Genetic Variability for Seedling Traits in Indian Mustard under Moisture Stress Conditions

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Eighty advanced progenies of Indian mustard derived from interspecific hybridization along with four check varieties were evaluated in an Augmented Randomized Complete Block Design with five blocks during *rabi* 2008-09. The data were subjected to obtain estimates of variability, heritability and genetic advance and correlations for different seed and seedling characteristics. Adequate variability was present for seed yield per plant, oil content, germination percentage, shoot length, root length, seedling elongation, fresh seedling weight and vigour index. Broad sense heritability was high (>50%) for all these characters. The seed yield per plant had positive and significant correlation with test weight, root length, seedling elongation and vigour index. On the basis of this study, it is suggested that test weight, root length, seedling elongation and vigour index should be considered in selection programme for yield improvement in the segregating material generated by using selected advance lines.

Key Words: Indian mustard, Vigour index, Heritability, Correlations

Introduction

Indian mustard [*Brassica juncea* (L.) Czern and Coss] is cultivated in a wide range of agro -climatic conditions. The productivity of this crop is low as it is normally grown on marginal and light texture soil using conserved moisture received from monsoon rains in about 37% of the total area under the crop. Depending on planting time and winter rain, the crop is exposed to water stress at one or more phenological stages when stored water becomes depleted (Kumar, 2001). This calls for screening and development of genotypes having good plant stand and vigour under prevailing environmental conditions because farmers with no or limited irrigation facilities opt for rapeseed-mustard as a crop, however, many times poor plant stand owing to poor germination due to limited moisture and/or mortality of seedling due to high temperature causes heavy losses in terms of yield (Kumar *et al.*, 1995). Ensuring good plant stand under prevailing condition is the biggest challenge to the *Brassica* researchers. The seed size, seed weight and vigour index influences the crop stand by ensuring germination and survival of seedling through supply of nutrients to the growing seedlings under field conditions (Gontia and Awasthi, 1999). Seedling vigour determines the ability of nutrient uptake from soil; thereby enhances the vegetative growth under adverse environmental conditions (Kant and Tomar, 1995). Deep root and long shoot are important survival traits under moisture stress. Therefore, it is important to design genotypes having deep root, and high vigour index. The information on genetic variability for seed and seedling traits and character association between these traits is scanty in Indian mustard. Therefore, the present investigation was planned to get information on these aspects.

Materials and Methods

The material for present investigation consisted of 80 advanced progenies of Indian mustard derived from inter-specific crosses between *Brassica juncea* x *B. carinata.* These progenies were evaluated during *rabi* 2008-09 in an Augmented Randomized Complete Block Design (Fedrer, 1956). The material was divided into five blocks, each block consisted of 16 progenies and 4 check varieties, namely, RH–819, PBR–97, Varuna and Rohini which were common to each block. In each block progenies and check varieties were sown in two row plots of 5 m length, spaced 30 cm apart with plant to plant distance of 10 cm achieved by thinning at 15-20 days after sowing. The experiment was conducted under rainfed condition and no presowing irrigation was given even for germination. Observations were recorded on ten randomly selected plants for seed characters. Oil and protein content were estimated by using Near Infrared Reflectance Spectroscopy apparatus. The laboratory experiment for study of seedling traits, *viz.* seed germination percentage, shoot length, root length, seedling elongation (cm), fresh seedling weight (mg) and vigour index was carried out in Petri dishes (9 cm diameter) by using the same seed lot as used for seed traits. 50 seeds of each genotype were placed in Petri dish with four replications, lined with two layers of Whatman filter paper (ISTA, 1985). Distilled water was applied to each petri dish for germination and recording of other seedling observations. The whole set

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of Petri dishes were kept in BOD incubator at 25^{o}C and 75 % RH for germination. Seeds with radical emergence of 2 mm length were counted for germination (Lang, 1965). Daily germination was recorded up to 7 days. Observations for seedling traits were recorded on ten randomly selected seedlings from each replication after 7 days. Vigour index was calculated by using the formula: VI = Germination (%) x (Root + Shoot length). Genotypic and phenotypic coefficient of variations, heritability in broad sense and genetic advance were calculated as per standard procedure. The simple correlation studies were carried out among the seed and seedling traits to know the relationship among the traits.

Results and Discussion

The varieties released so far, though have shown marked superiority over local types under irrigated conditions, could not make a desired impact under rainfed condition particularly in the arid and semi-arid zones and this perhaps is one of the major factor for poor adoption of the newly released varieties by resource poor farmers with limited irrigation facilities. Genotypes are generally developed and tested under the best agronomic conditions, the conditions which hardly prevail at farmers field (Meena *et al*., 2008). The varieties developed and recommended for cultivation should, therefore, possess besides high yield, the traits which ensure stability under diverse set of conditions. Assessment of genetic variability for quantitative traits is the first step in any breeding programme and presence of adequate genetic variability indicates about the possibility of the genetic improvement in crop species, as genetic variability is directly related to advancement that can be made by selection.

Analysis of variance revealed significant differences among progenies for most of the characters except protein content and test weight. This indicated that material had sufficient variability for these traits and response to selection may be expected in the breeding programme for seed yield and seedling traits, which may be used for further improvement. The block effects were non significant for all seedling traits except germination percentage indicating non-sensitivity of the material to the environment for these characters (Table not presented).

Estimates of genotypic and phenotypic variances indicated that in general, magnitude of the PCV was higher as compared to GCV for all the characters in the present investigation indicating a positive effect of environment on the character expression. The variances of various characters were compared on the basis of coefficient of variation. Seed yield per plant followed by root length exhibited comparatively higher estimates of genotypic as well as phenotypic coefficient of variation (Table 1). It indicated that simple selection for root length might be advantageous. These results were in agreement with earlier reports of Das *et al.* (2001) and Singh *et al.* (2007). In an augmented design, it is assumed that the estimate of error variance is inflated and thus may not check the variation among genotypes with precision. With the help of GCV and PCV alone, it is not possible to determine the amount of variation, which is heritable. Thus, the heritability estimate along with genetic advance is more meaningful.

Since, in augmented design only the error variance of check varieties could be subtracted from the variance of genotypes a portion of it may be confounded with the genotypic variance used for calculating the heritability, therefore, caution should be exercised in interpreting the estimates of heritability values as they represent only the upper limit of heritability. The estimates of heritability in present investigation were of higher magnitude (>50%) for all the characters studied. Similar reports were made by Swarnker *et al.* (2002) and Meena *et al.* (2008).

The genetic advance was highest for seed yield per plant followed by root length, seedling elongation and fresh seedling weight. These findings indicate that there is good scope for development of genotypes having deep root system, high seed yield per plant and high shoot length, which would perform better in water stress conditions. High heritability values accompanied with high genetic advance were observed for root length and fresh seedling weight. Similar reports of high heritability with high genetic advance for these characters were made by Meena *et al.* (2008). This indicates that selection will be more effective for these characters in comparison to other.

The correlation coefficients based on mean values of seed and seedling characters are presented in Table 2. Seed yield per plant showed positive and significant correlation with root length, test weight, seedling elongation and vigor index. Therefore, high yielding genotypes can be developed with deep root and fast growing seedling traits for efficient use of scarce water resource. The result of present investigation is in accordance with the report of Sikarwar *et al.* (1997) and Meena *et al.* (2008). 1000-seed weight was found to be positively and significantly associated with shoot length and fresh seedling weight while negatively associated with oil content; this indicated that bolder seeds had thicker seed coat (Sharma and

Table1. Overall mean value of progenies, their range, genotypic and phenotypic coefficients of variation, heritability in broad sense and genetic advance as percentage of mean for seed and seedling traits in Indian mustard

Character	Mean	Range	Genotypic coefficient of variation (GCV)	Phenotypic coefficient of variation (PCV)	Heritability in broad sense (%)	Genetic advance as percentage of mean
Seed yield per plant (g)	8.10	4.14-16.12	18.43	22.52	66.96	31.07
*Test weight (g)	3.81	2.23-4.42	–	–	–	–
*Protein content (%)	19.61	17.61-21.03	–	–	–	–
Oil content (%)	42.93	40.75-44.89	1.31	1.74	57.14	2.05
Germination percentage	93.47	86.25-99.25	2.72	3.32	57.43	3.93
Shoot length (cm)	4.63	3.66-5.94	8.08	9.41	73.68	14.28
Root length (cm)	8.74	5.28-13.39	12.10	14.65	68.29	20.61
Seedling elongation	13.37	10.17-18.77	9.22	10.73	73.78	16.31
Fresh seedling weight (mg)	52.22	38.82-68.01	9.12	9.79	86.82	17.52
Vigour index	12.49	8.68-16.29	8.28	10.37	63.69	13.61

*As mean sum of squares were non significant for this characters, genetic parameters could not be estimated

Table 2. Correlation coefficient on the basis of unadjusted values (phenotypic level) between different characters of Indian mustard

Characters	Seed yield per plant (g)	Test weight (g)	Protein content (%)	Oil content (%)	Germination percentage	Shoot length (cm)	Root length (cm)	Seedling elongation	Fresh seedling weight (mg)
Test weight (g)	0.234*								
Protein content (%)	0.032	-0.068							
Oil contents (%)	-0.077	-0.044	-0.301**						
Germination Percentage	-0.057	0.148	-0.231*	0.261*					
Shoot length (cm)	-0.006	0.228*	-0.188	0.100	0.089				
Root length (cm)	0.286**	0.014	-0.259*	-0.111	-0.299**	0.264*			
Seedling elongation	0.273*	0.082	-0.283**	-0.067	-0.233*	0.540**	0.954**		
Fresh seedling weight (mg)	0.050	0.223*	-0.048	0.053	-0.190	0.262*	0.301**	0.343**	
Vigour index	0.256*	0.130	-0.360**	0.011	0.062	0.577**	0.890**	0.956**	0.296**

*Significant at p= 0.05, ** Significant at p= 0.01

Singh, 1994). Thicker seed coat reduces the oil percent and increases the fibre content of seed meal. Therefore, genotypes with medium seed size have to be selected for maximizing the oil production/unit. Oil content revealed significant positive correlation with germination percent. Similar result was earlier obtained by Swami and Bajaj (1988) and Ozer and Dogru (1999). Shoot length had positive and significant correlation with seed yield, root length, seedling elongation, and fresh seedling weight and vigour index as earlier reported by Sharma and Singh (1994). Seedling elongation revealed significant and positive correlation with seed yield, shoot length, fresh seedling weight and vigour index (Kant and Tomar, 1995).

Protein content showed negative correlation with all the characters under study except seed yield per plant. Similarly, oil content exhibited negative correlation with seed yield per plant, protein content, root length, and seedling elongation. Germination percentage also showed negative correlation with seed yield per plant, protein content, root length, seedling elongation and fresh seedling weight. Adams (1967) had shown that component compensation and negative correlation arise in response to competition between developmentally flexible components.

Association between some characters was non significant which implies that the two variables are not linearly related on these two may be related but in a non linear fashion (Gomez and Gomez, 1980). It was also noted that characters which exhibited positive association with seed yield per plant also exhibited positive association among themselves thus these characters could be simultaneously improved to increase the seed yield.

The conclusion from present study indicated that root

Table 3. Selected advance breeding lines with desirable seed and seedling characteristics

Progeny	Seed yield per plant (g)	Test weight (g)	Protein content (%)	Oil content (%)	Germination percentage	Shoot length (cm)	Root length (cm)	Seedling elongation	Fresh seedling weight (mg)	Vigour index
08-537-40	16.12	3.91	19.65	41.66	92.25	4.97	9.76	14.73	56.40	13.57
08-541-44	14.47	3.32	19.70	42.45	90.00	5.04	10.01	15.05	53.93	13.60
08-538-41	14.12	4.06	20.15	42.38	96.25	5.10	10.69	15.79	52.28	15.14
08-553-57	12.57	4.42	19.92	42.00	92.00	4.75	9.11	13.86	66.08	12.77
08-548-52	10.77	3.68	19.92	42.82	92.00	4.20	7.77	11.97	43.39	11.00

length, seedling elongation and vigour index are most important characters that should be considered in selection procedure because all these characters had high heritability, moderate genetic advance and also exhibited positive association with seed yield ultimately these characters would result in enhancement of yield in moisture stress conditions having variable moisture regimes. On the basis of present experimentation, the advanced breeding lines with the characters necessary for developing stable high oil yielding lines for variable moisture regimes are presented in Table 3. These lines may be used in crossing programme to select desirable segregants.

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