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Genetic variability, association and path analysis in Indian mustard (*Brassica juncea*)

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Abstract

Ninety diverse genotypes of Indian mustard [*Brassica juncea* (L.) Czern & Coss.] were evaluated for fifteen quantitative traits. Both phenotypic and genotypic coefficients of variation were higher for important traits including number of secondary branches/ plant, seed yield/ plant, and 1000-seed weight. High heritability in conjunction with high genetic advance were observed for seed yield/ plant, number of secondary branches/ plant, 1000- seed weight, number of seeds/ siliqua, primary branch angle, number of primary branches/ plant, siliqua angle, siliquae on main shoot, and siliqua length suggesting predominant role of additive gene action for expression of these traits. Seed yield/ plant was found to be positively and significantly correlated with number of primary branches/ plant, number of secondary branches/ plant, primary branch angle, main shoot length, siliqua length, and number of seeds/ siliqua; seed yield/ plant had negative association with oil content. Path analysis revealed that main shoot length, number of primary branches/ plant, number of seeds/ siliqua, and primary branch angle showed positive direct effect on seed yield/ plant which suggested that selection for number of primary branches/ plant, primary branch angle, main shoot length, number of seeds/ siliqua would be quite effective in improving seed yield in Indian mustard.

Key words: *Brassica juncea, genetic advance, genetic variability, heritability, path analysis*

Introduction

Indian mustard [*Brassica juncea* (L.) Czern & Coss.] is one of the most important oilseed crops of the country, and it occupies considerably large acerage among the *Brassica* group of oil seed crops. India stands second in both acreage and production of rapeseed and mustard in Asia. The crops are cultivated on an area of 6.51 million ha with a net production of 7.67 million tonnes, and an average yield of 1179 kg/ha (Anonymous, 2011). In India, mustard and rapeseed are grown largely in Uttar Pradesh, Rajasthan, Haryana, Assam, Gujarat, Punjab, West Bengal, and Madhya Pradesh. The success of any breeding programme depends upon the genetic variability engraved in the breeding material. The assessment of parameters including phenotypic and genotypic coefficients of variation, heritability in broad sense, and genetic advance as % of mean is a pre-requisite for making effective selection. Yield is a complex trait, polygenic in inheritance, more prone to environmental fluctuations than ancillary traits such as branches/ plant, seeds/siliqua, main shoot length, and 1000-seed weight. Understanding the association between yield and its components is of paramount importance for making the best use of these relationships in selection (Sarawgi *et al.*, 1997). The path coefficient analysis helps breeders to explain direct and indirect effects, and hence been extensively used in breeding experiments in different crop species (Ali *et al.*, 2003; Akbar *et al.*, 2003). The present investigation was undertaken to assess the genetic variability, trait association, and path coefficient analysis in Indian mustard.

Materials and Methods

Ninety diverse genotypes of Indian mustard (*Brassica juncea* L. Czern & Coss.) were grown at the research area of the Oilseeds Section, Department of Genetics & Plant Breeding, CCS HAU, Hisar during *rabi*, 2010-2011 in randomized block design with three replications within plot size of 1.5 x 5 m. The observations were recorded on five randomly selected plants for fifteen traits, including days to 50% flowering, days to maturity, plant height (cm), number of primary branches/plant, number of secondary branches/plant, primary branch angle, main shoot length (cm), number of siliquae on main shoot, siliqua density, arrangement of siliqua based upon angle from main shoot, siliqua length (cm), seeds/ siliqua, seed yield/ plant (g), 1000- seed weight (g), and oil content (%). The phenotypic and genotypic coefficients of variation (GCV and PCV), heritability in broad sense, genetic advance as % of mean, correlation coefficients at genotypic and phenotypic level, and path coefficient analysis computed using standard statistical methods.

Results and Discussion

Wide range of variation was observed for most of the traits like seed yield per plant, number of primary branches per plant, number of secondary branches per plant, primary branch angle, main shoot length, siliquae on main shoot, siliqua density, siliqua angle, siliqua length, number of seeds / siliqua, 1000- seed weight, and oil content (Table 1). Estimates of PCV and GCV were observed higher for various traits including number of secondary branches/ plant, seed yield, and 1000- seed weight. Similar findings were reported for different traits in Indian mustard by Singh (2004) and Yadava *et al.* (2011). The coefficient of variation doesn't offer the full scope of heritable variation. It can be determined with greater degree of accuracy when heritability in conjunction with genetic advance is studied. Hence, heritability and genetic advance are important parameters to study the scope of improvement in various characters through selection. High heritability estimates along with high genetic advance are more helpful in predicting the gain under selection than heritability estimates alone. In the present study, high heritability coupled with high genetic advance was observed for seed yield/ plant, number of secondary branches/ plant, 1000- seed weight, number of seeds/ siliqua, primary branch angle, number of primary branches/ plant, siliqua angle, siliquae on main shoot, and siliqua length. This indicated that improvement in these traits could be made by simple selection. Panse

Table 1: Estimates of genotypic (GCV) and phenotypic (PCV) co-efficient of variation, heritability (bs) and genetic advance (% of mean) for seed yield and component traits in Indian mustard

Characters	Mean	Range		GCV	PCV	Heritability (%)	Genetic advance (% of mean)
		Min.	Max.				
Days to flowering	53.3	44.0	59.0	5.6	6.1	83.8	10.6
Days to maturity	146.1	141.0	150.3	1.3	1.6	60.4	2.0
Plant height	2.2	1.8	2.5	5.3	7.1	56.4	8.2
No. of 1^0 branches/plant	4.5	3.1	7.4	17.7	20.5	74.6	31.4
No. of 2^0 branches/plant	15.0	10.1	32.1	35.6	36.6	94.6	71.3
Primary branch angle	31.7	18.0	45.9	16.6	17.9	86.4	31.8
Main shoot length	82.9	71.0	110.3	10.0	11.5	75.6	18.0
Siliquae on main shoot	49.9	38.3	83.7	15.5	17.4	85.0	28.6
Siliqua density	1.7	1.2	2.3	12.5	15.4	64.8	20.7
Siliqua angle	26.1	14.5	40.7	15.8	17.1	85.1	30.0
Siliqua length	4.4	3.4	6.1	12.2	13.2	85.2	23.1
No. of seeds/ siliqua	14.9	11.0	21.6	16.5	16.8	92.2	31.9
1000- seed weight	5.3	3.5	6.7	26.1	26.2	99.1	53.5
Oil content	39.4	36.8	43.2	4.1	4.3	88.4	7.9
Seed yield/plant	26.0	13.8	40.3	32.0	32.8	95.5	64.4

Table 2: Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients among seed yield and its component characters in Indian mustard

Characters	Days to flowering	Days to maturity	Plant height	No. of 1^0 branches /plant	No. of 2^0 branches /plant	Primary branch angle	Main shoot length	Siliquae on main shoot	Siliqua density	Siliqua angle	Siliqua length	No. of seeds/ Siliqua	1000 -seed Weight (g)	Oil content	Seed yield/ plant
Days to flowering	1.00	0.19	0.01	-0.08	-0.18	-0.02	-0.02	0.08	-0.11	0.07	0.05	0.02	0.26	-0.17	-0.02
Days to maturity	0.25*	1.00	0.20	-0.03	-0.16	-0.02	-0.06	-0.30	0.31	0.03	0.27	0.02	0.30	-0.03	0.18
Plant height	-0.01	0.08	1.00	0.24	-0.02	-0.04	0.07	0.01	0.02	0.22	0.06	-0.29	-0.10	-0.17	0.14
No. of 1^0 branches/plant	-0.06	-0.05	0.15	1.00	0.59	0.03	0.46	0.49	-0.17	0.04	0.16	-0.09	-0.17	-0.35	0.44**
No. of 2^0 branches/plant	-0.15	-0.09	0.01	0.52**	1.00	0.06	0.61	0.51	-0.10	-0.01	0.20	0.12	-0.23	-0.26	0.30*
Primary branch angle	-0.04	-0.03	-0.03	0.04	0.06	1.00	0.06	-0.07	0.12	-0.10	0.25	0.30	0.39	0.02	0.27*
Main shoot length	-0.01	-0.04	0.04	0.34**	0.53**	0.03	1.00	0.57	0.12	0.08	0.30	0.04	-0.19	-0.28	0.21*
Siliquae on main shoot	0.04	-0.21*	0.07	0.38**	0.44**	-0.05	0.47**	1.00	-0.73	-0.04	-0.02	0.20	-0.19	-0.23	0.17
Siliqua density	-0.06	0.19	-0.06	-0.13	-0.06	0.07	0.24*	-0.73*	1.00	0.09	0.26	-0.23	0.10	0.06	-0.04
Siliqua angle	0.06	0.06	0.14	0.03	0.01	-0.08	0.06	-0.03	0.05	1.00	0.05	-0.10	-0.27	-0.07	-0.08
Siliqua length	0.03	0.19	0.02	0.13	0.18	0.22*	0.22*	-0.03	0.19	0.03	1.00	0.18	0.32	-0.10	0.22*
No .of seeds/ siliqua	0.01	0.01	-0.21*	-0.06	0.13	0.27*	0.05	0.18	-0.16	-0.08	0.16	1.00	0.19	-0.07	0.32**
1000- seed weight	0.24*	0.23*	-0.07	-0.15	-0.21*	0.36**	-0.16	-0.17	0.08	-0.25*	0.30**	0.18	1.00	0.17	0.05
Oil content	-0.16	-0.02	-0.12	-0.28**	-0.24*	0.01	-0.23*	-0.19	0.06	-0.06	-0.09	-0.06	0.15	1.00	-0.30**
Seed yield/plant	-0.02	0.14	0.09	0.39**	0.29**	0.25*	0.21*	0.16	-0.03	-0.06	0.23*	0.30**	0.05	-0.28**	1.00

*,,** significant at p=0.05 and p=0.01, respectively

Table 3: Direct and indirect effects of different characters on seed yield in *Indian* mustard

Characters	Days to flowering	Days to maturity	Plant height	No. of 1^0 branches /plant	No. of 2^0 branches /plant	Primary branch angle	Main shoot length	Siliquae on main shoot	Siliqua density	Siliqua angle	Siliqua length	No. of seeds/ Siliqua	1000 seed Weight (g)	Oil content	rG (correlation coefficientswith seed yield)
Days to flowering	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.0011	0.00	-0.02
Days to maturity	0.03	0.15	0.03	-0.00	-0.02	-0.00	-0.01	-0.04	0.05	0.00	0.04	0.00	0.0446	-0.00	0.18
Plant height	0.00	0.02	0.09	0.02	-0.00	-0.00	0.01	0.00	0.00	0.03	0.01	-0.01	-0.0091	-0.01	0.14
No. of 1^0 branches/plant	-0.04	-0.01	0.12	0.51	0.29	0.01	0.23	0.24	-0.08	0.02	0.08	-0.04	-0.0846	-0.17	0.44
No. of 2^0 branches/plant	-0.00	-0.00	-0.00	0.01	0.01	0.00	0.01	0.01	-0.00	-0.00	0.00	0.00	-0.0026	-0.00	0.30
Primary branch angle	-0.00	-0.00	-0.01	0.00	0.01	0.14	0.01	-0.01	0.02	-0.01	0.03	0.04	0.0523	0.00	0.27
Main shoot length	-0.01	-0.04	0.04	0.27	0.36	0.03	0.58	0.33	0.07	0.05	0.17	0.02	-0.1054	-0.16	0.21
Siliquae on main shoot	-0.08	0.29	-0.01	-0.48	-0.49	0.07	-0.56	-0.97	0.71	0.04	0.02	-0.20	0.1830	0.21	0.17
Siliqua density	0.08	-0.22	-0.01	0.12	0.07	-0.08	-0.09	0.52	-0.71	-0.07	-0.18	0.15	-0.0675	-0.04	-0.04
Siliqua angle	-0.01	-0.00	-0.02	-0.00	0.00	0.01	-0.01	0.00	-0.01	-0.11	-0.01	0.01	0.0295	0.08	-0.08
Siliqua length	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.01	-0.00	-0.0037	0.00	0.23
No.of seeds/siliqua	0.01	0.01	-0.10	-0.03	0.04	0.11	0.01	0.07	-0.08	-0.04	0.06	0.36	0.0652	-0.02	0.32
1000seed weight	-0.01	-0.01	0.00	0.01	0.01	-0.01	0.01	0.01	-0.00	0.01	-0.01	-0.01	-0.0371	-0.01	0.05
Oil content	0.02	0.00	0.02	0.03	0.03	-0.00	0.03	0.02	-0.01	0.01	0.01	0.01	-0.0161	-0.10	-0.30

(1978) expressed that high heritability together with high genetic advance was an indicative of additive gene effects, and high heritability associated with low genetic advance was indication of dominance and epistatic effects. These results are in conformity with those obtained by Singh (2004), Muhammad *et al.* (2007), Acharya and Pati (2008), Singh and Singh (2010) and Yadava *et al. (*2011) in Indian mustard. In contrast to present results, Mahla (2003) reported high heritability estimates for days to flowering and oil content, whereas, Larik and Rajput (2000) reported low genetic advance for plant height and days to maturity. The variation in the findings of different studies could be ascribed to differences in environment, and also due to different material used.

In the present study, the genotypic correlation coefficients were higher in magnitude than their respective phenotypic correlation coefficients for most of the traits indicating the depression of phenotypic expression by the environmental influence. Seed yield/ plant was found to be positively and significantly correlated with number of primary branches/ plant, number of secondary branches/ plant, primary branch angle, main shoot length, siliqua length, and number of seeds/ per siliqua (Table 2). Such positive association of seed yield/ plant with primary branches/ plant, secondary branches/ plant, number of seeds/ siliqua was also observed by Ramanjaneyulu and Giri (2007), Verma *et al.* (2008), Singh and Singh (2010), and Singh *et al.* (2003) for main shoot length, and Malik *et al.* (2000) for siliqua length. However seed yield was negatively and significantly correlated with oil content. Similar findings were observed by Singh and Chowdhury (1983) in Indian mustard.

The estimates of correlation coefficient, although, indicate inter- relationship of different traits, but it does not furnish information on cause and effect. Under such situation path analysis helps the breeder to identify the index of selection. Main shoot length showed the highest positive direct effect on seed yield per plant (Table 3) followed by number of primary branches/ plant, number of seeds/ siliqua, and primary branch angle; these traits also showed positive and significant correlation with seed yield/ plant. Therefore, considering these traits as selection criteria will be advantageous in bringing improvement in Indian mustard. These results are in conformity with the findings of Shalini *et al.* (2000), Pandey and Singh (2005), and Verma *et al.* (2008). Days to maturity, although, showed positive direct effects on seed yield per plant, but had non-significant correlation which may have negative effects via other traits. Since oil content was negatively correlated and had negative direct effect on seed yield/ plant it implies that consideration of this trait for increasing oil content is also valuable. Thus, the material studied is of diverse nature and information emanated would help in designing the selection methodology which can further be used in the breeding programme for improvement of seed yield.

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