



Assessment of genetic parameters and character association under different environments for yield and its traits in Indian mustard [*Brassica juncea* (L.) Czern & Coss]

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ARTICLE INFO	ABSTRACT
<p>Original Research Article Received on October 25, 2024 Revised on October 30, 2024 Accepted on November 23, 2024 Published on December 01, 2024</p> <p>Article Authors Sharad Kumar Singh Redu, Tejbir Singh</p> <p>Corresponding Author Email sharad13ip@gmail.com</p>	<p>The experiment was conducted to estimate the genetic variability, inter-relationships and path coefficient analysis among seed yield and its component traits in Indian mustard [<i>Brassica juncea</i> (L.) Czern & Coss]. Forty genotypes of Indian mustard were assessed in randomized block design with three replications for thirteen quantitative characters. The statistical analysis showed significant level of genetic variation across all genotypes in all environments as well as in pooled data for all the characters. High heritability in conjugation with high genetic advance were observed for days to 50% flowering, days to maturity, plant height, biological yield, number of siliqua/ plant and seed yield in most of the environments suggesting predominant role of additive gene action for expression of these traits. The genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance were found higher for days to 50% flowering, biological yield and number of siliqua per plant in most of the environments and pooled data. Seed yield per plant was found to be positively and significantly correlated with biological yield, number of siliqua per plant, harvest index, number of primary branches per plant, number of secondary branches per plant and siliqua length almost in all the environments as well as in pooled data. Path coefficient at phenotypic level further revealed the biological yield/ plant and harvest index exerted the major and positive direct effect on seed yield/ plant. The results of present study indicates that number of primary branches, number of secondary branches, biological yield, seeds per siliqua and length of siliqua trait found in these gene pool can be used to develop the high yielding varieties in future hybridization program.</p>
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Indian mustard is an important oil seed crop worldwide which is commonly known as rai, raya or laha in India. Indian mustard belongs to the family *Brassicaceae* and includes six cultivated species. The family *Brassicaceae* currently consisting of 3709 species and 338 genera and it is one of the ten most economically important plant family because it contains many species that are used for food, oil, and ornamental plants. *Brassica juncea* is mainly a self-pollinating crop (85-90%), but due to abiotic and biotic pollinating agents, there is frequent cross

pollination occur. However, the degree of cross pollination varies from 4.0 to 16.6 % due to frequent visit of insects particularly honeybee. Mustard crop is sown during rabi season mainly in northwest India, contributes nearly 33 percent to edible oil pool of the country (DRMR Annual Report, 2023-24). India is a major producer of mustard oil and now become rank 1 in oilseeds production of rapeseed mustard with total production of 13.16 million tonnes (ICAR-DRMR Annual Report, 2023-24).

Rapeseed-mustard production contributes to 33.24 % of total oilseeds production in India. Rapeseed mustard is cultivated on an area of 9.18 million/ha with a total net production of 13.26 million tonnes and with an average yields of 1444 kg/ha (Anonymous, 2023). The genetic variation among the available germplasm is very necessary for crop improvement programme. The success of breeding program, particularly in improving a specific trait through selection, depends on the genetic variability level within a given crop's available germplasm. Heritability, genetic advance, genotypic coefficient of variation, and phenotypic coefficient of variation all serve as useful biometric indicators of genetic diversity (Manjunath *et al.*, 2017). Examining the traits that contribute to yield can assist breeders in identifying desirable genotypes for enhancing yield and other agronomic characteristics. By studying the genetic architecture of yield, breeders can select genotypes with high yield potential and desired combinations of traits (Khan and Dar, 2010). 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). Considering these points, the present investigation was undertaken to study the genetic variability and character association analysis in Indian mustard.

Materials and Methods

The present investigation was conducted during rabi season 2022-23 and 2023-24 under early and late sown conditions at research farm, Department of Genetics and Plant breeding, Kisan P.G. College, Simbhaoli, Hapur (U.P.), India. In present study, forty genotypes of Indian mustard were selected for sowing. These genotypes were planted under randomized block design with three replications and each plot was consisted of single row of three-meter length. The inter and intra row spacing were kept at 30 cm and 15 cm, respectively. All the recommended agricultural practices were adopted to raise a healthy crop. Observations were recorded on five randomly selected plants of each genotype from each replication for 13 characters.

The data were recorded for the following 13 characters namely days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, biological yield (g), number of siliqua per plant, length of siliqua (cm), seeds per siliqua, thousand seed weight (g), harvest index (%), oil content (%) and seeds yield per plant (g). The oil content was recorded by using Fourier Transform Near-Infrared Reflectance Spectroscopy (FT-NIRS) at DRM, Bharatpur, Rajasthan. Plot means were used for different statistical analyses *viz.*, analysis of variance (ANOVA) as per (Panse and Sukhatme, 1967); PCV and GCV as per (Burton and Devane, 1953); heritability (broad sense) and genetic advance as per (Lush, 1940); phenotypic and genotypic correlation coefficient as per (AL- Jibouri *et al.*, 1958) and path coefficient analysis computed as per (Dewey and Lu, 1959). In present investigation, path coefficient analysis was performed with seed yield per plant as the dependent variable and other observed traits as independent variables.

Results and Discussion

The analysis of variance (ANOVA) of different environments (E1, E2, E3 and E4) as well as pooled data explored significant difference for thirteen studied traits across forty mustard genotypes (table 1), as shown in table 2. These results explored a great degree of genetic variation among all the genotypes for all the traits undertaken present study gives a clue for further analysis of variability parameters of Indian mustard. Similar finding was also observed by (Kumar and Pandey, 2013, Shrivastava *et al.*, 2023 and Choudhary *et al.*, 2023). The estimates of genotypic coefficient of variation (GCV) phenotypic coefficient of variation (PCV), heritability (broad sense), genetic advance and genetic advance as a percentage of mean are shown in table 3. The genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance were found to be higher for the biological yield, number of siliqua per plant and days to 50% flowering in almost all environments as well as in pooled data. Similar findings were reported by (Gupta *et al.*, 2019, Patel *et al.*, 2019, Rout *et al.*, 2019 and Awasthi *et al.*, 2020).

Table 1. List of the diverse genotypes used in present study

S. N.	Name of Genotypes	S. N.	Name of Genotypes
1.	KMR-850	21.	Pusa Jai kisan
2.	Pusa Bahar	22.	KMR-18-3
3.	KMR-14-1	23.	KMR-18-4
4.	Pusa Mahak	24.	KMR-15-2
5.	Azad Chetna	25.	RLM 619
6.	PM-28	26.	KMR-19-4
7.	Pusa Tarak	27.	KMR-19-5
8.	Jawahar Mustard	28.	KMR-17-5
9.	Kranti	29.	BR-40
10.	CS-54	30.	Pusa Bold
11.	Jagan Nath	31.	KMR-16-2
12.	Aravali	32.	PM-29
13.	DRMR-IJ-31	33.	Pusa Agrani
14.	Vaibhav	34.	KMR-15-1
15.	KMR-17-4	35.	RH-40-6
16.	Varun	36.	KMR-17-3
17.	KMR-17-2	37.	KMR-16-3
18.	TKM 19-1	38.	Gujrat Mustard
19.	RH-819	39.	KMR-40-60
20.	RH-30R-17-18	40.	KMR-18-1

High heritability (broad sense) coupled with high genetic advance as a percentage of the mean was observed for 1000 seed weight, seed yield, biological yield, days to 50 % flowering, seeds per siliqua and harvest index was observed in most of the environments and in pooled data. High heritability in conjunction with high genetic advance indicated additive gene effects, but high heritability in conjunction with low genetic advance indicated dominance and epistatic effects. These findings are supported by (Devi, 2018, Rout *et al.*, 2019 and Pradhan *et al.*, 2021). The significant correlation coefficient at phenotypic level under different environments and pooled data for 13 characters is present in table 4. In general, the value of genotypic correlation coefficient was higher than the values of phenotypic correlation coefficient showing the interaction of environments effects. In present investigation, the significance of only phenotypic correlation coefficient was tested. Among the thirteen characters studied, the seed yield showed significant and positive association with biological yield and number of siliqua per plant in E1, E2, E3 (E=Environment) and pooled data; positive association with harvest index E1, E2, E4 and pooled data; positive association with number of primary branches per plant, number of secondary branches per plant and siliqua length in

E1, E2 and pooled data; positive association with seeds per siliqua in E1 and pooled data. Seed yield not showed any negative association with any trait in all environments and pooled data. Among the significant *inter se* association, biological yield showed positive association with number of primary branches per plant in E1, E2 and pooled; with number of secondary branches per plant in E1, E2, E3 and pooled data. Other significant *inter se* are also present which are given in table 4. Most of the *inter se* association were positive in most of the environments. Similar findings were observed by (Shrivastava *et al.*, 2023). Only very few *inter se* association were found negative in few environments. Only oil content showed negative association with days to 50 % flowering and days to maturity only in E3 and pooled data; harvest index showed negative association with number of secondary branches per plant and biological yield only in very few environments and biological showed negative association with days to 50 % flowering and days to maturity in E4 only.

These finding are supported by (Sur *et al.*, 2023) and is not recommended for selection to improve seed yield. All significant association are given in table 4. The path coefficient analysis was carried out with the objectives of assessing the direct and indirect contribution of different characters towards seed yield in different environments (E1, E2, E3 and E4) as well as in pooled data and only the effects at phenotypic level described in view of their relevance in making visual or direct selection. 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. The direct effects, indirect effects via biological yield and indirect effects via harvest index towards seed yield at phenotypic level under different environments and pooled data is given in table 5. The direct and indirect effects are not consistent in all the environments. A perusal of the table 5 indicated that the range of the magnitude of direct effect for harvest index were highest (0.6528 – 1.3783) in most of the environments followed by biological yield (0.4964-1.1888). The magnitude of direct effect were highest for biological yield in E3 and pooled data and harvest index in E1, E2 and E4.

Table 2. Analysis of variance for 13 characters in forty genotypes under different environments and pooled data in Indian mustard

S. N.	Source of Variation	df	Env.	DF	DM	PHT	PB	SB	BY	NSPP	SL	SPS	TSW	HI	OC	SY
1	Replications	2	E1	1.66	10.13	2.38	0.534	0.203	3.69	2099.20	0.003	1.23	0.034	1.41	0.01	0.40
			E2	1.60	12.66	20.18	0.303	0.721	1.11	537.71	0.091	0.84	0.188	0.30	0.08	0.00
			E3	4.01	15.41	40.93	0.103	1.47	101.38	357.74	0.012	0.40	0.01	73.04	0.16	1.00
			E4	1.76	6.43	39.73	0.008	3.89	20.33	117.77	0.155	0.72	0.014	39.50	0.33	2.08
			Pooled	0.90	10.28	3.32	0.023	1.11	9.33	115.10	0.024	0.39	0.01	14.54	0.01	0.58
2	Treatments	39	E1	127.32**	129.00**	333.69**	1.277**	2.270**	307.39**	6477.37**	0.237**	19.21**	3.400**	64.39**	24.73**	34.57**
			E2	112.90**	127.40**	172.66**	0.719**	1.303**	266.78**	6523.72**	0.335**	22.38**	3.302**	91.10**	22.65**	58.12**
			E3	123.51**	132.90**	752.71**	0.478**	4.30**	877.64**	16997.52**	0.132**	10.01**	3.47**	109.67**	25.82**	15.85**
			E4	115.52**	122.82**	371.60**	0.462**	2.41**	492.81**	12032.83**	0.117**	10.63**	3.674**	119.21**	23.40**	14.35**
			Pooled	111.11**	104.42**	132.18**	0.161**	0.86**	147.76**	2912.01**	0.060**	5.73**	3.39**	18.27**	16.27**	12.28**
3	Error	78	E1	1.87	1.81	20.26	0.159	0.379	4.72	311.34	0.039	0.49	0.012	1.37	0.02	0.38
			E2	1.81	2.57	34.74	0.207	0.278	5.55	544.38	0.051	0.69	0.028	1.61	0.05	0.29
			E3	2.73	3.90	21.13	0.162	0.24	12.07	304.85	0.064	2.23	0.03	6.71	0.04	0.67
			E4	4.04	6.55	21.61	0.123	0.57	13.25	69.55	0.043	1.96	0.022	4.91	0.01	0.41
			Pooled	1.09	1.61	7.07	0.036	0.10	2.41	70.55	0.013	0.25	0.01	1.29	0.01	0.15

Note: ** = Significant at P = 0.01 level, Env. = Environments

DF- Days to 50% flowering, DM- Days to maturity, PHT- Plant height (cm), PB- No. of primary branches/ plant, SB- No. of secondary branches/ plant, BY- Biological yield(g), NSPP- No. of siliqua/ plant, SL- Length of siliqua (cm), SPS- Seeds/ siliqua, TSW- Thousand seed weight (g), HI- Harvest index (%), OC- Oil content (%), SY- Seed yield (g)

Table 3. Heritability (Broad sense), genetic advance, genetic advance as percentage of mean, genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for thirteen characters under different environments and pooled data

S. N.	Characters	Heritability					GA					GA as % of mean				
		E1	E2	E3	E4	Pooled	E1	E2	E3	E4	Pooled	E1	E2	E3	E4	Pooled
1.	Days to 50 % flowering	95.71	95.35	93.64	90.19	97.12	13.03	12.24	12.65	11.93	12.29	21.96	20.64	21.12	19.93	20.63
2.	Days to maturity	95.91	94.18	91.69	85.54	95.52	13.14	12.90	12.94	11.86	11.79	8.43	8.26	8.26	7.56	7.54
3.	Plant height (cm)	83.76	56.96	92.03	84.37	85.50	19.27	10.54	30.86	20.44	12.30	11.07	6.03	17.59	11.79	7.05
4.	No. of primary branches/ plant	70.14	45.16	39.45	47.94	53.93	1.05	0.57	0.42	0.48	0.31	17.92	9.35	8.08	9.48	5.55
5.	No. of second. branches/ plant	62.46	55.10	85.07	51.83	71.37	1.29	0.89	2.21	1.16	0.87	12.77	8.84	19.40	9.87	8.05
6.	Biological yield (g)	95.53	94.01	95.98	92.35	95.27	20.22	18.64	34.28	25.03	14.00	35.31	35.22	60.78	43.30	24.95
7.	No. of siliqua per plant	86.85	78.55	94.81	98.29	93.07	87.03	81.51	149.62	128.97	61.16	23.79	21.49	60.85	35.11	18.01
8.	Length of siliqua (cm)	62.59	65.08	26.37	36.14	54.59	0.42	0.51	0.16	0.19	0.19	8.72	10.75	3.43	4.14	4.04
9.	Seeds per Siliqua	92.79	91.28	53.71	59.65	88.14	4.96	5.29	2.43	2.71	2.61	30.59	32.32	15.84	17.77	16.55
10.	Thousand seed weight (g)	98.97	97.54	97.11	98.21	99.45	2.18	2.13	2.17	2.25	2.18	48.58	46.89	48.13	49.63	48.27
11.	Harvest index (%)	93.88	94.87	83.64	88.59	81.40	9.15	10.96	11.04	11.97	4.42	38.18	55.33	42.14	47.27	18.56
12.	Oil content (%)	99.78	99.32	99.55	99.89	99.86	5.91	5.63	6.03	5.75	4.79	15.14	14.33	15.45	14.65	12.24
13.	Seed yield (g)	96.79	98.53	88.29	91.81	96.34	6.84	8.98	4.35	4.25	4.07	50.09	84.40	31.70	30.94	31.41

Table 3. Continued

S. N.	Characters	GCV					PCV				
		E1	E2	E3	E4	Pooled	E1	E2	E3	E4	Pooled
1.	Days to 50 % flowering	10.90	10.26	10.60	10.19	10.16	11.14	10.51	10.95	10.73	10.31
2.	Days to maturity	4.18	4.13	4.19	3.97	3.74	4.27	4.26	4.37	4.29	3.83
3.	Plant height (cm)	5.87	3.88	8.90	6.23	3.70	6.41	5.14	9.28	6.78	4.00
4.	No. of primary branches/ plant	10.39	6.76	6.25	6.65	3.67	12.41	10.06	9.95	9.60	5.00
5.	No. of secondary branches/ plant	7.85	5.78	10.21	6.65	4.63	9.93	7.79	11.07	9.24	5.48
6.	Biological yield (g)	17.54	17.63	30.12	21.88	12.41	17.94	18.19	30.74	22.76	12.71
7.	No. of siliqua per plant	12.39	11.77	30.34	17.19	9.06	13.30	13.28	31.16	17.34	9.39
8.	Length of siliqua (cm)	5.35	6.47	3.24	3.34	2.65	6.76	8.02	6.31	5.55	3.59
9.	Seeds per siliqua	15.41	16.42	10.49	11.17	8.56	16.00	17.19	14.31	14.46	9.12
10.	Thousand seed weight (g)	23.71	23.05	23.71	24.31	23.50	23.83	23.34	24.06	24.53	23.56
11.	Harvest index (%)	19.13	27.58	22.37	24.38	9.99	19.74	28.31	24.45	25.90	11.07
12.	Oil content (%)	7.36	6.98	7.51	7.11	5.95	7.36	7.00	7.53	7.12	5.95
13.	Seed yield (g)	24.72	41.28	16.38	15.68	15.53	25.12	41.58	17.43	16.36	15.83

Table 4. Significant correlation coefficients at phenotypic level under different environments and pooled data in Indian mustard

S. N.	Character Combination	Significant Correlation Coefficient				
		E1	E2	E3	E4	Pooled
1.	Seed yield vs. No. of Primary branches/ plant	0.578**	0.373*	-	-	0.445**
	vs. No. of secondary branches/ plant	0.534**	0.520**	-	-	0.394**
	vs. Biological yield (g)	0.625**	0.730**	0.625**	-	0.714**
	vs. No. of siliqua per plant	0.614**	0.560**	0.579**	-	0.623**
	vs. Length of siliqua (cm)	0.467**	0.678**	-	-	0.375*
	vs. Seeds per siliqua	0.611**	-	-	-	0.347*
	vs. Thousand seed weight (g)	0.369*	-	-	-	-
	vs. Harvest index (%)	0.677**	0.861**	-	0.543**	0.575**
2.	Oil content vs. Days to 50 % flowering	-0.449**	-	-0.440**	-	-0.394**
	vs. Days to maturity	-	-	-0.446**	-	-0.371*
	vs. Harvest index (%)	-	-	-	-	0.332*
3.	Harvest index vs. Days to maturity	-	-	-	0.401**	-
	vs. Plant height (cm)	-	-	-	0.306*	-
	vs. No. of secondary branches/ plant	-	0.367*	-0.365*	-	-
	vs. Biological yield (g)	-	-	-0.770**	-0.739**	-
	vs. No. of siliqua per plant	-	0.469**	-	-	-
	vs. Length of siliqua (cm)	0.328*	0.559**	-	-	-
	vs. Seeds per siliqua	0.431**	-	-	-	-
	vs. Thousand seed weight (g)	0.461**	-	-	-	-
4.	Seeds per siliqua vs. No. of Primary branches/ plant	0.359*	-	-	-	-
	vs. No. of secondary branches/ plant	0.305*	-	-	-	-
	vs. Biological yield (g)	0.377*	0.348*	-	-	0.409**
	vs. No. of siliqua per plant	0.338*	0.339*	0.374*	-	-
	vs. Length of siliqua (cm)	0.324*	-	-	-	0.315*
5.	Length of siliqua vs. No. of Primary branches/ plant	0.348*	0.383*	-	-	-
	vs. No. of secondary branches/ plant	0.433**	0.310*	-	-	-
	vs. Biological yield (g)	-	0.529**	-	-	0.398**
	vs. No. of siliqua per plant	0.505**	0.330*	-	-	-
6.	No. of siliqua / plant vs. No. of Primary branches/ plant	0.477**	-	-	-	-
	vs. No. of secondary branches/ plant	0.561**	0.347*	-	0.358*	0.363*
	vs. Biological yield (g)	0.607**	0.440**	0.545**	-	0.567**
7.	Biological yield vs. Days to 50 % flowering	-	-	-	-0.409**	-
	vs. Days to maturity	-	-	-	-0.396**	-
	vs. No. of Primary branches/ plant	0.426**	0.356*	-	-	0.367*
	vs. No. of secondary branches/ plant	0.454**	0.483**	0.412**	-	0.423**
8.	No. of secondary. branches / plant vs. No. of Primary branches/ plant	0.475**	-	-	-	-
	Plant height vs. Days to 50 % flowering	-	-	0.400**	-	-
9.	vs. Days to maturity	-	-	0.394**	-	-
	Days to maturity vs. Days to 50 % flowering	0.439**	0.755**	0.759**	0.720**	0.756**

Note: *, ** = Significant at P = 0.05 and P = 0.01 levels, respectively

Table 5. Direct effect (DE), indirect effect (IE) via biological yield (BY) and indirect effect (IE) via harvest index (HI) towards seed yield at phenotypic level under different environments and pooled data in Indian mustard

S.N. Characters	E1			E2			E3			E4			Pooled		
	DE	IE via BY	IE via HI	DE	IE via BY	IE via HI	DE	IE via BY	IE via HI	DE	IE via BY	IE via HI	DE	IE via BY	IE via HI
1 DF	-0.0183	0.0095	-0.0062	-0.0165	-0.1012	-0.1836	0.0326	0.0118	-0.1165	-0.0305	-0.4678	0.3190	0.0410	-0.2555	-0.0412
2 DM	0.0060	-0.1606	-0.0843	0.0016	-0.0620	-0.1117	0.0867	0.2195	-0.2193	0.0705	-0.4527	0.5534	0.0114	-0.1235	0.0294
3 PHT	-0.0160	-0.0337	-0.0117	-0.0106	0.0048	0.0144	0.0665	0.1704	-0.2465	-0.0621	-0.3344	0.4214	0.0205	-0.1901	-0.1155
4 PB	0.0540	0.2898	0.2206	0.0349	0.1767	0.1522	-0.0372	-0.0420	0.0215	-0.0011	-0.0570	0.1605	0.0117	0.3044	0.1220
5 SB	-0.0117	0.3083	0.1925	0.0108	0.2397	0.2527	0.0645	0.4893	-0.3265	-0.0661	0.0108	0.2563	-0.0220	0.3506	0.0743
6 BY	0.6798	-	-0.0985	0.4964	-	0.2054	1.1888	-	-0.6898	1.1437	-	-1.0192	0.8291	-	-0.0803
7 NSPP	0.0448	0.4124	0.1377	0.0041	0.2182	0.3228	0.2210	0.6479	-0.1928	0.0607	-0.2424	0.3742	0.0303	0.4700	0.1531
8 SL	-0.0162	0.2006	0.2441	0.0077	0.2624	0.3848	-0.0057	0.0298	-0.0582	-0.0336	0.0702	0.0555	-0.0003	0.3302	0.0722
9 SPS	0.0061	0.2560	0.3202	-0.0007	0.1729	0.1151	-0.1258	0.2072	-0.0281	-0.0184	0.1365	-0.1181	-0.0447	0.3388	0.0403
10 TSW	0.0142	-0.0154	0.3430	-0.0097	-0.0320	-0.1163	0.1257	-0.0326	0.0202	0.0264	-0.0192	0.0539	0.0688	-0.0109	0.0959
11 HI	0.7436	-0.0900	-	0.6885	0.1481	-	0.8955	-0.9158	-	1.3783	-0.8457	-	0.6528	-0.1020	-
12 OC	-0.0122	-0.1453	0.1063	0.0033	0.1251	0.1290	0.0775	-0.3505	0.2035	0.0301	-0.1655	0.1152	0.0485	-0.1541	0.2167

Note: Residual effect- E1 = 0.0178, E2 = 0.0125, E3 = 0.215, E4 = 0.225, Pooled = 0.03576

DE = Direct effect, IE = Indirect effects, BY = Biological yield, HI = Harvest index

DF- Days to 50% flowering, DM- Days to maturity, PHT- Plant height (cm), PB- No. of primary branches/ plant, SB- No. of secondary branches/ plant, BY- Biological yield (g), NSPP- No. of siliqua per plant, SL- Length of siliqua (cm), SPS- Seeds/ siliqua, TSW- Thousand seed weight (g), HI- Harvest index (%), OC- Oil content (%), SY- Seed yield (g)

For rest of the characters, the magnitudes of direct effect were low to very low. Among all the characters, the indirect effects of different characters were important for only biological yield and harvest index. Among these characters, primary branches per plant, secondary branches per plant, number of siliqua per plant, siliqua length and seeds per siliqua exhibited relatively high and positive indirect effects towards seed yield via biological yield in most of the environments and pooled data. Among these characters primary branches per plant, secondary branches per plant, number of siliqua per plant, siliqua length, seeds per siliqua, 1000 seed weight and oil content exhibited relatively high and positive indirect effects towards seed yield via harvest index in most of the environments.

Days to 50 % flowering, days to maturity and plant height exhibited positive indirect effects towards seed yield via biological yield and harvest index in almost all environments. The magnitude of direct effect and indirect effect through different characters were not isodirectional and not found worth mentioning. Similar results were reported by biological yield and harvest index by (Choubey *et al.*, 2022). 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.

References

- Anonymous (2023) Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Agricultural Statistics at a Glance, pp: 52.
- Akbar, M., Tariq, M., Yaqub, M., Anwar, M., Ali, M. and Iqbal, N. (2003) Variability, correlation and path coefficient studies in summer mustard [*Brassica juncea* (L.) Czern. & Coss.], *Asian Journal of Plant Sciences*, 2(9): 696-698.
- Ali, N., Farzad, J., Jaferieh, Y. E. and Mýrza, M. Y. (2003) Relationship among yield components and selection criteria for yield improvement in winter rapeseed [*Brassica napus* (L.) Czern. & Coss.], *Pakistan Journal of Botany*, 35(2): 167-174.
- Awasthi, D., Tiwari, V. K. and Kandalkar, V. S. (2020) Evaluation of heritability and genetic advance for morphological traits of Indian mustard germplasm, *Current Journal of Applied Sciences and Technology*, 39(21): 39-47.
- Chaubey, P., Singh, O. P., Yadav, V. and Nishad, Y. (2022) Correlation and path coefficient analysis for yield and its associated characters of Indian mustard (*Brassica juncea* L. Czern & Coss), *The Pharma Innovation Journal*, 11(8): 1911-1917.

- Choudhary, R. R., Singh, R. A. M. and Bishnoi, M. (2023) Genetic parameters and correlation studies in Indian mustard (*Brassica juncea* L.), *Journal of Oilseed Brassica*, 14(1): 68-72.
- Devi, B. (2018) Correlation and path analysis in Indian mustard (*B. juncea*) in agro-climatic condition of Jhansi (UP), *Journal of Pharmacognosy and Phytochemistry*, 7(1): 1678-1681.
- Gupta, M., Roy, H. S. and Bhadauria, S. S. (2019) Genetic variability analysis in F2/ F3 population derived through inter-specific hybridization in oilseed Brassica, *Electronic Journal of Plant Breeding*, 10(3): 1275-1282.
- ICAR-DRMR (2023-24) Data for the year 2023-24, 3rd Advance Estimates, DA & FW.
- Kumar, B. and Pandey, A. (2013) Diversity analysis in Indian mustard (*Brassica juncea* L. Czern & Coss), *Madras Agricultural Journal*, 100(1-3): 62-66.
- Manjunath, K., Bhagwat, V. R. and Patil, R. K. (2017) Studies on genetic variability and character association in Indian mustard (*Brassica juncea* L.), *Journal of Oilseed Brassica*, 8: 26-32.
- Patel, J. R., Prajapati, K. P., Patel, B. K., Patel, M. K., Patel, A. M., Jat, A. M., and Desai, A. G. (2019) Genetic variability and character association analysis for seed yield and its attributes in Indian mustard (*B. juncea*), *Pharma Innovation*, 8(4): 872-876.
- Pradhan, A. M., Chaudhary, M. R., Sawarkar, A. and Das, S. (2021) Genetic analysis of some genotypes of Indian mustard (*B. juncea*) for yield and yield attributing traits, *Current Journal of Applied Science and Technology*, 40(35): 51-60.
- Rout, R. K., Kerkhi, S. A. and Gupta, A. (2019) Estimation of genetic variability, heritability and Genetic advance in relation to seed yield and its attributing traits in Indian mustard, *Journal of Pharmacognosy and Phytochemistry*, 8(3): 4119-4123.
- Sarawgi, A. K., Rastogi, N. K. and Soni, D. K. (1997) Correlation and path analysis in rice accessions from Madhya Pradesh, *Field Crops Research*, 52(1-2): 161-167.
- Shrivastava, A., Tripathi, M. K., Solanki, R. S., Tiwari, S., Tripathi, N., Singh, J. and Yadav, R. (2023) Genetic correlation and path coefficient analysis of yield attributing parameters in Indian mustard, *Current Journal of Applied Science and Technology*, 42(7): 42-58.
- Singh, M., Tomar, A., Mishra, C. N. and Srivastava, S. B. L. (2011) Genetic parameters and characters association studies in Indian mustard, *Journal of Oilseed Brassica*, 2(1): 35-38.
- Sur, B., Rout, S., Singla, S., Mandal, R., Nath, S., Maying, B. and Roy, S. K. (2023) Evaluation of mustard genotypes [*Brassica juncea* (L.) Czern and Coss] for quantitative traits and character association of seed yield and yield components at sub-Himalayan region of West Bengal (India), *Plant Science Today*, 10(1): 166-178.