



Genetic variability for seed yield and its contributing traits in Indian Mustard [*Brassica juncea* (L.) Czern and Coss]

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Abstract

Indian mustard (*Brassica juncea* L.) is an important oilseed crop contributing substantially to India's edible oil production. The present investigation was undertaken to assess genetic variability among 30 Indian mustard genotypes evaluated for twelve quantitative traits. In *Rabi*, 2023–2024, the experiment was carried out at the Instructional Farm, Sri Karan Narendra College of Agriculture, Jobner, Jaipur, using a randomised block design with three replications. Significant differences between genotypes for every variable were found by analysis of variance, suggesting that there is sufficient genetic variability. The number of branches per plant showed moderate phenotypic variation (10 to 20 %), whereas the number of siliquae per plant and seed output per plant showed high phenotypic and genotypic coefficients of variation (>20 %). The majority of the remaining characteristics showed little phenotypic and genotypic coefficients of variation (<10 %). Plant height, days to maturity, oil content, days to 50 per cent flowering, siliquae per plant, seed production per plant and chlorophyll content all showed high heritability estimates, indicating little environmental influence. For certain traits, substantial heritability and moderate genetic advancement suggested that both additive and non-additive gene activity were involved, underscoring their value in selection for increased yield. Selection for traits exhibiting high heritability and genetic advance may facilitate the development of high-yielding Indian mustard varieties. Promising genotypes identified in present investigation may be employed in pedigree breeding, disruptive mating and recurrent selection breeding programme to combine favourable yield attributes in future Indian mustard cultivars.

Keywords: Indian mustard, Genetic variability, Genetic advance, Heritability

In India, one of the most significant *Rabi* oilseed crops grown is Indian mustard (*Brassica juncea* L. Czern and Coss), contributing significantly to the national edible oil requirement. Originally domesticated in China (Prain, 1898; Bailey, 1922), the crop later became an integral component of Indian agriculture. Commonly known as brown mustard, Chinese mustard or leaf mustard, it is a member of the family *Brassicaceae* and originated from *Brassica campestris* ($2n = 20$) and *Brassica nigra* ($2n = 16$) thus, it is a naturally occurring amphidiploid ($2n = 36$) (Nagaharu, 1935). After soybean, Indian mustard ranks second among oilseed crops and plays a crucial role in sustaining farmers, particularly in rainfed regions (Kumar *et al.*, 2008).

Mustard seed contains about 38-43 per cent oil, rich in erucic acid (38-57%) and linoleic acid (4.7-13 %), making it suitable for culinary as well as industrial uses (Prakash and Hinata, 1980). The crop is also utilized in the manufacture of soaps, lubricants and fertilizers, while its residue serves as valuable cattle feed (Reed, 1976). Owing to its adaptability to diverse agro-climatic conditions, tolerance to rainfall ranging from 500 to 4200 mm and relatively low water requirement (240-400 mm), Indian mustard is well suited for rainfed farming systems (Shekhawat *et al.*, 2012). Improvement in yield and productivity largely depends on the identification and selection of genotypes possessing superior yield potential and adaptability.

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Genetic variability forms the foundation of any crop improvement programme. The availability of sufficient genetic variation enables plant breeders to develop

improved cultivars through effective selection. Hutchinson (1940) emphasized the importance of genetic variability estimates in formulating efficient breeding strategies. Parameters such as genotypic and phenotypic coefficients of variation help in partitioning overall variability into two components *i.e.*, heritable ones and non-heritable ones. Several studies have highlighted the presence of substantial genetic variation and high heritability for seed yield and its attributing traits, facilitating effective selection in breeding programmes (Kumar *et al.*, 2020; Patel *et al.*, 2022). In view of these considerations, the current study was undertaken with the aim of evaluating genetic variability, heritability and genetic advance for important seed yield-related traits in Indian mustard crop.

The current study was carried out at Sri Karan Narendra College of Agriculture's Instructional Farm at Jobner, Jaipur, Rajasthan, during the *Rabi* season of 2023–2024. The experimental site, which is 450 meters above mean sea level and situated at 26°5' N latitude and 75°28' E longitude, is part of Rajasthan's Agro-climatic Zone III A (Semi-arid Eastern Plains). Thirty genotypes of Indian mustard (*Brassica juncea*), comprising released varieties, advanced breeding lines and germplasm accessions, were used in the study. These genotypes were procured from the Directorate of Rapeseed-Mustard Research (DRMR), Bharatpur, and the Department of Genetics and Plant Breeding, S.K.N. College of Agriculture, Jobner.

Randomised block design with three replications were used to conduct the experiment. Every genotype was cultivated in two rows, each measuring three meters, every replication. Twenty centimetres distance was used to separate plants and forty-five centimetres for rows. Throughout the crop season, all recommended agronomic techniques were adhered to consistently.

Observations were collected on twelve characters, namely days to 50 per cent flowering, days to maturity, plant height (cm), number of branches per plant, number of siliquae per plant, siliqua length (cm), siliqua density, number of seeds per siliqua, 1000-seed weight (g), seed yield per plant (g), chlorophyll content (SPAD value) and oil content (%). With the exception of days to 50 percent flowering, days to maturity, 1000-seed weight, and oil content, which were recorded on a plot basis, data were collected from five randomly chosen plants in each plot.

Statistical analysis was carried out following the procedure for randomized block design using Panse and Sukhatme (1985) method. The importance of treatment effects were analyzed using the F-test (Fisher and Yates, 1963). Genotypic and phenotypic variances were estimated as per Johnson *et al.* (1955) and Comstock and Robinson (1952). Coefficients of variation for genotype and phenotype were computed in accordance with Burton (1952). Genetic advancement and broad-sense heritability were calculated in accordance with Johnson *et al.* (1955).

Analysis of variance

For every trait under study, the genotypes varied significantly, according to the analysis of variance shown in **Table 1**, including days to 50 per cent flowering, days to maturity, plant height, branches per plant, siliquae per plant, siliqua length, siliqua density, seeds per siliqua, 1000-seed weight, seed yield per plant, chlorophyll content and oil content. The presence of significant variation among genotypes indicated adequate genetic diversity in the experimental material, which is essential for selection and genetic improvement. Similar observations were earlier reported in Indian mustard by Meena and Bishnoi (2023) and Sowmya *et al.* (2024).

Table 1. Analysis of variance showing mean sum of square for yield and its contributing traits of Indian mustard

S.No.	Source of variation	Replication	Genotypes	Error
1	d.f.	2	29	58
2	Days to 50 per cent flowering	0.53	42.79**	1.68
3	Days to maturity	0.54	29.90**	3.11
4	Plant height	3.13	289.12**	27.60
5	Branches per plant	0.01	0.97**	0.21
6	Siliquae per plant	1.41	15,562.56**	65.96
7	Siliqua length	0.03	0.08**	0.03
8	Siliqua density	0.000	0.004*	0.002
9	Seed per siliqua	0.14	0.29**	0.13
10	1000-seed weight	0.01	0.20**	0.09
11	Seed yield per plant	0.42	13.42**	0.45
12	Chlorophyll content	3.92	39.03**	1.79
13	Oil content	0.60	22.27**	2.36

*, ** Significant at 5 per cent and 1 per cent level, respectively

Table 2. Mean performance for seed yield and its contributing traits in different genotypes of Indian mustard

S. No.	Genotypes	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Branches per Plant	Siliqua per plant	Siliqua length (cm)	Siliqua density	Seed per siliqua	1000-seed weight (g)	Seed yield per plant (g)	Chlorophyll content (SPAD value)	Oil content (%)
1	DRMR-2059	48.33	133.33	143.53	6.20	251.73	4.88	0.57	8.80	7.62	8.42	42.63	36.65
2	PM-28	42.33	135.66	118.20	5.66	127.46	5.08	0.48	8.40	7.47	6.27	42.53	35.59
3	PM-25	43.66	133.33	117.53	6.06	127.06	5.09	0.52	8.46	7.48	4.08	42.10	35.59
4	BPR-540-6	46.33	135.33	124.13	6.00	134.40	4.76	0.52	8.33	7.59	6.76	38.63	30.48
5	EC-766136	43.33	133.66	121.73	6.20	138.20	5.13	0.48	8.66	7.74	6.25	40.33	33.46
6	IC-493018	48.33	139.00	125.80	7.20	396.26	5.00	0.55	8.40	7.73	12.43	42.46	40.12
7	IC-491584	43.00	141.00	119.53	6.00	129.86	5.32	0.55	8.80	7.74	3.57	43.50	30.33
8	IC-493008	46.66	132.00	124.26	5.66	146.40	4.84	0.55	8.40	7.61	4.73	41.10	30.93
9	DRMR-150-35	54.66	143.33	137.80	6.46	233.86	4.99	0.53	8.80	6.96	5.23	42.60	31.81
10	IC-122449	43.00	141.00	121.53	6.80	141.73	4.87	0.56	8.53	7.44	4.15	40.73	35.24
11	IC-344294	47.66	136.33	117.53	6.40	125.40	5.03	0.46	7.93	6.90	4.87	39.13	35.27
12	IC-122435	46.33	139.33	115.13	6.33	110.20	4.91	0.52	8.46	7.56	2.55	43.63	36.30
13	LAXMI	52.66	141.66	136.13	6.00	229.86	5.19	0.48	8.46	7.65	7.42	37.30	36.55
14	DRMR-1165-40	50.00	138.66	119.66	6.26	138.20	5.16	0.54	8.20	7.65	5.21	32.33	30.98
15	IC-493079	50.66	140.66	115.66	5.46	105.80	5.13	0.45	8.93	7.36	1.70	33.63	34.99
16	DRMR-2017-15	52.00	139.33	148.93	5.60	335.66	5.07	0.50	8.93	7.38	9.34	34.93	35.36
17	RAJAT	53.66	141.00	133.46	6.40	186.60	4.84	0.51	8.53	7.46	7.15	42.76	39.17
18	IC-310799	53.00	140.00	129.86	4.66	136.93	5.20	0.53	8.40	7.73	5.58	33.13	39.45
19	IC-492903	54.66	140.00	122.20	5.00	134.80	4.89	0.48	9.20	7.82	5.22	34.40	36.55
20	RH-406	55.33	140.00	129.66	5.80	146.53	4.82	0.51	8.40	7.51	5.24	40.90	34.89
21	BPR-543-2	52.33	139.33	123.86	6.20	124.46	4.76	0.52	8.00	7.15	6.51	41.76	35.22
22	IC-10977	50.66	140.00	127.73	5.46	142.73	4.97	0.51	8.00	7.47	5.74	38.06	35.92
23	BRIJRAJ	49.33	134.00	125.40	6.33	143.26	5.09	0.51	8.86	7.19	6.78	43.43	37.55
24	RH-725	51.33	135.66	139.33	6.93	242.13	5.30	0.59	8.73	7.52	7.51	39.96	38.44
25	IC-491403	53.00	134.00	144.20	6.20	294.60	5.34	0.55	8.93	7.46	7.36	37.76	36.61
26	NRCHB-101	49.66	139.00	116.53	5.73	123.46	4.97	0.51	8.40	7.20	5.45	41.80	31.39
27	BPR-349-9	49.00	140.00	114.53	5.20	121.60	4.78	0.55	8.33	7.36	4.36	41.33	36.55
28	KRANTI	50.00	142.00	118.26	6.13	123.60	4.92	0.50	8.60	6.89	5.39	35.00	34.05
29	IC-267538	52.66	141.00	136.26	7.00	170.93	5.00	0.59	8.93	7.83	7.46	40.83	34.15
30	EC-766430	48.33	141.66	113.26	5.86	108.33	5.12	0.55	8.86	7.80	3.08	32.60	31.09
	Mean	49.40	138.37	126.05	6.04	169.07	5.01	0.52	8.55	7.48	5.86	39.37	35.02
	S.E.m±	1.05	1.44	4.29	0.37	6.63	0.15	0.03	0.30	0.25	0.55	1.09	1.25
	CD at 5%	3.00	4.08	12.14	1.06	18.77	0.42	0.11	0.86	0.72	1.56	3.10	3.55

Mean performance of genotypes

On basis of seed yield per plant, siliqua per plant, branches per plant and other desirable attributes, highlighted genotypes IC-493018, DRMR-2017-15, DRMR-2059, RH-725, IC-267538 and LAXMI exhibited superior performance over the general mean (Table 2). Tahira *et al.* (2016) also showed similar results for seed output, number of siliquae per plant and number of branches per plant in Indian mustard.

Genetic variability parameters

In the present investigation, for all the traits only marginal differences were observed between phenotypic and genotypic coefficients of variation (Table 3). In general, the estimates of PCV were slightly higher than the corresponding GCV values, indicating a relatively low influence of environmental factors on trait expression and suggesting the dependability of selection based on phenotypic performance. Comparable observations have also been reported by Meena and Bishnoi (2023) and Reddy and Shrivastav (2022) in Indian mustard crop. The magnitude of GCV and PCV varied from 2.15 to 42.51 per cent and 2.50 to 42.78 per cent, respectively. Higher values were obtained for both the GCV and PCV for siliquae per plant and seed yield per plant, implying greater scope for improvement through direct selection. These findings are in agreement with earlier reports by Meena and Bishnoi (2023) in Indian mustard. Conversely, low estimates of genotypic and phenotypic coefficients of variation were noted for days to 50 per cent flowering, days to maturity, branches per plant (GCV), plant height, siliqua length, siliqua density, seeds per siliqua, 1000-seed weight, chlorophyll content and oil content, indicating limited prospects for genetic improvement through selection. Similar trends were documented in Indian mustard by Tripathi *et al.* (2019) and Yadav *et al.* (2021).

The present investigation revealed high heritability estimates for siliquae per plant, seed yield per plant, days to 50 per cent flowering, chlorophyll content, plant height, days to maturity and oil content. Earlier reports have also documented high heritability for these traits in Indian mustard (Padra and Lal, 2021; Saiyad *et al.*, 2021). The occurrence of high heritability suggests a predominant role of additive genetic variance, thereby indicating the effectiveness of selection for their improvement. In contrast, branches per plant exhibited moderate heritability, which is found in agreement with the results of Devi *et al.* (2024) in Indian mustard crop. Moderate heritability for this trait may be attributed to the influence of non-additive gene effects and genotype × environment interactions, thereby limiting the efficiency of simple selection. Low heritability estimates were recorded for siliqua length, 1000-seed weight, seeds per siliqua and siliqua density, indicating limited scope for improvement through direct selection. Similar observations in Indian mustard were reported by Padra and Lal (2021), suggesting the involvement of non-additive type of gene action in the inheritance of these characters.

The assessment of heritability along-with genetic advance provides a more dependable criterion for predicting selection response than heritability alone (Johnson *et al.*, 1955). In the present study, the highest genetic advance as per cent of mean was observed for siliquae per plant and seed yield per plant, which is in close agreement with the findings of Meena and Singh (2021), Reddy and Shrivastav (2022) and Meena and Bishnoi (2023) in Indian mustard crop, supporting the role of additive gene action. This indicates that these traits are largely governed by additive gene action, which is fixable in nature and can be improved by selection.

Table 3. Estimates of genetic variability parameters for yield and its contributing traits of Indian mustard

S.No. Traits	Mean	Range	Coefficient of variation (%)		Heritability (%)	Genetic Advance	G.A. as % of mean
			Genotypic	Phenotypic			
1 Days to 50 % flowering	49.40	42.33-55.33	7.49	7.94	89.06	7.19	14.56
2 Days to maturity	138.37	132.00-143.33	2.15	2.50	74.10	5.29	3.82
3 Plant height (cm)	126.05	113.26-148.93	7.40	8.49	75.95	16.76	13.29
4 Branches per plant	6.04	4.66-7.20	8.34	11.27	54.78	0.76	12.72
5 Siliquae per plant	169.07	105.80-396.26	42.51	42.78	98.73	147.11	87.01
6 Siliqua length (cm)	5.01	4.76-5.34	2.52	4.44	32.09	0.14	2.94
7 Siliqua density	0.52	0.45-0.59	4.15	9.81	17.94	0.01	3.62
8 Seed per siliqua	8.55	7.93-9.20	2.62	5.08	26.61	0.23	2.78
9 1000-seed weight (g)	7.48	6.89-7.83	2.53	4.88	26.81	0.20	2.70
10 Seed yield per plant (g)	5.86	1.70-12.43	35.45	37.27	90.45	4.07	69.45
11 Chlorophyll content (SPAD value)	39.37	32.33-43.63	8.94	9.57	87.34	6.78	17.22
12 Oil content (%)	35.02	30.33-40.12	7.35	8.56	73.77	4.55	13.01

High heritability along-with moderate genetic advance was recorded for chlorophyll content, days to 50 per cent flowering, plant height and oil content, while branches per plant exhibited moderate range heritability along with moderate genetic advance. Similar trends in Indian mustard have been concluded by Saiyad *et al.* (2021) and Devi *et al.* (2024), indicating the involvement of both additive and non-additive gene effects in the expression of these traits. Traits such as siliqua density, siliqua length, seeds per siliqua and 1000-seed weight exhibited low heritability along with low range genetic advance, whereas days to maturity showed high range heritability but low range genetic advance. These results are in agreement with findings of Saiyad *et al.* (2021) on Indian mustard crop, suggesting the predominance of non-additive type of gene action which has little scope for selection-based enhancement.

The findings of the present investigation identified the Indian mustard genotypes IC-493018, DRMR-2017-15, DRMR-2059, RH-725, IC-267538 and LAXMI as superior performers with respect to seed yield and therefore promising candidates for yield enhancement programmes. With regard to oil content, genotype IC-493018 recorded the highest value (40.12 %), followed by IC-310799 (39.45 %), RAJAT (39.17 %) and RH-725 (38.44 %), indicating their potential for improving oil productivity. To effectively exploit the genetic potential of these genotypes, breeding approaches such as multiple crossing, intermating among selected lines, disruptive mating and the exploitation of transgressive segregants are suggested. Subsequent delayed and rigorous selection in advanced generations would facilitate the identification of desirable recombinants after minimizing the influence of dominant gene effects.

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