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Genetic Variability for Seed and Seedling Traits in the Advance Breeding Lines of Indian Mustard [*Brassica juncea* (L.) Czern & Coss]

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ABSTRACT: Forty five genotypes including six well adapted cultivars and thirty nine advance breeding lines of Indian mustard were evaluated to assess genetic variability for seed and seedling traits. The material showed considerable variability for majority of traits as indicated by genotypic coefficient of variation. High genetic variability was found for seed yield, root length, fresh seedling weight, vigour index, seedling dry weight, shoot length and 1000-seed weight. Broad sense heritability and genetic advance were also found high for root-shoot ratio, fresh seedling weight, root and shoot length, 1000-seed weight and vigour index. Correlation studies revealed positive and significant association of above traits with seed yield. It can therefore be concluded from present study that there exist sufficient scope for yield improvement through selection of 1000-seed weight, root length, root-shoot ratio, fresh seedling weight and vigour index in the segregating material generated by using selected advance lines.

Key words: Indian mustard, root-shoot ratio, vigour index, genetic variability

Among *Brassica* oil seed crops, Indian mustard [*B. juncea* (L.) Czern and Coss] is most important crop in India. It is grown under a wide range of climatic conditions with low inputs on marginal and sub-marginal lands. 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 [1]. 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 [2]. Seedling vigour determines the ability of nutrient uptake from soil, thereby enhances the vegetative growth under adverse environmental conditions [3]. Deep root and long shoot are important survival traits under moisture stress. Therefore, it is important to design genotypes having deep root, high root-shoot ratio and high vigour index. The information on genetic variability and character association between seed and seedling traits with yield is scanty in Indian mustard. The present investigation is an attempt in this direction to get information on these aspects.

MATERIALS AND METHODS

The materials for the present investigation consisted of forty five genotypes including thirty nine advance breeding lines and six cultivars (Rohini, Bio-902, Pusa bold, Kranti, Varuna and Vashundhra) of Indian mustard. These lines have been developed through inter-varietal and inter-specific crosses (*B. juncea, B. napus, B. carinata, B. campestris* and *B. nigra*) therefore, have very wide genetic base in respect to most of agro-morphological characteristics. The material was

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sown in CRBD with 3 replications during *rabi* 2006-07 at NRCRM, Bharatpur under preliminary yield trials. The plot size was of five rows plots of five meter length with row to row spacing at 30 cm and between plants at 15 cm. The seed lot used for conducting the preliminary yield trial was also used for assessing the seed and seedling traits. Observations were recorded on ten randomly selected plants for seed traits. Oil and protein content were estimated by using Near Infrared Reflectance Spectroscopy apparatus.

Data on seed coat was recorded by first drying the seeds in hot air oven for 24 hours at 50°C and then weighing. The seeds were then kept for germination on moist filter paper in Petri plates for two days to remove the seed coat. Seed coat of each seed was removed and collected by gently pressing the germinated seeds. The seed coat collected from at least 200 seeds was again oven dried for 24 hours and weighed. The seed coat as per cent of whole seed (by weight) was then calculated.

The seedling characteristics viz. germination, root and shoot length, root-shoot ratio, seedling fresh and dry weight and vigour index were studied in laboratory. The germination test and other seedling traits were recorded as per ISTA procedures [4]. Twenty five seeds of each genotype were placed on two layers of blotting paper in each Pelri dish (9 cm diameter) in three replications. Four ml of distilled water was then added to each Petri plate and kept in B.O.D. incubator at 25±1°C and 80±5 % RH for germination. Observation for seedling traits were recorded on ten randomly selected seedlings from each replication after seven days. Vigour index was calculated by using the formula; Vigour index - Germination (%) x (Root + Shoot length). Genotypic and phenotypic coefficient of variation, genetic advance and heritability in broad sense were estimated. The simple correlation studies were carried out among the seed and seedling traits to know the relationship among the traits.

RESULTS AND DISCUSSION

Poor adoption of the newly released varieties is one of many factors responsible for poor productivity of the crop. Genotypes are generally developed and tested under the best of agronomic conditions, the conditions which hardly prevails at farmer's field. Indian mustard is generally grown by the resource poor farmers with limited irrigation facilities. The varieties developed and recommended for cultivation should therefore posses besides high yield, the traits which ensures stability under diverse set of conditions. In any breeding programme, the presence of exploitable genetic variability for easily observable/ measurable traits is the key for success. The evaluated genotypes showed considerable variability for majority of traits under study except protein content, germination per cent, root-shoot ratio and seedling dry weight (Table 1). This suggests that the material has adequate variability and response to selection may be expected in the breeding programme for seed yield. Estimates of genotypic and phenotypic coefficient of variations showed that the phenotypic variations were higher than genotypic variations, indicating the role of environmental factors on the character expression. The seed yield, 1000-seed weight, root length, seedling fresh weight and vigour index showed highest variability. Similar results of significant variability for different traits in Indian mustard were reported by earlier researchers [5].

The broad sense heritability (%) estimates were of higher magnitude for 1000-seed weight (68.6), seed coat as per cent of whole seed (65.1), root length (58.5), root-shoot ratio (77.5), seedling fresh weight (73.1) and vigour index (68.6). For these traits similar reports were made by Uddin *et al.* [6], and Sawerker *et al.* [7] in *B. juncea.*

The root length (56.7), root-shoot ratio (68.5) and vigour index (46.1) has high genetic advance coupled with high heritability. The findings indicates that there is good scope for development of genotypes having deep root system, high root-shoot ratio and high vigour index, which would perform better in water stress conditions. The high genetic advance for these traits was also reported by Kumar and Sangwan [8] and Uddin *et al.* [6].

The correlation coefficients based on mean values of seed and seedling characters are presented in Table 2. Seed yield showed positive

Table 1. Mean ± Sem, range, CV(%), GCV, PCV, heritibility and genetic advance of advanced breeding lines of *B. juncea*

Character/parameter	Mean±Sem	Range	Genotypic coefficient of variation	Phenotypic coefficient of variation	Heritability (broad sense)	Genetic adv. as % of mean	CD
Seed yield/plant (g)	15.52±0.58	10.0-22.0	37.26	95.31	15.29	30.01	1.654**
Test weight (g)	4.48±0.15	2.85-6.24	18.40	22.22	68.59	31.40	0.183*
Oil content	40.02±0.21	37.36-43.09	2.47	3.71	44.19	3.38	3.262*
Protein (%)	20.50±0.12	18.71-21.33	2.67	3.91	46.78	3.77	NS
Seed coat as % of whole seed	18.45±0.32	14.85-22.25	8.78	10.89	65.10	14.60	1.164**
Germination %	97.89±0.16	95.33-99.33	0.54	1.41	14.74	0.43	NS
Shoot length (cm)	5.12±0.14	3.72-6.58	13.46	22.42	36.02	16.64	0.553*
Root length (cm)	7.55±0.55	2.21-5.48	35.98	47.04	58.50	56.69	0.963**
Root-shoot ratio	1.45±0.09	0.57-2.05	37.76	42.89	77.50	68.47	NS
Fresh seedling weight (g)	3.95±0.21	2.07-6.22	27.07	31.66	73.12	47.69	0.326**
Dry seedling weight (g)	0.29±0.01	0.17-0.43	20.87	43.15	23.40	20.80	NS
Vigour index (%)	12.36±0.65	5.82-19.42	27.02	32.64	68.56	46.09	1.158*

*.**:indicating significant value at 5% and 1% level of significance, respectively

and significant correlation with 1000-seed weight, root length, root-shoot ratio and vigour index [9]. Hence, high yielding genotypes can be developed with deep root and fast growing seedling traits for efficient water use. 1000-seed weight was positively and significantly associated with seed yield and seed coat as per cent of whole seed and showed no association with oil content. However, Gupta *et al.* [10] and Dubey *et al.* [11] have indicated negative correlation between thousand seed weight and oil content. In our study, it was found that seed coat though have contributed significantly toward increased seed weight, it has hardly any relevance for plant stand establishment and oil content. However, measurement of seed coat offer an opportunity to select for the genotype in which increase in seed weight is not because of seed coat.

Seedling traits viz. shoot and root length, root-shoot ratio, seedling fresh and dry weight and vigour index had positive and significant correlation with each other. Root length, root-shoot ratio and vigour index had positive correlation with seed yield as earlier reported by Kant and Tomar [3]. The genotype with high root-shoot ratio is generally able to establish itself under limited moisture, a condition which a variety frequently encounter as the farmers uses the conserved moisture for raising the mustard crop. The vigour index exhibited positive and significant association with seed yield, test weight and all the seedling traits. It shows that vigour index as indicated by the present study not only helps in increased yield realization but also minimize the losses due to abiotic stresses by improving the stand establishment [1]. So for the selection of high seed and oil yielding genotypes

for *on farm* situation, vigour index and seed coat measurement are effective selection criterion which has easy application in the breeding programmes. Besides this, as vigour index does not have any correlation with seed coat per cent and oil content, it is quite feasible to combine these traits into a single genetic background by selective mating. On the basis of present experimentation, the advance breeding lines with the pedigree and characters necessary for developing stable high oil yielding for variable moisture regimes are presented in Table 3. These lines if involved in a crossing programme with diallel selective mating design can throw desirable segregants.

Table 2. Correlation coefficients among seed and seedling traits of advanced breeding lines of *B. juncea*

	Seed yield/ plant	1000 seed wt.(g)	Oil content (%)	Protein (%)	Seed coat as% of whole seed	Shoot length (cm)	Root length (cm)	Root-shoot ratio	Fresh seed-ling wt.(g)	Dry seed-ling wt.(g)
Test weight (g)	0.371*									
Oil content (%)	0.052	-0.011								
Protein (%)	0.293	-0.411	0.534**							
Seed coat as % of whole seed	0.213	0.325*	0.508**	0.192						
Shoot length (cm)	0.264	0.064	0.076	-0.036	0.063					
Root length (cm)	0.394*	0.068	0.193	0.008	0.775**					
Root-shoot ratio	0.750*	-0.295	-0.006	0.241	-0.059	0.532**	0.939**			
Fresh seedling weight (g)	0.180	-0.044	0.050	0.138	0.255	0.276	0.379*	0.340*		
Dry seedling weight (g)	0.156	0.158	0.112	-0.012	0.136	0.243	0.216	0.153	0.837**	
Vigour index	0.449**	0.362*	0.062	0.139	0.016	0.853**	0.988**	0.884**	0.376*	0.348*

*,**: indicating significant value at 5% and 1% level of significance, respectively

Table 3. Selected advance lines with desirable seed and seedling traits and their comparisons with the checks

Parentage	1000-seed weight	Oil content	Seed coat as % of whole seed	Root length	Root-shoot ratio	Vigour index
RN 490/PR8903	4.8	40.9	14.9	8.92	2.01	13.16
Rohini/Kranti	5.9	41.0	17.4	10.39	1.80	16.0
RH 819/Rohini	5.0	39.8	17.9	8.92	1.42	14.81
MDOC 43/NRCG 57	5.0	38.6	20.8	13.17	2.0	19.42
Chopka/B nigra	4.0	39.9	17.9	13.08	1.98	13.35
Kranti	3.5	39.3	20.8	7.97	1.69	11.36
Rohini	4.3	43.1	17.1	6.78	1.35	11.67

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