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STUDY OF GENETIC VARIABILITY FOR SEED YIELD AND ITS ATTRIBUTES IN INDIAN MUSTARD (*Brassica juncea* (L.) Czern and Coss.)

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ABSTRACT
Genetic variability, heritability and genetic advance were studied in a set of 60 genotypes of Indian mustard [*Brassica juncea* (L.) Czern and Coss]. The genotypes were evaluated for 17 characters *viz.,* days to flowering, days to maturity, plant height (cm), number of branch per plant, number of siliqua per plant, seeds per siliqua, length of siliqua (cm), 1000-seed weight (g), seed yield per plant (g), oil content (%), palmitic acid (%), stearic acid (%), oleic acid (%), linoleic acid (%), linolenic acid (%), eicosenoic acid (%) and erucic acid (%) to study the extent of genetic variability. Analysis of variance revealed significant genotypic differences for all the seventeen characters under study which indicate wide range of variation was apparent for all the characters. The genotypic coefficient of variation was observed highest for the characters *viz.*, stearic acid and oleic acid. Moderate estimates of genotypic coefficient of variation was observed for number of branch per plant, 1000-seed weight, seed yield per plant, palmitic acid, linoleic acid, eicosenoic acid and erucic acid. Days to flowering, days to maturity, plant height, number of siliqua per plant, seeds per siliqua, length of siliqua, oil content and lenolenic acid had lower values of genotypic coefficient of variation. High heritability (bs) were observed for the characters *viz.*, oleic acid, erucic acid, palmitic acid, stearic acid, eicosenoic acid, linoleic acid, 1000-seed weight, linolenic acid, days to flowering, seed yield per plant and length of siliqua. Heritability (bs) was moderate for number of branch per plant, seeds per siliqua, plant height, oil content, days to maturity and number of siliqua per plant. High heritability (99.40 %) coupled with high genetic advance (77.27 %) was observed for oleic acid followed by stearic acid, erucic acid, eicosenoic acid, lenoleic acid, palmitic acid, 1000-seed weight and seed yield per plant indicated that phenotypic selection would be effective for genetic improvement of these traits. High heritability accompanied with moderate genetic advance was observed for lenolenic acid, days to flowering and length of siliqua indicated presence of both additive and non-additive gene action. High heritability with low genetic advance was noted for days to maturity and oil content, which may be due to low value of estimated phenotypic variance for these traits.

KEY WORDS: Genetic variability, heritability, Genetic advance and Indian Mustard

INTRODUCTION
The genus *Brassica* is an important member of the *Brassicaceae* family. It comprises several economically important species which yields edible roots, stems, leaves, buds, flowers and seeds condiment. Oilseed *brassica* is commonly known as mustard and rapeseed are the important species largely grown as oilseed crop in subtropical and tropical countries. In Asia, mustard and rapeseed are chiefly grown in China, India and Pakistan and also grown in other than Asia *i.e.* Europe, Canada and USSR. Indian mustard [*Brassica juncea* (L.) Czern and Coss] popularly known as rai, raya or laha is one of the most important oilseed crops of the country and it occupies considerably large acerage among the *Brassica* group of oilseed crops. It is natural amphidiploids of *Brassica campestris* (2n=20) and *Brassica nigra* (2n=16). It is predominantly self-pollinated crop. Indian mustard seed contains about 38 to 42 % oil and 24 % protein and considered as major source of edible oil. Oil quality was determined by fatty acid profile, whereas, level of erucic acid predicts the quality of seed oil. Due to the presence of undesirable long chain fatty acids like eicosenoic acid (10%) and erucic acid (50%) in the seed oil, it becomes detrimental to human health. Erucic acid increases blood cholesterol, interferes in myocardial conductance and shortens coagulation time. Oleic and linoleic acids are high in oil for edible purposes and higher quantity of linolenic, eicosenoic and erucic acid are valued for industrial purposes. The success of any breeding programme depends upon the genetic variability engraved in the breeding material. Germplasm, which is prerequisite for any breeding programme, serves as a valuable source material as it provides scope for building for genetic variability. The assessment of variability parameters including phenotypic and genotypic coefficients of variation, heritability in broad sense and genetic advance

as per cent of mean is a prerequisite for making effective selection. With the virtue of this fact the present investigation was undertaken to determine genetic variability, heritability and genetic advance in a set of 60 genotypes of Indian mustard.

MATERIAL AND METHODS

The present investigation on genetic variability in Indian mustard [*Brassica juncea* (L.) Czern and Coss] was conducted in *rabi* season of the year 2017-18 at Castor-Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The experiment was laid out in Randomized Block Design with three replications. Each plot consisted of single row of 5.0 meter length. The inter row and intra row spacing was 45 cm and 15 cm, respectively. The sowing was carried out by hand drilling. The experiment and other post-sowing operations were carried out in accordance with the practices recommended for the mustard crop. The data were recorded from five randomly selected plants from each entry in each replication for seventeen characters *viz*., days to flowering, days to maturity, plant height (cm), number of branch per plant, number of siliqua per plant, seeds per siliqua, length of siliqua (cm), 1000-seed weight (g), seed yield per plant (g), oil content (%), palmitic acid (%), stearic acid (%), oleic acid (%), linoleic acid (%), linolenic acid (%), eicosenoic acid (%) and erucic acid (%). The characters such as days to flowering and days to maturity were recorded on plot basis. The mean over replication of each character was subjected to statistical analysis. Genotypic and phenotypic variances were computed according to method suggested by Johnson *et al.* (1955). Genotypic and phenotypic coefficient of variation (GCV and PCV) were estimated based on formulae given by Burton (1952) and heritability and genetic advance as per cent mean were calculated according to Allard (1960).

RESULTS AND DISCUSSION

The analysis of variance for different characters is presented in Table 1. The analysis of variance for genotypes was highly significant for all the characters, which indicated the presence of high amount of genetic variability for all the characters under study. The estimates of genotypic (σ_g^2) and phenotypic (σ_p^2) variances were obtained from analysis of variance. The mean values and variance components were used to compute other genetic parameters *viz*., heritability in broad sense [$H^2_{(bs)}$], genotypic co-efficient of variance (GCV), phenotypic co-efficient of variance (PCV) and genetic advance as per cent of mean (GA as % of mean) which are presented in Table 2. The perusal of data revealed that there is an ample scope to identify desirable genotypes to improve different characters. A wide range of phenotypic variability was present in respect of seed yield per plant, plant height and number of siliqua per plant. Moderate level of phenotypic variability was found for days to flowering and days to maturity, while low level found in number of branch per plant, seeds per siliqua, length of siliqua and 1000-seed weight.

The phenotypic variation is not the precise criterion for estimate the amount of genetic variability present in breeding population. The other genetic parameters such as genotypic co-efficient of variation, heritability and genetic advance are important to study the extent of genetic variability more precisely. Further, the phenotypic variance was partitioned into its genotypic and environmental components to know the genetic variability present in each character. It was observed that for most of the characters, genotypic component of variance was higher than environmental components, indicating that phenotypic variability was a reliable measure of genotypic variability (Table 2). Therefore, selection would be effective for these characters. The phenotypic and genotypic variances were high for plant height, number of siliqua per plant, seed yield per plant, oleic acid and erucic acid. These findings were supported by Akabari *et al*. (2015) for plant height and seed yield per plant and Roy *et al.* (2018) and Akabari *et al.* (2015) for number of siliqua per plant. Moderate estimates of genotypic and phenotypic components of variances were observed for days to flowering and days to maturity. These results were in conformity with Akabari *et al.* (2015) for days to maturity. Low estimates of genotypic and phenotypic variances were observed for number of branch per plant, seeds per siliqua, length of siliqua, 1000-seed weight, oil content, palmitic acid, stearic acid, lenoleic acid, lenolenic acid and eicosenoic acid. Similar results were also obtained by Roy *et al.* (2018) and Akabari *et al.* (2015) for number of branch per plant, seeds per siliqua, length of siliqua and 1000-seed weight. The highest genotypic co-efficient of variation was observed for stearic acid and oleic acid. These results were corroborated with Sushil Kumar (2013) for oleic acid. These value of genetic co-efficient of variation indicates the presence of high amount of variability and thereby much more effective for selection. Number of branch per plant, number of siliqua per plant, 1000-seed weight, seed yield per plant, palmitic acid, lenoleic acid, eicosenoic acid and erucic acid exhibited moderate values of genetic co-efficient of variation. While, days to flowering, days to maturity, plant height, seeds per siliqua, length of siliqua, oil content and lenolenic acid had lower values suggesting that these characters were more influenced by environment and the selection of these characters will not be much effective. Similar findings were also reported by Bineeta Devi (2018) and Trivedi *et al.* (2016) for number of branch per plant, Akabari *et al.* (2015) for 1000-seed weight, Arpna *et al.* (2018) for seed yield per plant, Sushil Kumar (2013) for palmitic acid, eicosenoic acid and erucic acid, Bineeta Devi (2018) and Akabari *et al.* (2015) for days to flowering, days to maturity and plant height, Trivedi *et al.* (2016) for seeds per siliqua, Bineeta Devi (2018) for length siliqua and Trivedi *et al.* (2016), Akabari *et al.* (2015) and Sushil Kumar (2013) for oil content.

TABLE 1: Analysis of variance for different seventeen characters in Indian mustard [*Brassica juncea* (L.) Czern and Coss]

Source of variation	Degree of freedom	Days to flowering	Days to maturity	Plant height	Number of branch per plant	Number of siliqua per plant	Seeds per siliqua	Length of siliqua	Seed yield per plant
Replication	2	7.205	5.67	65.605	9.151	1869.41	0.738	0.142	4.072
Genotypes	59	25.92**	20.314**	771.076**	18.872**	3464.841**	3.708**	0.499**	57.428**
Error	118	2.73	7.647	183.164	3.519	1321.95	0.821	0.087	7.451

Source of variation	1000-seed weight	Oil content	Palmitic acid	Stearic acid	Oleic acid	Linoleic acid	Linolenic acid	Eicosenoic acid	Erucic acid
Replication	0.041	3.022	7E-06	0.00002	0.002	0.00007	0.048	0.002	0.00001
Genotypes	0.969**	2.873**	0.193**	0.163**	61.389**	14.506**	4.319**	2.042**	116.206**
Error	0.027	1.009	0.002	0.001	0.133	0.374	0.243	0.019	0.461

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

The estimates of heritability and genetic advance are important for the expression of seed yield. These parameters are also helpful in designing breeding programme. The heritability (broad sense) estimates were quite high for the characters *viz.*, oleic acid, erucic acid, palmitic acid, stearic acid, eicosenoic acid, lenoleic acid, 1000-seed weight, lenolenic acid, days to flowering, seed yield per plant and length of siliqua. Moderate values of heritability were recorded for number of branch per plant, seeds per siliqua, plant height, oil content, days to maturity and number of siliqua per plant. The high heritability coupled with high genetic advances was recorded for oleic acid, stearic acid, erucic acid, eicosenoic acid, lenoleic acid, palmitic acid, 1000-seed weight and seed yield per plant (Table 2). These results indicated the importance of additive gene action for their inheritance and improvement could be brought about by phenotypic selection. These results were in conformity with Sushil Kumar (2013) for oleic acid, Trivedi *et al.* (2016) and Akabari *et al.* (2015) for 1000-seed weight, Roy *et al.* (2018), Trivedi *et al.* (2016) and Akabari *et al.* (2015) for seed yield per plant. High heritability accompanied with moderate genetic advance was found for lenolenic acid, days to flowering and length of siliqua which indicate involvement of both additive and non-additive gene action. Similar results were found by Trivedi *et al.* (2016), Akabari *et al.* (2015) and Bind *et al.* (2014) for days to flowering and Roy *et al.* (2018), Akabari *et al.* (2015) and Bind *et al.* (2014) for length of siliqua. High heritability with low genetic advance was noted for days to maturity and oil content, which may be due to low value of estimated phenotypic variance for these traits. These findings were in accordance with those of Akabari *et al*. (2015) and Bind *et al.* (2014) for days to maturity and Trivedi *et al.* (2016) and Bind *et al.* (2014) for oil content.

From the foregoing discussion, it can be concluded that the characters *viz*., plant height, number of siliqua per plant, seed yield per plant, oleic acid and erucic acid possessed substantial to high genetic variability in the genotypes studied. This variability was due to moderate to high differences in the genetic makeup of genotypes and controlled by additive gene action which revealed that direct selection would be efective for those above mentioned traits. Therefore, due weightage should be given to these characters while selection for improving seed yield in Indian mustard.

TABLE 2 : Mean, range, genotypic, phenotypic and environmental variance, GCV, PCV, heritability (broad sense) and GA as percent of mean for different characters in Indian mustard [*Brassica juncea* (L.) Czern and Coss]

Characters	Mean	Range	Genotypic variance (σ^2_g)	Phenotypic variance (σ^2_p)	Environmental variance (σ^2_e)	GCV (%)	PCV (%)	h^2 (broad sense) (%)	GA as % of mean
Days to flowering	40.66	35.00 - 47.66	7.73	10.46	2.73	6.84	7.96	73.90	12.11
Days to maturity	109.33	100.36 - 112.80	4.22	11.87	7.65	1.88	3.15	35.60	2.31
Plant height (cm)	183.81	147.33 - 221.33	195.97	379.14	183.17	7.62	10.59	51.70	11.28
Number of branch per plant	15.79	11.70 - 22.31	5.12	8.04	3.52	14.32	18.61	59.30	22.71
Number of siliqua per plant	273.94	215.66 - 350.66	714.30	2036.25	1321.95	9.76	16.47	35.11	11.90
Seeds per siliqua	13.91	11.80 - 16.46	0.96	1.78	0.82	7.05	9.60	54.00	10.67
Length of siliqua	4.52	3.68 - 5.46	0.14	0.23	0.09	8.20	10.50	61.00	13.19
Seed yield per plant	20.68	13.23 - 37.01	16.66	24.11	7.45	19.74	23.75	69.10	33.80
1000-seed weight (g)	5.14	3.59 - 6.14	0.31	0.34	0.03	10.90	11.36	92.00	21.54
Oil content (%)	37.50	34.79 - 39.11	0.62	1.63	0.01	2.10	3.41	38.10	2.67
Palmitic acid (%)	1.92	1.51 - 3.16	0.06	0.07	0.00	13.17	13.41	97.30	26.66
Stearic acid (%)	1.00	0.77 - 2.53	0.05	0.06	0.00	23.23	23.56	97.10	47.20
Oleic acid (%)	12.00	8.57 - 44.46	20.41	20.55	0.13	37.63	37.75	99.40	77.27
Linoleic acid (%)	16.54	13.78 - 29.10	4.71	5.09	0.37	13.13	13.64	92.60	26.02
Linolenic acid (%)	14.11	8.60 - 16.61	1.36	1.60	0.24	8.26	8.97	84.80	15.67
Eicosenoic acid (%)	5.22	3.88 - 8.35	0.67	0.69	0.02	15.74	15.97	96.50	31.96
Erucic acid (%)	49.21	8.13 - 53.67	38.58	39.04	0.46	12.62	12.70	98.80	25.85

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