 | 0.250 | 7.74 |
| Seed Yield (g/plant) | 3.71-6.77 | 3.197** | 0.627 | 1.315 | 15.187 | 21.992 | 0.477 | 21.60 |

+ = Genotypic Coefficient of Variability.
++ = Phenotypic Coefficient of Variability.
*, ** = Significant at 5 % and 1 % level, respectively.

**Table 2. Simple correlation coefficients of eight components of yield per plant in winter rapeseed (*Brassica napus*)**

| Trait | Days to maturity | Plant height (cm) | Branches/ plant | Pods/ plant | Seeds/ pod | Seed weight (g) | Harvest index (%) | Seed yield/plant (g) |
|---|---|---|---|---|---|---|---|---|
| Flowering duration | -0.136 | -0.335** | -0.126 | -0.020 | -0.089 | 0.363** | 0.191 | 0.238* |
| Days to maturity | | -0.313** | -0.019 | -0.138 | 0.147 | -0.217* | -0.040 | -0.077 |
| Plant height (cm) | | | -0.052 | -0.041 | 0.303** | -0.198* | -0.127 | 0.032 |
| Branches/plant | | | | 0.557** | -0.326** | 0.026 | -0.076 | -0.096 |
| Pods/plant | | | | | -0.196* | 0.140 | -0.117 | 0.106 |
| Seeds/pod | | | | | | -0.198* | 0.015 | 0.035 |
| Seed weight (g) | | | | | | | 0.236* | 0.432** |
| Harvest index (%) | | | | | | | | 0.573** |

*, **Significant at 5% and 1% level respectively.

**Table 3. Analysis of direct and indirect effects of eight characters on yield per plant in winter rapeseed (*Brassica napus*).**

| Trait | Direct effect | Indirect Effects | | | | | | | | Total indirect effect | Total effect |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Flowering duration | Days to maturity | Plant height (cm) | Branches/ plant | Pods/ plant | Seeds/ pod | Seed weight (g) | Harvest index (%) | | |
| Flowering duration | +0.076 | | 0.001 | -0.060 | 0.020 | -0.005 | -0.003 | 0.105 | 0.100 | +0.162 | +0.238 |
| Days to maturity | -0.015 | -0.011 | | 0.055 | 0.003 | -0.032 | 0.004 | -0.064 | -0.022 | -0.062 | -0.077 |
| Plant height (cm) | +0.177 | -0.026 | -0.015 | | 0.008 | -0.010 | 0.009 | -0.058 | -0.067 | -0.145 | +0.032 |
| Branches/plant | -0.164 | -0.010 | 0.000 | -0.010 | | 0.128 | -0.011 | 0.007 | -0.040 | +0.067 | -0.097 |
| Pods/plant | +0.230 | -0.002 | 0.001 | -0.008 | -0.091 | | -0.007 | 0.040 | -0.062 | -0.125 | +0.105 |
| Seeds/pod | +0.031 | -0.007 | -0.003 | 0.053 | 0.053 | -0.046 | | -0.058 | 0.007 | +0.080 | +0.031 |
| Seed weight (g) | +0.290 | 0.027 | 0.003 | -0.036 | -0.005 | 0.032 | -0.007 | | 0.124 | +0.142 | +0.432 |
| Harvest index (%) | +0.525 | 0.014 | 0.000 | -0.023 | 0.012 | -0.028 | 0.000 | 0.068 | | +0.048 | +0.573 |

Genotypic coefficient of variation was highest in plant yield (15.187) followed by flowering duration (10.95), whereas, phenotypic coefficient of variation was high for pods per plant (26.889) and seed yield (21.991). These results are in agreement with the results of Labana *et al*., (1980). Moreover, Ali (1985) also found high genotypic and phenotypic variances for pods per plant and plant height.

Broad sense heritability estimates ranged from 0.099 (branches/plant) to 0.903 (days to maturity). For most of the traits the heritability estimates were low due to larger phenotypic variances indicating great environmental influence. Highest heritability of 0.903 was obtained for days to maturity followed by days to flowering (0.662), seed weight (0.548) and seed yield per plant (0.477). To predict the selection effects precisely, heritability accompanied with genetic advance is more useful than heritability alone (Johnson *et al.*, 1955). Therefore, genetic advance was also computed as percentage of mean. The results indicated that maximum genetic advance of 21.60% followed by 18.37% was recorded in seed yield/plant and days to flowering, respectively. Moderate heritability of seed weight (0.548) and seed yield (0.477) coupled with high genetic advance indicates the presence of additive gene effects, hence their improvement can be done through mass selection. These results confirm the findings of Singh & Singh (1997) and Sheikh *et al*., (1999).

Highly significant and positive correlations of seed yield per plant with harvest index (0.573) and seed weight (0.432) were found. Flowering duration was also significantly correlated (0.238) with seed yield (Table 2). Seed yield per plant was negatively and non-significantly correlated with days to maturity and branches per plant; this is in agreement with Masood *et al.* (1999). Branches per plant also showed medium and highly significant correlation (0.557) with pods per plant and negative but highly significant correlations with seeds/pod (-0.326). Correlations of seed weight with harvest index and flower duration and plant height with seeds per pod were also positive and significant. Since the simple correlation coefficients did not give clear information about the interrelationship between the causal and resultant variables, the correlation coefficient estimates were partitioned into direct and indirect effects to establish the intensity of effects of independent variables on dependent one.

The data presented in Table 3 revealed that the direct effect of harvest index on seed yield was highest and positive (0.525) followed by seed weight (0.290) and pods per plant (0.230). The direct effect of seeds per pod on plant yield was less but positive. Masood *et al*., (1999) also reported the same results in rapeseed. The positive direct effect of harvest index on yield per plant established in this study supports the statement of Djakov (1982) that the breeding for increased harvest index remains the most effective method of breeding for high yield.

The path coefficient analysis further indicated that the positive direct effect of harvest index was masked by the negative indirect effect of plant height (-0.023) and pods per plant (-0.028), whereas the positive and direct effect of seed weight was also masked by some other characteristics including plant height (-0.036), branches per plant (-0.005) and seeds per pod (-0.007). The data further indicated that the total positive effect of harvest index (0.573) on yield per plant was the result of positive and indirect effect of seed weight (0.068) and flower duration (0.014) and branches per plant (0.012). However, the total positive effect of seed weight (0.432) seemed to be due to positive indirect effect of harvest index (0.124). The direct effect of pods per plant followed by plant height was (0.230) and (0.177), respectively on plant yield. Ali *et al*., (2002) and Shalini *et al*., (2000) found similar results in Indian mustard reporting highest direct effect of pods per plant and seed weight on yield per plant.

Negative direct effects on plant yield were exhibited by days to maturity and branches per plant with values of -0.015 and -0.164, respectively. The corresponding correlation coefficients of these two traits on plant yield were also with negative direction. A further perusal of the Table-3 revealed that the total positive effect of flowering duration (0.238) on yield per plant was ascribed due to positive indirect effect of seed weight (0.105) and harvest index (0.100). In the study the highest positive indirect effect of flowering duration (0.162) and seed weight (0.142) were realized on plant yield. As Donald (1962) emphasized the importance of harvest index, hence its use can be a criterion for indirect selection for high yield in rapeseed.

By comparing the correlation coefficients values of eight independent variables against the yield per plant, significant differences became evident. Harvest index and seed weight had highly significant association with plant yield. By partitioning the mutual relationship among the independent variables into direct and indirect effects on yield, it came into account that harvest index and seed weight were the only characteristics that exhibited the highest direct effect on yield per plant. Therefore, both these traits seem to be a good selection criteria to improve seed yield of winter type rapeseed.

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