Journal of Oilseed Brassica, 13 (1) : 59-63, January 2022

Genetic variability analysis in different F_1 combinations in Indian mustard (*Brassica juncea* L)

Sharanjeet Kaur, Ravindra Kumar*, Vijay Singh and Saurabh Gupta

Mata Gujri College Fatehgarh Sahib, Punjabi University, Patiala 140406 Punjab, India
**Corresponding author: godwalravindra@gmail.com*
(Received: 19 December 2021; Revised: 25 December 2021; Accepted: 27 December 2021)

Abstract

The existence of genetic variability for the selection of improved genotypes is a crucial necessity for crop improvement program in Indian mustard (*Brassica juncea* L.) which is important to understand the relationship between attributes for effective indirect selection of traits. Five diverse parents were crossed in half diallel mating design and made 10 F_1 hybrids during winter 2019-2020. With the aim to study the genetic variability and correlation between traits among, these genotypes and their hybrids were evaluated. Study observed high PCV and GCV by siliquae/ plant. High heritability along with high genetic advance (GA) was observed for siliquae/ plant, biological yield/ plant and test weight (TW). At genotypic levels, it was revealed that harvest index (HI) had significant positive correlation with seed yield/ plant. Path coefficient analysis of yield traits contributing towards seed yield/ plant revealed high positive path coefficient in HI followed by biological yield/ plant and highly negative path coefficient exhibited in TW followed by siliquae/ plant.

Keywords: *Character, correlation, heritability, Indian mustard, variability*

Introduction

Indian mustard (*Brassica juncea* L.) is an important Rabi season crop extensively grown as under irrigated condition (Devi, 2018). Mustard is mainly grown in both tropical and temperate climates. Mustard crops need a temperature between 10^0C to 25^0C and are grown in areas where 625 mm-1000 mm annual rainfall is received (Reddy, 2015). Mustard is grown from sandy loam to clay loam soils in various soil types, but best on light loam soils. In water logging conditions, mustard crops do not grow in heavy soils and require soil pH 6.0-7.5 (Madhusoodanan *et al.*, 2016). The mustard seed contains carbohydrates of nutritious quality 4.51 g, 1.41 g sugar fibre 2 g, 0.47 g of fat and 2.56 g of protein/100 g. The volume of oil ranges from 37% to 49% (Bhownik *et al*. 2014, Barfa, 2016). The genetic heterogeneity present in the available germplasm of a particular crop determines the effectiveness of any breeding strategy, and the enhancement of a specific trait through selection. The improvement of any breeding population is dependent on heritability, GA and selection intensity of the characters (Singh *et al*., 2014). For various targeted qualities, heritability and GA estimations assist the breeder in using proper breeding methodology in the crop improvement programme (Patel *et al*., 2021). The primary goal of every crop enhancement effort is to increase production. As is well known, yield is a complicated feature that is influenced by a number of different supplementary characteristics, the majority of which are inherited quantitatively. Components having a high heritability and a positive association with yield can be employed in indirect yield selection and as an alternative way of yield improvement selection. Path coefficient analysis is the most effective statistical method determining direct and indirect relationship among the different variables (Yadava *et al*., 2011). As a result, understanding the direct and indirect effects of various components on yield is critical in selecting high-yielding genotypes.

Materials and Methods

A set of five genetically diverse Indian mustard lines was used in present study namely Geeta, IC-571649, IC-589676, Jagannath and IC-589669 grown with three replications at Experimental Farm, Mata Gujri College, Fatehgarh Sahib, Punjab during *Rabi* 2018-19. This place is situated between 30^0-27' and 30^0-46' latitudes and 76^0-04' and 76^0-38'E longitude and a mean height of 247 meters above sea level. Seed sowing was done by hand in rows with spacing of 60 cm between the rows and 25 cm within row on 15 October 2019 (Timely sown environment) and proper distance of plants maintained by thinning. The entire recommended package required for a healthy crop was given for raising mustard crop commercial check.

Result and Discussion

Heritability and genetic advance (GA)

Among the yield and yield contributed traits high PCV and GCV shown by siliquae/ plant (23.1 and 22.61) followed by secondary branches/ plant (23.3 and 19.4), test weight (18.9 and 18.1), HI (18.8 and 17.6), primary branches (17.3 and 14.9), biological yield (15.3 and 14.8), seed yield/ plant (13.7 and 12.2), siliqua length (13.1 and 11.2), days to first flowering (10.1 and 8.6), plant height (9.5 and 8.2), number of seeds/ siliqua (7.5 and 6.1), days to 50% flowering (7.3 and 6.3) and days to maturity (5.3 and 4.9) respectively so the result indicating that PCV as higher than respective GCVs for all the traits denoting environmental factors influencing their expression to some degree or other. Similar result reported by Lakra *et al*. (2020) in which highest GCV and PCV reported in siliquae/ plant (Table 1).

High heritability exhibited for siliquae/ plant (96.2%) followed by biological yield/ plant (93.5%), TW (91.2%), HI (87.8%), days to maturity (85.2%), seed yield/ plant (78.8%), plant height (74.8%), primary branches/ plant (74.5%), days to 50% flowering (73.6%), siliqua length (73.1%), days to first flowering (72.3%), secondary branches/ plant (69.7%) and number of seeds/ siliqua (66.6%). Low heritability recorded in number of seeds/ siliqua (66.6%) which shows that this trait is moderately affected by environmental agencies than genotypic differences. Similar result reported by Kumar *et al.* (2019) and Rout *et al.* (2018). Estimation of GA was maximum for siliquae/ plant (146.0) followed by plant height (25.6), biological yield/ plant (19.7), days to maturity (13.3), HI (9.9), days to 50% flowering (6.95), days to first flowering (6.6), secondary branches/ plant (6.0), seed yield/ plant (4.3), TW (1.9), number of seeds/ siliqua (1.4), primary branches/ plant (1.4) and siliqua length (0.83). Similarly, Ray *et al.* (2019) reported highest GA in siliquae/ plant.

Genetic advance (GA) as percent of mean was maximum result recorded for siliquae/ plant (45.7) followed by TW (35.6), HI (34.0), secondary branches/ plant (33.4), biological yield/ plant (29.4), primary branches/ plant (26.5), seed yield/ plant (22.3), siliqua length (19.7), days to first flowering (15.0), plant height (14.7), days to 50% flowering (11.0), number of seeds/ siliqua (10.3) and days to maturity (9.3) among all the traits under investigation which limits the scope of improvement in this trait through simple selection. This result is compared with the result reported by Patil *et al.* (2018) and highest GA as percent mean reported in siliquae/ plant by Awasthi *et al.* (2020) in which high GA as percent mean reported in harvest index.

Correlation

Correlation described as the degree of association between two variables (Asuero *et al*., 2006). Correlation

Table 1: Estimates of different genetic parameters of variation for 13 traits among parents and crosses

Parameters	Mean	Min	Max	var (g)	var (p)	GCV (%)	PCV (%)	Heritability (%)	Genetic Advance	GA as % means
Days to first flowering	38.0	50.4	43.9	14.1	19.5	8.6	10.1	72.3	6.6	15.0
Days to 50% flowering	55.8	70.2	63.0	15.5	21.0	6.3	7.3	73.5	7.0	11.0
Days to maturity	131.3	155.5	144.2	49.2	57.7	4.9	5.3	85.2	13.3	9.3
Primary branches/plant	3.9	6.7	5.3	0.6	0.8	14.9	17.3	74.5	1.4	26.5
Secondary branches/plant	12.5	24.4	18.0	12.2	17.5	19.4	23.3	69.7	6.0	33.4
Plant height (cm)	148.0	192.3	174.3	206.4	275.9	8.2	9.5	74.8	25.6	14.7
No. of siliquae/ plant	197.3	404.7	319.5	5219.0	5425.0	22.6	23.1	96.2	146.0	45.7
Siliqua length (cm)	3.2	5.0	4.2	0.2	0.3	11.2	13.1	73.1	0.8	19.7
No. of seeds /siliqua	12.0	15.3	13.7	0.7	1.1	6.1	7.5	66.6	1.4	10.3
Test weight (g)	3.7	6.9	5.3	0.9	1.0	18.1	18.9	91.2	1.9	35.6
Biological yield/ plant (g)	53.9	90.7	67.1	98.1	104.9	14.8	15.3	93.5	19.7	29.4
Harvest index	21.6	37.1	29.1	26.2	29.9	17.6	18.8	87.8	9.9	34.0
Seed yield/ plant (g)	15.4	23.2	19.2	5.5	6.9	12.2	13.7	78.8	4.3	22.3

Table 2: Phenotypic correlation analysis showing effects of 13 characters on seed components in Indian mustard

Parameters	Days to first flowering	Days to 50% flowering	Days to maturity	Primary branches	Secondary branches	Plant height (cm)	No. of siliquae /plant	Siliqua length (cm)	No. of seeds /siliqua	Test weight (g)	Biological yield /plant (g)	Harvest index	Seed yield/ plant(g)
Days to first flowering	1.000	0.603**	0.086	0.087	0.236	0.256	0.022	0.257	0.178	0.100	0.410**	-0.118	0.247
Days to 50% flowering		1.000	-0.047	-0.080	0.291*	0.193	-0.034	0.085	0.148	0.228	0.295*	-0.091	0.147
Days to maturity			1.000	-0.067	-0.407**	-0.029	-0.269	-0.317*	-0.186	-0.439**	-0.232	0.261	0.091
Primary branches				1.000	-0.094	0.065	0.053	0.251	0.272	0.009	0.148	-0.229	-0.101
Secondary branches					1.000	0.507**	-0.114	0.306*	0.286*	0.055	0.040	0.059	0.124
Plant height (cm)						1.000	-0.266	0.048	0.381**	-0.324*	-0.006	0.125	0.160
No. of siliquae/ plant							1.000	0.043	0.033	0.661**	0.512**	-0.595**	-0.322*
Siliqua length (cm)								1.000	0.360*	0.232	0.355*	-0.194	0.102
No. of seeds /siliqua									1.000	-0.020	0.046	-0.249	-0.264
Test weight (g)										1.000	0.513**	-0.347*	0.026
Biological yield /plant (g)											1.000	-0.680**	0.080
Harvest index												1.000	0.664**
Seed yield/ plant(g)													1.000

*, ** significant at 5% and 1% level respectively

Table 3: Path coefficient analysis showing direct and indirect effect of 12 characters on seed yield at phenotypic level

Parameter	Days to first flowering	Days to 50% flowering	Days to maturity	Primary branches	Secondary branches	Plant height (cm)	No. of siliqua /plant	Siliqua length (cm)	No of seeds /siliqua	Test weight (g)	Biological yield /plant (g)	Harvest index
Days to first flowering	**0.025**	-0.027	-0.004	0.005	0.004	-0.012	-0.001	-0.012	0.006	-0.001	0.426	-0.161
Days to 50% flowering	0.015	**-0.045**	0.002	-0.005	0.005	-0.009	0.002	-0.004	0.005	-0.003	0.307	-0.124
Days to maturity	0.002	0.002	**-0.048**	-0.004	-0.007	0.001	0.018	0.014	-0.007	0.005	-0.241	0.354
Pprimary branches	0.002	0.004	0.003	**0.057**	-0.002	-0.003	-0.004	-0.011	0.010	0.000	0.154	-0.311
Secondary branches	0.006	-0.013	0.020	-0.005	**0.017**	-0.024	0.008	-0.014	0.010	-0.001	0.041	0.080
Plant height (cm)	0.006	-0.009	0.001	0.004	0.008	**-0.048**	0.018	-0.002	0.014	0.004	-0.006	0.170
No. of siliqua/ plant	0.001	0.002	0.013	0.003	-0.002	0.013	**-0.066**	-0.002	0.001	-0.008	0.532	-0.808
Siliqua length in cm	0.006	-0.004	0.015	0.014	0.005	-0.002	-0.003	**-0.045**	0.013	-0.003	0.369	-0.264
No of seeds/ siliqua	0.004	-0.007	0.009	0.015	0.005	-0.018	-0.002	-0.016	**0.036**	0.000	0.047	-0.338
Test weight (g)	0.002	-0.010	0.021	0.001	0.001	0.015	-0.044	-0.010	-0.001	**-0.012**	0.534	-0.471
Biological yield /plant (g)	0.010	-0.013	0.011	0.008	0.001	0.000	-0.034	-0.016	0.002	-0.006	**1.040**	-0.923
Harvest index	-0.003	0.004	-0.013	-0.013	0.001	-0.006	0.040	0.009	-0.009	0.004	-0.707	**1.357**
Seed yield/ plant(g)	0.247	0.147	0.091	-0.101	0.124	0.160	-0.322*	0.102	-0.264	0.026	0.080	0.664**

Residual Effects (P) = 0.0246

analyses revealed that genotypic and phenotypic connections were in the same direction for most character pairs, with genotypic estimates being greater than phenotypic estimates, indicating a hereditary relationship between the characters (Sikarwar *et al.*, 2000). First flowering shows significant correlation in positive with 50% flowering (0.603). Days to 50% flowering shows positive significant correlation with biological yield/ plant (0.295). Secondary branches/ plant showed significant correlation in positive with plant height (0.507) followed by siliqua length (0.306) and number of seeds/ siliqua (0.286). Plant height shows positive significant correlation with number of seeds/siliqua (0.381). Siliquae/ plant shows significant correlation with TW (0.661) followed by biological yield (0.512). Siliqua length shows significant positive correlation with number of seeds/ siliqua (0.360). TW exhibited significant positive correlation with biological yield/ plant (0.513). HI significant and positive correlation with seed yield/ plant (0.664) (Table 2). These results are in conformity with the findings of Kumar *et al.* (2016) and Rout *et al*. (2019) in which out of thirteen traits HI shows highly significant and positive correlation with seed yield/ plant and siliquae/ plant.

Path analysis

Path analysis as a methodology holds strength because it allows researchers to study direct and indirect effects simultaneously with multiple independent and dependent variables (Valenzuela and Bachmann, 2017). When an independent variable has a direct effect on a dependent variable, it is called a direct effect. When an independent variable influences a dependent variable through a mediating variable, it is called an indirect effect (Baron and Kenny, 1986).

Direct effect at phenotypic level

Analysis of direct effect at phenotypic level revealed that HI (1.357) revealed highest positive direct effect on seed yield/ plant followed by biological yield/ plant (1.040), primary branches/ plant (0.057), number of seeds/ plant (0.036), days to first flowering (0.025) and secondary branches/ plant (0.017). TW (-0.185) shows highly direct negative effect on seed yield/ plant followed by siliquae/ plant (-0.066), days to maturity (-0.048), plant height (-0.048), days to 50% flowering (-0.045), siliqua length (-0.045) at phenotypic level (Table 3). Similar result notified by Verma *et al*. (2008) and Tripathi *et al.* (2020).

Indirect effect at phenotypic level

The indirect effect at phenotypic level seed yield/ plant revealed positive path coefficient for ten traits namely days to first flowering (0.247), days to 50% flowering (0.147), days to maturity (0.091), secondary branches/ plant (0.124), plant height (0.160), siliqua length (0.102), TW (0.048), biological yield/ plant (0.080) and HI (0.664) and negative path coefficient shown by three traits such as primary branches (-0.101), siliquae/ plant (-0.322) and number of seeds/ siliqua (-0.264). Similar reported by Rathod *et al*. (2013) in which highest indirect effect on seed yield/ plant by HI.

Conclusion

PCV and GCV reported high for number of siliquae/ plant, TW and HI. Moderate PCV and GCV observed in days to maturity and days to 50% flowering. High heritability reported in broad sense along with high GA as percent mean was observed in siliquae/ plant and biological yield/ plant. Observation recorded for phenotypic correlation exhibited that, the seed yield/ plant had significant positive correlation with HI. Path coefficient analysis of different quantitative traits contributing towards seed yield/ plant revealed high positive path coefficient in HI followed by biological yield/ plant and highly negative path coefficient exhibited in test weight followed by siliquae/ plant.

References

Awasthi D, Tiwari VK and Kandalkar VS. 2020. Evaluation of heritability and genetic advance for morphological traits of Indian mustard germplasms. *Curr Appl Sci Technol* **39**: 39-47.

Baron RM and Kenny DA. 1986. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *J Pers Soc Psychol* **51**: 1173–1182.

Devi B**.** 2018**.** Correlation and path analysis in Indian mustard (*B. juncea*) in agro – climatic conditions of Jhansi (U.P.). *J Pharmacogn Phytochem* **7**: 1678-1681.

Barfa D. 2016. Heterosis and combining ability analysis for seed yield in Indian mustard [*B. juncea* (L) Czern & Coss.]. M Sc Thesis, Department of Plant Breeding & Genetics Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, College of Agriculture, Gwalior (M.P.).

Bhowmik B, Mitra B and Bhadra K. 2014. Diversity of insect pollinators and their effect on the crop yield of *B. juncea*, NPJ-93 from southern West Bengal. *Int J Recent Sci Res* **5**: 1207-1213.

Kumar R, Kaur S, Bala K, Kaur S and Sharma L. 2019. Assessment of genetic variability, correlation and path analysis for yield traits in F1 hybrids of Indian mustard [*B. juncea* (L) Czern & Coss.]. *Agriways* **7**: 1-7.

Kumar R, Gaurav SS, Jayasudha S and Kumar H. 2016 Study of correlation and path coefficient analysis in germplasm lines of Indian mustard (*B. juncea* L). *Agric Sci Digest* **36**:92-96.

Lakra A, Tantuway G, Tirkey AE and Srivastava K. 2020. Genetic variability and trait association studies in Indian mustard (*B. juncea* (L) Czern & Coss*). Int J Curr Microbiol Appl Sci* **9**: 2556-2563.

Madhusoodanan KJ, Hrideek TK, Kuruvilla KM and Thomas J. 2016. Mustard - cultivation practices. *Indian J Arecanut, Spices Med plants* **5**: 157-161.

Meena HS, Kumar A, Ram AB, Singh V V, Meena PD, Singh BK and Singh D. 2015. Combining ability and heterosis for seed yield and its components in Indian mustard (*B. juncea* L). *J Agric Sci Technol* **17**: 1861-1871**.**

Paroda RS and Kumar P. 2000. Food production and demand situation in South Asia. *Agric Econ Res Rev* **13**: 1-24.

Patel PB, Patel PJ, Patel JR and Patel PC. 2021. Elucidation of genetic variability and inter-relationship studies for seed yield and quality traits in Indian mustard [*B. juncea* (L) Czern & Coss]. *Elec J Plant Breed* **12**: 589 - 596

Patil S, Kalamkar V, Deotale R D, Kamdi S R, Kuchanwar O and Chopde N. 2018. Genetic analysis of siliqua per plant and seed yield per plant in mustard (*B. juncea*). *Int J Curr Microbiol Appl Sci* **6**: 1355-1360.

Rathod VB, Mehta DR and Solanki HV. 2013. Correlation and path coefficient analysis in Indian mustard [*B. juncea* (L) Czern & Coss.]. **2**:514-519.

Ray J, Singh OP, Pathak VN and Verma SP. 2019. Assessment of genetic variability, heritability, genetic advance and selection indices for yield contributing traits in Indian mustard [*B. juncea*]. *Int J Chem Stud* **7**: 1096-1099.

Reddy J. 2015. Comprehensive guide for mustard farming details, https:/www.agrifarming.in/mustard-farming-information.

Rout S, Kerkhi SA and Chauhan C. 2018. Character association and path analysis among yield components in Indian mustard [*B. juncea* (L) Czern & Coss.]. *Int J Curr Microbiol Appl Sci* **7**: 50-55.

Rout S, Kerkhi SA and Gupta A. 2019. Estimation of genetic variability, heritability and genetic advance in relation to seed yield and its attributing traits in Indian mustard [*B. juncea* (L) Czern & Coss.]. *J Pharmacogn Phytochem* **8**: 4119-4123.

Sikarwar RS, Dixit SS and Hirve CD. 2000. Genetic association, path analysis, heritability and genetic advance studies in mustard [*B. juncea* (L) Czern & Coss.]. *J Oilseeds Research* **17**:11-16.

Singh AK, Nandan R and Singh P. 2014. Genetic variability and association analysis in rice germplasm under rainfed conditions. *Crop Res* **47**: 7-11

Tripathi N, Kumar N, Tiwari R and Verma OP. 2020. Correlation and path coefficient analysis for seed yield, its component and oil content in Indian mustard (*B. juncea* L) under normal and saline/alkaline condition. *J Pharmacogn Phytochem* **9**: 2846-2850.

Valenzuela S and Bachmann I. 2017. Path analysis, John Wiley & Sons, DOI: 10.1002/9781118901731. iecrm0181.

Verma R, Sharma R and Sharma SK. 2008. Association studies among yield and its component characters in Indian mustard [*B. juncea* (L) Czern & Coss.]. *Indian J Genet Plant Breed* **68:** 87-89.

Yadava DK, Giri SC, Vignesh M, Vasudev S, Yadav AK, Dass B, Singh R, Singh N, Mohapatra T and Prabhu KV. 2011. Genetic variability and trait association studies in Indian mustard (*B. juncea*). *Indian J Agric Sci* **81**: 712–716.