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GENETIC VARIABILITY, CORRELATION AND PATH ANALYSIS OF YIELD AND ITS COMPONENTS IN WINTER RAPESEED (*BRASSICA NAPUS L.)*

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Abstract

Twenty-five winter type rapeseed genotypes selected from diverse germplasm were studied to estimate heritable variation, correlation among yield and yield components and effective selection criteria to improve yield. The genotypes differed significantly for all the traits studied. Genotypic and phenotypic variances were high for pods per plant and plant height, whereas the highest genotypic and phenotypic coefficients of variability were found for seed yield and pods per plant, respectively. Broad sense heritability ranged from 0.146 (seeds per pod) to 0.488 (seed yield). Moderate heritability of seed yield and seed weight coupled with high genetic advance indicated that improvement could be done through mass selection for these traits. Seed yield was positively correlated with all the yield components. Plant height has also shown positive correlation with branches per plant, pods per plant and seeds per pod. Path coefficient analysis indicated that pods per plant, seeds per pod and seed weight have considerable direct positive effect on seed yield. Pods per plant has also shown positive indirect effect for all the yield components.

Introduction

Rapeseed and mustard has recently been exploited as an edible oil crop in Iran and the Government is keenly interested to boost up the production of this crop. A large number of genotypes, both winter and spring types, have been introduced from diverse sources of the world. So there is a great scope to enhance the yield potential through selection and breeding local varieties.

Presence of genetic variability, inter-relationship and heritability of the characters provide an opportunity to the breeders to select an ideal genotype directly or through indirect selection of a specific trait. Labana *et.al.*, (1980) reported high genotypic and phenotypic variances for plant height in Indian mustard with high estimates of coefficient of variability for seed yield and seeds per pod. Ali (1985) reported high genotypic and phenotypic variances for pods per plant and plant height, but highest genotypic and phenotypic coefficient of variability were obtained for seed weight. He also reported high heritability coupled with high genetic advance for seed weight and pods per plant, whereas correlations of seed yield with plant height, branches per plant and pods per plant were positive and significant. Sandhu & Gupta (1996) found positive and significant correlations of seed and oil yield with plant height, primary branches and pods per plant, but days to 50% flowering and seed weight exhibited a negative correlation with yield. High heritability estimates associated with high genetic advance for plant height, pods per plant and seed yield were also found by Singh & Singh (1997). They also reported

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greatest direct and positive effect of pods per plant, seeds per pod and seed weight on seed yield. Khulbi & Pant (1999) indicated positive correlations of seed yield with pods per plant, pod length, seeds per pod, 1000-seed weight and harvest index in Indian mustard. Path coefficient analysis revealed that all these characters are important to influence the yield directly or indirectly. For high seed yield selection of plant height, secondary branches and 1000-seed weight is recommended by Surender *et al.*, (1999). Sheikh *et al.*, (1999) indicated high heritability estimates coupled with high genetic advance for seed yield / plant, secondary and primary branches / plant, pods / plant and 1000-seed weight in *Brassica campestris* genotypes. They also reported positive genotypic and phenotypic correlations of all these characters with seed yield / plant. Larik & Rajput (2000) reported strong positive correlation of seed yield with plant height, branches per plant, pods per plant and seeds per pod in both *B. juncea* and *B. napus* species. Path analysis indicated that all the traits contributed signficantly towards seed yield per plant. They found that branches per plant and pods per plant are the most important yield components which could be used as selection criteria for yield improvement. High correlation of seed yield with all the yield components were also found in Indian Mustard (Shalini *et al.*, 2000). They also revealed that number of pods had the highest direct effect on seed yield followed by seed weight and primary branches per plant suggesting that the selection should be made for these traits to improve the seed yield in Indian Mustard.

The present studies were carried out to estimate the heritable variation, correlation among yield and yield components, effective selection criteria for high yield in winter type rapeseed and its utilization in recently developed rapeseed breeding programme in Iran.

Materials and Methods

Twenty-five winter type rapeseed (*Brassica napus*) genotypes selected from the available diverse germplasm (introductions from France, Germany, Denmark and Sweden) were evaluated for genetic parameters at Seed and Plant Improvement Institute (SPII), Karaj-Iran. These genotypes were planted in a randomized complete block design with four replications. Four rows of five meter length were planted for each genotype with a row spacing of 30 cm. Recommended dose of fertilizers was applied. The experiment was maintained according to the recommended cultural practices.

At maturity five plants were randomly selected from each entry in each replication and the data for plant height, branches per plant, pods per plant, seeds per pod, seed weight and seed yield were recorded. Genetic parameters like genotypic variance (GV), phenotypic variance (PV), genotypic coefficient of variability (GCV), phenotypic coefficient of variability (PCV), broad sense heritability (H^2) and expected genetic advance (ΔG) were computed according to Burton & Devane (1953). Genetic advance was calculated on 5% selection intensity basis whereas, the correlations among yield components and path coefficient analysis were calculated according to Singh & Chaudhary (1979).

Table 1. Range, means and mean squares of yield and yield components in winter rapeseed.

Trait	Range	Means	Mean Squares
Plant Height (cm)	149.00 – 176.50	162.69	221.74**
Branches/plant	4.33 – 7.38	5.79	2.01**
Pods/plant	118.00 – 220.00	149.06	2483.76**
Seeds/pod	15.00 – 25.35	20.92	27.29*
Seed Wt. (mg)	2.77 – 4.05	3.27	0.36**
Seed Yield (g/plant)	3.29 – 7.15	3.15	1.35**

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

Table 2. Genetic parameters of yield and yield components of winter rapeseed.

Trait	Genotypic variance	Phenotypic variance	GCV*	PCV**	Broad-sense heretability	Genetic advance (% of mean)
Plant Height	36.29	112.86	3.70	6.53	0.322	4.33
Branches/plant	0.30	1.12	9.38	18.28	0.263	9.91
Pods/plant	331.78	1488.41	12.22	25.88	0.223	11.88
Seeds/pod	2.77	18.98	7.95	20.82	0.146	6.25
Seed Wt.	0.07	0.15	8.09	11.85	0.466	11.39
Seed Yield	0.27	0.55	16.47	23.57	0.488	23.71

* Genotypic Coefficient of Variability

** Phenotypic Coefficient of Variability

Results and Discussion

The genotypes differed significantly for all the traits studied, indicating the presence of sufficient genetic variation for effective selection to identify the superior genotypes (Table 1). Seed yield ranged from 3.29 to 7.15 g/plant and the highest seed yield was obtained by a genotype Ebonite with the highest number of branches per plant (7.38) and pods per plant (220). Maximum plant height of 176.5 cm was recorded in genotype Embleme, whereas number of seeds per pod (25.35) and seed weight (4.05 mg) were the highest in Modina and Regent x Cobra, respectively.

Genotypic and phenotypic variances were high for pods per plant (331.78 & 1488.41) and plant height (36.29 & 112.86) (Table 2). There were large differences among genotypic and phenotypic variances for almost all the traits indicating the influence of environment. Genotypic coefficient of variability was highest for seed yield (16.47) followed by pods per plant (12.22) and branches per plant (9.38) whereas, the phenotypic coefficient of variability was high for pods pèr plant (25.88) followed by seed yield (23.57). These results are in agreement with Labana *et al.*, (1980) who reported high genotypic and phenotypic variances for plant height with high estimates of coefficient of variability for seed yield per plant in mustard. Ali (1985) also observed high genotypic and phenotypic variances for pods per plant and plant height with high estimates of coefficient of variability for pods per plant and seed weight.

Broad sense heritability estimates were low due to larger phenotypic variances indicating a great environmental influence. Heritability estimates ranged from 0.146 to 0.488. Highest heritability of 0.488 was obtained for seed yield closely followed by seed weight (0.466). Plant height, branches per plant and pods per plant showed heritability of 0.322, 0.263 and 0.223, respectively. Low heritability of seeds per pod indicated that this trait has more environmental influence. Heritability accompanied with genetic advance is more useful than heritability alone for predicting the selection effect (Johnson *et al.*, 1955). Therefore genetic advance as a percentage of mean was also computed in these studies. The results in Table 2, indicated that maximum genetic advance of 23.71% was obtained for seed yield followed by pods per plant (11.88%) and seed weight (11.39%). Moderate heritability of seed yield and seed weight coupled with high genetic advance indicates that additive gene effects are more important and the improvement can be done through mass selection for these traits. This confirms the findings of Ali (1985), Singh & Singh (1997) and Sheikh *et al.*, (1999) who observed high heritability associated with high genetic advance for seed weight and pods per plant. Moderate heritability for plant height (0.322) associated with low genetic advance (4.30%) indicates that non additive gene effects are more important and mass selection on phenotypic value may not be much effective to improve this trait.

Genotypic correlations were higher than phenotypic correlations and most of the phenotypic correlations among yield components were positive but non significant (Table 3). Seed yield was positively correlated with all the yield components studied. Positive and significant genotypic correlations of seed yield were found with pods per plant (0.793), branches per plant (0.605), seeds per pod (0.510), seed weight (0.431) and plant height (0.430). Plant height has also shown positive and significant genotypic correlation with branches per plant (0.444), pods per plant (0.553) and seeds per pod (0.416). Similar results have been reported by Ali (1985), Singh & Singh (1997) and Shalini *et al.*, (2000) who found positive and significant associations of seed yield with branches per plant, pods per plant and seeds per pod in Indian mustard. However, the results don't agree with Sandhu & Gupta (1996) who reported negative correlation between seed yield and seed weight. Branches per plant have shown a strong correlation with pods per plant both at genotypic and phenotypic levels indicating less environmental effect on this association. Correlation between seeds per pod and seed weight was also significant but it was negative. These results also agree with the finding of Ali (1985) in mustard.

Table 3. Genotypic and phenotypic correlation coefficients among yield and yield components in winter type rapeseed.

Trait		Plant height	Branches/ plant	Pods/ plant	Seeds/ pod	Seed wt.	Seed yield
Plant Height	G	1.000	0.444**	0.553**	0.416**	0.078	0.430**
	P	1.000	0.208	0.188	-0.088	-0.020	0.113
Branches/plant	G		1.000	0.742**	0.248*	0.438**	0.605**
	P		1.000	0.746**	0.058	0.163	0.408**
Pods/plant	G			1.000	0.240*	0.131	0.793**
	P			1.000	0.049	0.072	0.395**
Seeds/pod	G				1.000	-0.325**	0.510**
	P				1.000	0.068	0.305**
Seed Wt.	G					1.000	0.431**
	P					1.000	0.321**

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

Table 4. Direct and indirect effect of yield components in winter rapeseed based on genotypic correlations.

Trait	Plant height	Branches/ plant	Pods/ plant	Seeds/ pod	Seed wt.	Seed yield
Plant Height (cm)	-0.322	-0.333	0.668	0.345	0.070	0.430
Branches/plant	-0.143	-0.749	0.897	0.205	0.392	0.605
Pods/plant	-0.178	-0.556	1.209	0.199	0.116	0.793
Seeds/pod	-0.134	-0.186	0.290	0.829	-0.291	0.510
Seed Wt. (mg)	-0.026	-0.329	0.157	-0.270	0.895	0.431

Path coefficient analysis based on genotypic correlations indicated that pods per plant, seeds per pod and seed weight have considerable direct positive effect on seed yield, whereas, plant height and branches per plant showed negative direct effect (Table 4). Positive direct effect of pods per plant, seed weight and seeds per pod on seed yield along with a significant positive correlation with seed yield suggests that these characters could be a good selection criteria to improve seed yield. Plant height and branches per plant also showed significant positive correlation with seed yield but the direct effect on seed yield was negative. Hence, these characters may not be an effective selection criteria for yield improvement. These results confirm the findings of Singh & Singh (1997) who reported greatest direct and positive effect of pods per plant, seeds per pod and seed weight on seed yield in Indian mustard. Khulbi & Pant (1999) also suggested that pods per plant, pod length, seed weight, seeds per pod and harvest index are the major characters influencing the seed yield directly or indirectly. Larik & Rajput (2000) and Shalini *et al.*, (2000) also found similar results suggesting that pods per plant and branches per plant are the best selection criteria to improve yield in *B. juncea*.

Pods per plant showed maximum positive direct effect along with positive indirect effect for all the yield components, which was considerably high for plant height and branches per plant. Therefore this trait should be given more emphasis to achieve maximum gain through selection.

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