



# International Journal of Research in Agronomy

E-ISSN: 2618-0618

P-ISSN: 2618-060X

© Agronomy

[www.agronomyjournals.com](http://www.agronomyjournals.com)

2024; SP-7(9): 784-791

Received: 23-06-2024

Accepted: 29-07-2024

**Keshav Babu**

Department of Genetics and Plant Breeding, Chandra Shekhar Azad University of Agriculture and Technology, Uttar Pradesh, India

**Mahak Singh**

Department of Genetics and Plant Breeding, Chandra Shekhar Azad University of Agriculture and Technology, Uttar Pradesh, India

**RK Yadav**

Department of Genetics and Plant Breeding, Chandra Shekhar Azad University of Agriculture and Technology, Uttar Pradesh, India

**VK Yadav**

Department of Genetics and Plant Breeding, Chandra Shekhar Azad University of Agriculture and Technology, Uttar Pradesh, India

**Lokendra Singh**

Department of Genetics and Plant Breeding, Chandra Shekhar Azad University of Agriculture and Technology, Uttar Pradesh, India

**Shweta**

Department of Genetics and Plant Breeding, Chandra Shekhar Azad University of Agriculture and Technology, Uttar Pradesh, India

**CL Maurya**

Department of Seed Science and Technology Chandra Shekhar Azad University of Agriculture and Technology, Uttar Pradesh, India

**Ravi Dixit**

Department of Seed Science and Technology Chandra Shekhar Azad University of Agriculture and Technology, Uttar Pradesh, India

**Corresponding Author:**

**Keshav Babu**

Department of Genetics and Plant Breeding, Chandra Shekhar Azad University of Agriculture and Technology, Uttar Pradesh, India

## Study on correlation coefficient, direct and indirect effect of various characters on seed yield and quality traits in Indian mustard [*Brassica juncea* (L.) Czern and Coss]

**Keshav Babu, Mahak Singh, RK Yadav, VK Yadav, Lokendra Singh, Shweta, CL Maurya and Ravi Dixit**

DOI: <https://doi.org/10.33545/2618060X.2024.v7.i9Sk.1596>

### Abstract

A study was conducted to evaluate correlation and path analysis of 18 yield and quality characters in Indian mustard (*Brassica juncea*). 15 lines and 4 and their crosses were evaluated during 2023-24 in randomized block design with three replications at CSAUA&T Kanpur. At phenotypic and genotypic level, seed yield per plant exhibits significant and positive correlation with harvest index in both F<sub>1</sub> and F<sub>2</sub> generation. High direct positive impact on seed yield at phenotypic level exerted by harvest index and biological yield/plant in both F<sub>1</sub>'s and F<sub>2</sub>'s. At genotypic level high direct positive impact on seed yield exerted by harvest index, biological yield/plant in F<sub>1</sub> and by oil content, plant height in F<sub>2</sub> generation. Hence these characters given more weightage in selection programme of high yielding genotypes.

**Keywords:** Correlation coefficient, path coefficient, *Brassica juncea*

### Introduction

Indian mustard [*Brassica juncea* (L.) Czern and Coss] is the second most important oilseed crop of the world as well as India after groundnut. It is a natural amphidiploid (2n=36) of *Brassica campestris* (2n=20) and *Brassica nigra* (2n=16). Indian mustard is popularly known as rai, raya or laha and it occupies considerably large acreage among the Brassica group. These crops are grown in diverse agro-climatic conditions varying from north-eastern/north-western hills down south under irrigated/rainfed, timely/late sown and sole/mixed cropping in leading states Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat, Haryana, West Bengal, Assam, Bihar and Punjab. The estimated area, production and productivity of rapeseed-mustard in the world was 42.53 million hectares (mha), 88.07 million tonnes (mt) and 2070 kg/ha, respectively. Globally, India account for 21.7% and 14.1% of the total acreage and production (USDA). In India, the estimated area, production and productivity of rapeseed-mustard was 9.57 million hectares (mha), 11.52 million tonnes (mt) and 1203 kg/ha, respectively, during 2022-23 (Anonymous, 2023) [1]. In terms of area under oilseeds, India holds premier position in the world but the yield of the most of oilseeds is less than the world average. (India). Yield is a complex character, which is highly influenced by the environment, hence direct selection for yield alone limits the selection efficiency and ultimately results in limited success in yield improvement. Thus, effective improvement in yield may be brought about through selection of yield component characters. Yield component characters show association among themselves and also with yield. Correlation is the measure of mutual relationship between two variables and measures the degree of closeness and the linear relationship between them. Path coefficient analysis is a partial regression technique which separates the direct effects from the indirect effects through other related characters by partitioning the correlation coefficient into direct and indirect effects on yield. It is most efficient method to establish relationships among the variables that affect grain yield as it allows determination of the relative magnitude of each. Therefore, the objective of this study was to assess the association among yield and yield contributing traits and identify

traits those have the most direct and indirect effects on grain yield

### Materials and Methods

The investigating material consisting of 139 genotypes (19 parents, 60 F<sub>1</sub>S and 60 F<sub>2</sub>S crosses) was sown on 5<sup>th</sup> November, 2023 in a randomized block design with three replications during rabi season at crop research farm Nawabganj of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. Each parent and F<sub>1</sub> was planted in single row while each F<sub>2</sub>S planted in two rows, of 5 meter long and 45 cm apart, 15 cm Plant to plant distance was maintained by thinning. All the recommended cultural practices were applied to raise good crop. Observations were recorded on Days to 50% flowering, Days to maturity, Plant height, Number of primary branches/plant, Number of secondary branches/plant, Leaf area index, Length of main raceme, Number of siliquae on main raceme, Number of siliquae/plant, Number of seeds/ siliquae, 1000-seed weight, Oil content, Methionine content, Tryptophan content, Protein content, Harvest-index, Biological yield/plant, Seed yield/plant. The partitioning of genotypic and phenotypic correlation coefficient of traits in to direct and indirect effect was carried out using standard procedure.

### Result and Discussion

#### Correlation coefficient

The study of correlation provides an estimate of association between various characters. The yield, prime object for breeder, is a complex and polygenic character and highly influenced by environment. So direct selection only through yield would not be effective. Correlation studies of yield and its component characters decide the selection criteria to be adopted. The data available to the plant breeder on two or more plant characteristics of a sample or a group of strains of a particular crop helps immensely in estimating the degree of association among them (Table 1a, 1b, 1c and 1d). The concept of correlation was presented and elaborated by Fisher (1918) and Wright (1921) [4]. De Vries stated that correlation between botanical markers and breeding qualities are to be considered as reliable guide lines in the work of association. Duwey and Lu (1959) [3] emphasized to recognized to nature o population under consideration as the magnitude of correlation coefficient. In the present investigation, the association study was taken up among F<sub>1</sub> and F<sub>2</sub> derived from Line x Tester design. In general, the phenotypic correlation are in same direction but lower in magnitude revealing the pleiotropic effects rather than linkage for these association.

Phenotypic correlation in F<sub>1</sub> generation seed yield /plant exhibited highly significant and positive correlation with harvest index (0.906) followed by number of primary branches (0.441), tryptophan content (0.418), length of main raceme (0.417), oil content (0.409), number of siliquae /plant (0.392), leaf area index (0.358), protein content (0.338), number of secondary branches /plant (0.275), number of seeds /siliquae (0.267), methionine content (0.264), number of siliquae on main raceme (0.228). While highly significant negative correlation with days to 50% flowering (-0.221), days to maturity (-0.188). Non-significant positive correlation with 1000 seed weight, and non-significant negative correlation with plant height (-0.118), biological yield /plant (-0.068).

In F<sub>2</sub> generation seed yield / plant exhibited positive highly significant association at phenotypic level with harvest index (0.924) followed by plant height (0.284), length of main raceme (0.193) and highly significant negative correlation with

tryptophan content (-0.234). Significant negative correlation with number of secondary branches/plant (-0.157), number of siliquae on main raceme (-0.143). while non-significant positive correlation with protein content (0.110) followed by leaf area index (0.099), oil content (0.095), biological yield/ plant (0.043), 1000-seed weight (0.017) and non-significant negative correlation with number of siliquae/plant (-0.098), Days to 50% flowering (-0.073), number of seeds/siliquae (-0.022), Days to maturity (-0.019), methionine content (-0.017), number of primary branches/plant (-0.012). Highly significant positive correlation observed between days to 50% flowering with number of seeds/siliquae (0.205) followed by number of primary branches/plant (0.187), and significant positive correlation with number of siliquae on main raceme (0.135). Positive non-significant correlation with number of secondary branches/plant (0.118), 1000-seed weight (0.093), tryptophan content (0.032). While negative significant correlation with leaf area index (-0.148), oil content (-0.132) and negative non-significant correlation with methionine content (-0.105) followed by days to maturity (-0.103), plant height (-0.103), harvest index (-0.074), protein content (-0.058), biological yield/plant (-0.036), length of main raceme (-0.010). Similar finding also reported by Binesh *et al.*, (2012) [5], Ara *et al.*, (2013) [6], Tahira *et al.*, (2014) [7].

#### Genotypic correlation

In F<sub>1</sub> generation seed yield/ plant exhibited significant positive correlation with harvest-index (0.923) followed by protein content (0.618), oil content (0.540), number of primary branches/plant (0.476), length of main raceme (0.470), tryptophan content (0.444), number of siliquae/plant (0.421), leaf area index (0.382), number of seeds/ siliquae (0.307), number of secondary branches/plant (0.297), methionine content (0.291), number of siliquae on main raceme (0.265), while, significant negative correlation with days to 50% flowering (-0.264), days to maturity (-0.257), plant height (-0.152) and non-significant positive sand negative correlation with 1000-seed weight (0.071) and biological yield/plant (-0.068) respectively.

In F<sub>2</sub> generation seed yield/ plant exhibited significant positive correlation with harvest-index (0.978) followed by plant height (0.334), length of main raceme (0.212), protein content (0.187), oil content (0.162), while significant negative correlation with tryptophan content (-0.254), number of siliquae on main raceme (-0.187), number of secondary branches/plant (-0.172), and non-significant positive correlation with leaf area index (0.110), biological yield/plant (0.065), 1000-seed weight (0.017), number of seeds/ siliquae (0.001), and non-significant negative correlation with number of siliquae/plant (-0.114), days to 50% flowering (-0.107), methionine content (-0.022), days to maturity (-0.010), number of primary branches/plant (-0.003). Similar results also reported by Chaturvedi *et al.*, (2021) [16], Lavanya *et al.*, (2022) [14], Evangelin *et al.*, (2023) [15].

#### Path coefficient

Path analysis partitions the correlation coefficient into direct and indirect effects of component characters (Independent variables) on yield (Dependent variable). It gives the understanding of cause-and-effect relationship between different character combinations (Table 2a, 2b, 2c and 2d). Path coefficient analysis was proposed by Wright (1921) [4] and later more lucidly explained by Dewey and Lu (1959) [3].

#### Phenotypic path

In F<sub>1</sub>'s high order of positive direct effect on seed yield/plant exhibited by harvest index (1.1293) followed by biological

**Table 1a:** Phenotypic correlation coefficient analysis of F<sub>1</sub> for seed yield and its component traits in Indian mustard

Characters	Days to 50% flowering	Days to Maturity	Plant height	No. of Primary Branches/Plant	No of secondary Branches /plant	Leaf area Index	Length of Main raceme	Siliqua on main raceme	No. of Siliqua/plant	No. of Seeds/siliqua	1000-Seed weight	Oil content	Methionine content	Tryptophan content	Protein content	Harvest-Index	Biological yield / plant	Seed yield /plant
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days to 50% flowering	1.000	0.095	0.127	-0.183**	-0.113	-0.229**	-0.080	-0.144*	-0.035	0.071	0.060	-0.141*	-0.316**	-0.292**	-0.107	-0.244**	0.129*	-0.221**
Days to maturity		1.00	0.122	-0.260**	-0.383**	-0.147*	-0.032	-0.200**	-0.267**	-0.113	-0.218**	-0.255**	-0.210**	-0.392**	-0.057	-0.264**	0.242**	-0.188**
Plant height			1.00	-0.174**	-0.132*	-0.371**	-0.019	-0.264**	-0.281**	-0.245**	-0.152*	-0.201**	-0.246**	-0.461**	-0.075	-0.205**	0.265**	-0.118
No. of primary branches/plant				1.00	0.354**	0.362**	0.199**	0.458**	0.245**	0.323**	-0.140*	0.175**	0.397**	0.415**	0.165*	0.440**	-0.124	0.441**
No. of primary branches/plant					1.00	0.139*	0.078	0.335**	0.204**	0.134*	0.116	0.372**	0.250**	0.402**	0.160*	0.267**	-0.073	0.275**
Leaf area index						1.00	0.342**	0.310**	0.263**	0.225**	0.015	0.138*	0.457**	0.356**	0.226**	0.329**	-0.044	0.358**
Length of main raceme							1.00	0.282**	0.210**	0.268**	0.100	0.194**	0.100	0.071	0.252**	0.340**	0.069	0.417**
No. of siliqua on main raceme								1.00	0.408**	0.397**	0.087	0.461**	0.248**	0.443**	0.237**	0.278**	-0.176**	0.228**
No. of siliquae/plant									1.00	0.317**	0.203**	0.420**	0.293**	0.486**	0.426**	0.446**	-0.250**	0.392**
No. of seed/siliquae										1.00	0.090	0.236**	0.197**	0.374**	0.216**	0.273**	-0.087	0.267**
1000-seed weight											1.00	0.243**	-0.145*	0.238**	0.079	0.102	-0.092	0.069
Oil content												1.00	0.107	0.445**	0.290**	0.398**	-0.097	0.409**
Methionine content													1.00	0.565**	0.158*	0.339**	-0.266**	0.264**
Tryptophan content														1.00	0.246**	0.527**	-0.394**	0.418**
Protein content															1.00	0.369**	-0.179**	0.338**
Harvest-index																1.00	-0.482**	0.906**
Biological yield/plant																	1.00	-0.068

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

**Table 1b:** Genotypic correlation coefficient analysis of F<sub>1</sub> for seed yield and its component traits in Indian mustard

Characters	Days to 50% flowering	Days to Maturity	Plant height	No. of Primary Branches/plant	No of secondary branches/plant	Leaf area Index	Length of Main raceme	Siliqua on main raceme	No. of Siliqua/plant	No. of Seeds/siliqua	1000-Seed weight	Oil content	Methionine content	Tryptophan content	Protein content	Harvest-Index	Biological yield / plant	Seed yield /plant
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days to 50% flowering	1.000	0.115	0.145*	-0.233**	-0.155*	-0.274**	-0.128*	-0.179**	-0.053	0.072	0.062	-0.224**	-0.405**	-0.339**	-0.214**	-0.313**	0.214**	-0.264**
Days to maturity		1.00	0.208**	-0.341**	-0.518**	-0.235**	-0.083	-0.277**	-0.363**	-0.173**	-0.288**	-0.399**	-0.293**	-0.538**	-0.279**	-0.373**	0.391**	-0.257**
Plant height			1.00	-0.212**	-0.154*	-0.427**	0.005	-0.305**	-0.328**	-0.309**	-0.180**	-0.282**	-0.305**	-0.528**	-0.154*	-0.255**	0.336**	-0.152*
No. of primary branches/plant				1.00	0.384**	0.385**	0.232**	0.509**	0.267**	0.372**	-0.156*	0.179**	0.424**	0.450**	0.286**	0.478**	-0.132*	0.476**
No. of primary branches/plant					1.00	0.148*	0.081	0.373**	0.215**	0.141*	0.123	0.468**	0.268**	0.427**	0.242**	0.288**	-0.072	0.297**
Leaf area index						1.00	0.376**	0.338**	0.266**	0.256**	0.014	0.178**	0.479**	0.373**	0.373**	0.358**	-0.050	0.382**
Length of main raceme							1.00	0.328**	0.237**	0.332**	0.102	0.271**	0.107	0.070	0.462**	0.379**	0.122	0.470**
No. of siliqua on main raceme								1.00	0.446**	0.467**	0.105	0.601**	0.282**	0.495**	0.414**	0.322**	-0.209**	0.265**
No. of siliquae/plant									1.00	0.355**	0.214**	0.542**	0.315**	0.507**	0.665**	0.496**	-0.320**	0.421**
No. of seed/siliquae										1.00	0.108	0.342**	0.217**	0.430**	0.367**	0.313**	-0.085	0.307**
1000-seed weight											1.00	0.292**	-0.160*	0.249**	0.118	0.106	-0.102	0.071
Oil content												1.00	0.143*	0.559**	0.544**	0.544**	-0.166*	0.540**
Methionine content													1.00	0.601**	0.268**	0.383**	-0.331**	0.291**
Tryptophan content														1.00	0.402**	0.564**	-0.450**	0.444**

Protein content															1.00	0.692**	-0.372**	0.618**
Harvest-index																1.00	-0.444**	0.923**
Biological yield/plant																	1.00	-0.068

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

**Table 1c:** Phenotypic correlation coefficient analysis of F<sub>2</sub> for seed yield and its component traits in Indian mustard

Characters	Days to 50% flowering	Days to Maturity	Plant height	No. of Primary Branches/plant	No of secondary Branches /plant	Leaf area Index	Length of Main raceme	Siliqua on main raceme	No. of Siliqua/plant	No. of Seeds/siliqua	1000-Seed weight	Oil content	Methionine content	Tryptophan content	Protein content	Harvest-Index	Biological yield / plant	Seed yield /plant
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days to 50% flowering	1.000	-0.103	-0.086	0.187**	0.118	-0.148*	-0.010	0.135*	0.095	0.205**	0.093	-0.132*	-0.105	0.032	-0.058	-0.074	-0.036	-0.073
Days to maturity		1.00	0.029	-0.051	-0.140*	0.108	0.062	-0.058	0.004	0.120	-0.026	0.100	0.058	-0.037	0.003	-0.047	0.090	-0.019
Plant height			1.00	-0.194**	-0.062	0.180**	0.180**	0.075	0.033	0.049	-0.050	0.154*	0.126	-0.127*	0.133*	0.178**	0.263**	0.284**
No. of primary branches/plant				1.00	-0.064	0.177**	-0.048	0.123	-0.141*	0.115	-0.190**	-0.037	-0.041	0.105	-0.098	-0.053	0.100	-0.012
No. of primary branches/plant					1.00	0.023	-0.059	0.076	0.064	-0.115	0.158*	0.034	-0.061	0.012	-0.032	-0.156*	0.020	-0.157*
Leaf area index						1.00	0.011	-0.181**	-0.163*	0.125	0.001	0.046	0.241**	0.161*	-0.038	0.060	0.087	0.099
Length of main raceme							1.00	0.055	0.135*	0.103	0.112	-0.003	0.107	-0.050	0.167*	0.155*	0.111	0.193**
No. of siliqua on main raceme								1.00	0.225**	0.240**	-0.095	-0.097	-0.198**	-0.048	0.055	-0.187**	0.122	-0.143*
No. of siliquae/plant									1.00	0.059	-0.187**	0.043	-0.109	-0.187**	0.063	-0.077	-0.060	-0.098
No. of seed/siliquae										1.00	-0.031	-0.113	-0.128*	0.039	0.125	-0.023	0.013	-0.022
1000-seed weight											1.00	0.018	0.040	0.046	0.024	-0.006	0.070	0.017
Oil content												1.00	0.141*	-0.008	0.051	0.059	0.120	0.095
Methionine content													1.00	0.441**	0.008	-0.026	0.027	-0.017
Tryptophan content														1.00	-0.080	-0.242**	0.018	-0.234**
Protein content															1.00	0.113	-0.059	0.110
Harvest-index																1.00	-0.201**	0.924**
Biological yield/plant																	1.00	0.043

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

**Table 1d:** Genotypic correlation coefficient analysis of F<sub>2</sub> for seed yield and its component traits in Indian mustard

Characters	Days to 50% flowering	Days to Maturity	Plant height	No. of Primary Branches/plant	No of secondary branches/ plant	Leaf area Index	Length of Main raceme	Siliqua on main raceme	No. of Siliqua/plant	No. of Seeds/siliqua	1000-Seed weight	Oil content	Methionine content	Tryptophan content	Protein content	Harvest-Index	Biological yield / plant	Seed yield /plant
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days to 50% flowering	1.000	-0.195**	-0.186**	0.202**	0.157*	-0.208**	0.037	0.215**	0.144*	0.323**	0.117	0.228**	-0.145*	0.009	-0.150*	-0.074	-0.075	-0.107
Days to maturity		1.00	0.195**	-0.056	-0.263**	0.255**	0.070	-0.073	0.089	0.183**	-0.062	0.267**	0.143*	-0.071	0.070	-0.093	0.333**	-0.010
Plant height			1.00	-0.236**	-0.064	0.178**	0.245**	0.101	0.035	0.102	-0.041	0.213**	0.150*	-0.159*	0.282**	0.223**	0.438**	0.334**
No. of primary branches/plant				1.00	-0.077	0.205**	-0.040	0.168**	-0.172**	0.154*	-0.207**	-0.148*	-0.043	0.127	-0.110	-0.055	0.230**	-0.003
No. of primary branches/plant					1.00	0.020	-0.059	0.095	0.060	-0.136*	0.156*	0.071	-0.065	0.014	-0.094	-0.177**	0.016	-0.172**
Leaf area index						1.00	0.029	-0.217**	-0.177**	0.141*	0.003	0.080	0.254**	0.184**	-0.102	0.077	0.121	0.110
Length of main raceme							1.00	0.025	0.151*	0.153*	0.116	-0.010	0.126	-0.072	0.307**	0.164*	0.189**	0.212**

No. of siliqua on main raceme								1.00	0.246**	0.299**	-0.104	-0.132*	-0.226**	-0.062	0.099	-0.229**	0.230**	-0.187**
No. of siliquae/plant									1.00	0.089	-0.198**	0.072	-0.121	-0.202**	0.114	-0.088	-0.100	-0.114
No. of seed/siliquae										1.00	-0.052	0.171**	-0.143*	0.065	0.263**	-0.027	0.116	0.001
1000-seed weight											1.00	0.036	0.041	0.044	-0.016	-0.009	0.126	0.017
Oil content												1.00	0.189**	-0.029	0.568**	0.095	0.227**	0.162*
Methionine content													1.00	0.461**	-0.012	-0.031	0.038	-0.022
Tryptophan content														1.00	-0.107	-0.251**	0.017	-0.254**
Protein content															1.00	0.243**	-0.209**	0.187**
Harvest-index																1.00	-0.258**	0.978**
Biological yield/plant																	1.00	0.065

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

**Table 2a:** Genotypic path coefficient of F<sub>1</sub> for 18 characters in L x T fashion in Indian mustard

Characters	Days to 50% flowering	Days to Maturity	Plant height	No. of Primary Branches /plant	No of secondary Branches /plant	Leaf area Index	Length of Main raceme	Siliqua on main raceme	No. of Siliqua/plant	No. of Seeds/siliqua	1000-Seed weight	Oil content	Methionine content	Tryptophan content	Protein content	Harvest-Index	Biological yield / plant	Seed yield /plant
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days to 50% flowering	-0.0012	-0.0014	-0.0031	-0.0013	0.0004	0.0022	0.0000	0.0033	0.0004	-0.0009	-0.0006	-0.0022	-0.0013	-0.0043	-0.0064	-0.3414	0.0943	-0.264**
Days to maturity	-0.0001	-0.0121	-0.0044	-0.0019	0.0014	0.0019	0.0000	0.0051	0.0028	0.0023	0.0027	-0.0040	-0.0010	-0.0068	-0.0083	-0.4068	0.1720	-0.257**
Plant height	-0.0002	-0.0025	-0.0211	-0.0012	0.0004	0.0035	0.0000	0.0056	0.0026	0.0040	0.0017	-0.0028	-0.0010	-0.0067	-0.0046	-0.2777	0.1477	-0.152*
No. of primary branches/plant	0.0003	0.0041	0.0045	0.0055	-0.0011	-0.0031	0.0000	-0.0093	-0.0021	-0.0049	0.0015	0.0018	0.0014	0.0057	0.0086	0.5213	-0.0583	0.476**
No. of primary branches/plant	0.0002	0.0063	0.0033	0.0021	-0.0028	-0.0012	0.0000	-0.0068	-0.0017	-0.0019	-0.0012	0.0047	0.0009	0.0054	0.0072	0.3137	-0.0317	0.297**
Leaf area index	0.0003	0.0029	0.0090	0.0021	-0.0004	-0.0082	0.0000	-0.0062	-0.0021	-0.0033	-0.0001	0.0018	0.0016	0.0047	0.0112	0.3906	-0.0218	0.382**
Length of main raceme	0.0002	0.0010	-0.0001	0.0013	-0.0002	-0.0031	-0.0001	-0.0060	-0.0018	-0.0043	-0.0010	0.0027	0.0004	0.0009	0.0139	0.4129	0.0539	0.470**
No. of siliqua on main raceme	0.0002	0.0034	0.0064	0.0028	-0.0010	-0.0028	0.0000	-0.0182	-0.0035	-0.0061	-0.0010	0.0060	0.0009	0.0063	0.0124	0.3513	-0.0921	0.265**
No. of siliquae/plant	0.0001	0.0044	0.0069	0.0015	-0.0006	-0.0022	0.0000	-0.0081	-0.0078	-0.0046	-0.0020	0.0054	0.0010	0.0064	0.0199	0.5412	-0.1408	0.421**
No. of seed/siliquae	-0.0001	0.0021	0.0065	0.0021	-0.0004	-0.0021	0.0000	-0.0085	-0.0028	-0.0131	-0.0010	0.0034	0.0007	0.0055	0.0110	0.3415	-0.0375	0.307**
1000-seed weight	-0.0001	0.0035	0.0038	-0.0009	-0.0003	-0.0001	0.0000	-0.0019	-0.0017	-0.0014	-0.0095	0.0029	-0.0005	0.0032	0.0035	0.1156	-0.0447	0.071
Oil content	0.0003	0.0048	0.0059	0.0010	-0.0013	-0.0015	0.0000	-0.0110	-0.0042	-0.0045	-0.0028	0.0100	0.0005	0.0071	0.0163	0.5926	-0.0731	0.540**
Methionine content	0.0005	0.0036	0.0064	0.0023	-0.0008	-0.0039	0.0000	-0.0051	-0.0025	-0.0028	0.0015	0.0014	0.0033	0.0076	0.0080	0.4170	-0.1455	0.291**
Tryptophan content	0.0004	0.0065	0.0111	0.0025	-0.0012	-0.0030	0.0000	-0.0090	-0.0039	-0.0056	-0.0024	0.0056	0.0020	0.0127	0.0120	0.6148	-0.1980	0.444**
Protein content	0.0003	0.0034	0.0032	0.0016	-0.0007	-0.0030	0.0000	-0.0075	-0.0052	-0.0048	-0.0011	0.0054	0.0009	0.0051	<b>0.0300</b>	0.7541	-0.1639	0.618**
Harvest-index	0.0004	0.0045	0.0054	0.0026	-0.0008	-0.0029	0.0000	-0.0059	-0.0039	-0.0041	-0.0010	0.0054	0.0013	0.0072	0.0207	<b>1.0900</b>	-0.1956	0.923**
Biological yield/plant	-0.0003	-0.0047	-0.0071	-0.0007	0.0002	0.0004	0.0000	0.0038	0.0025	0.0011	0.0010	-0.0017	-0.0011	-0.0057	-0.0112	-0.4845	<b>0.4400</b>	-0.068

Resi-0.00185

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



**Table 2b:** Phenotypic path coefficient of F<sub>1</sub> for 18 characters in L x T fashion in Indian mustard

Characters	Days to 50% flowering	Days to Maturity	Plant height	No. of Primary Branches/plant	No of secondary branches/plant	Leaf area Index	Length of Main raceme	Siliqua on main raceme	No. of Siliqua/plant	No. of Seeds/siliqua	1000-Seed weight	Oil content	Methionine content	Tryptophan content	Protein content	Harvest-Index	Biological yield / plant	Seed yield /plant
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days to 50% flowering	-0.0035	-0.0003	-0.0016	0.0002	-0.0007	0.0000	-0.0001	0.0019	-0.0002	-0.0003	-0.0004	-0.0002	0.0004	-0.0025	-0.0006	-0.2758	0.0623	-0.221**
Days to maturity	-0.0003	-0.0027	-0.0016	0.0003	-0.0024	0.0000	-0.0001	0.0026	-0.0013	0.0004	0.0016	-0.0004	0.0003	-0.0034	-0.0003	-0.2980	0.1168	-0.188**
Plant height	-0.0005	-0.0003	-0.0128	0.0002	-0.0008	0.0000	0.0000	0.0035	-0.0014	0.0010	0.0011	-0.0003	0.0003	-0.0040	-0.0004	-0.2315	0.1279	-0.1180
No. of primary branches/plant	0.0006	0.0007	0.0022	-0.0011	0.0022	0.0000	0.0003	-0.0060	0.0012	-0.0013	0.0010	0.0003	-0.0005	0.0036	0.0009	0.4969	-0.0597	0.441**
No. of primary branches/plant	0.0004	0.0010	0.0017	-0.0004	0.0063	0.0000	0.0001	-0.0044	0.0010	-0.0005	-0.0008	0.0006	-0.0003	0.0035	0.0008	0.3016	-0.0353	0.275**
Leaf area index	0.0008	0.0004	0.0048	-0.0004	0.0009	-0.0001	0.0006	-0.0041	0.0013	-0.0009	-0.0001	0.0002	-0.0006	0.0031	0.0012	0.3720	-0.0212	0.358**
Length of main raceme	0.0003	0.0001	0.0003	-0.0002	0.0005	0.0000	0.0017	-0.0037	0.0010	-0.0011	-0.0007	0.0003	-0.0001	0.0006	0.0013	0.3839	0.0333	0.417**
No. of siliqua on main raceme	0.0005	0.0005	0.0034	-0.0005	0.0021	0.0000	0.0005	-0.0131	0.0020	-0.0016	-0.0006	0.0007	-0.0003	0.0039	0.0012	0.3143	-0.0849	0.228**
No. of siliquae/plant	0.0001	0.0007	0.0036	-0.0003	0.0013	0.0000	0.0004	-0.0054	0.0048	-0.0012	-0.0015	0.0006	-0.0004	0.0042	0.0022	0.5031	-0.1207	0.392**
No. of seed/siliquae	-0.0003	0.0003	0.0031	-0.0003	0.0009	0.0000	0.0005	-0.0052	0.0015	-0.0039	-0.0007	0.0004	-0.0003	0.0033	0.0011	0.3083	-0.0419	0.267**
1000-seed weight	-0.0002	0.0006	0.0020	0.0002	0.0007	0.0000	0.0002	-0.0012	0.0010	-0.0004	-0.0072	0.0004	0.0002	0.0021	0.0004	0.1146	-0.0447	0.0690
Oil content	0.0005	0.0007	0.0026	-0.0002	0.0024	0.0000	0.0003	-0.0061	0.0020	-0.0009	-0.0018	0.0015	-0.0001	0.0039	0.0015	0.4492	-0.0467	0.409**
Methionine content	0.0011	0.0006	0.0032	-0.0004	0.0016	0.0000	0.0002	-0.0033	0.0014	-0.0008	0.0010	0.0002	-0.0013	0.0049	0.0008	0.3830	-0.1286	0.264**
Tryptophan content	0.0010	0.0011	0.0059	-0.0004	0.0025	0.0000	0.0001	-0.0058	0.0023	-0.0015	-0.0017	0.0007	-0.0008	0.0087	0.0013	0.5948	-0.1901	0.418**
Protein content	0.0004	0.0002	0.0010	-0.0002	0.0010	0.0000	0.0004	-0.0031	0.0020	-0.0009	-0.0006	0.0004	-0.0002	0.0022	0.0053	0.4164	-0.0866	0.338**
Harvest-index	0.0009	0.0007	0.0026	-0.0005	0.0017	0.0000	0.0006	-0.0037	0.0021	-0.0011	-0.0007	0.0006	-0.0005	0.0046	0.0019	1.1293	-0.2326	0.906**
Biological yield/plant	-0.0005	-0.0007	-0.0034	0.0001	-0.0005	0.0000	0.0001	0.0023	-0.0012	0.0003	0.0007	-0.0001	0.0004	-0.0034	-0.0009	-0.5440	0.4829	-0.0680

Resi-0.00148

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

**Table 2c:** Genotypic path coefficient of F<sub>2</sub> for 18 characters in L x T fashion in Indian mustard

Characters	Days to 50% flowering	Days to Maturity	Plant height	No. of Primary Branches/plant	No of secondary Branches /plant	Leaf area Index	Length of Main raceme	Siliqua on main raceme	No. of Siliqua/plant	No. of Seeds/siliqua	1000-Seed weight	Oil content	Methionine content	Tryptophan content	Protein content	Harvest-Index	Biological yield / plant	Seed yield /plant
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days to 50% flowering	-0.531	-0.007	-0.166	0.134	-0.002	0.117	0.024	0.048	-0.030	0.248	0.035	-0.333	0.041	0.001	0.271	-0.055	0.097	-0.107
Days to maturity	0.104	0.038	0.174	-0.037	0.003	-0.144	0.046	-0.016	-0.018	0.141	-0.019	0.390	-0.040	-0.004	-0.126	-0.069	-0.432	-0.010
Plant height	0.099	0.007	0.894	-0.157	0.001	-0.100	0.161	0.023	-0.007	0.078	-0.012	0.311	-0.042	-0.010	-0.510	0.166	-0.567	0.334**
No. of primary branches/plant	-0.107	-0.002	-0.211	0.666	0.001	-0.116	-0.026	0.038	0.035	0.118	-0.063	-0.216	0.012	0.008	0.200	-0.041	-0.297	-0.003
No. of primary branches/plant	-0.083	-0.010	-0.057	-0.051	-0.011	-0.011	-0.039	0.021	-0.012	-0.104	0.047	0.103	0.018	0.001	0.169	-0.132	-0.021	-0.172**
Leaf area index	0.111	0.010	0.159	0.137	0.000	-0.564	0.019	-0.049	0.036	0.108	0.001	0.117	-0.071	0.011	0.184	0.057	-0.156	0.110

Length of main raceme	-0.019	0.003	0.219	-0.027	0.001	-0.016	0.657	0.006	-0.031	0.118	0.035	-0.015	-0.035	-0.004	-0.554	0.122	-0.245	0.212**
No. of siliqua on main raceme	-0.114	-0.003	0.090	0.112	-0.001	0.123	0.017	0.224	-0.050	0.229	-0.032	-0.193	0.063	-0.004	-0.179	-0.170	-0.297	-0.187**
No. of siliquae/plant	-0.077	0.003	0.031	-0.115	-0.001	0.100	0.099	0.055	-0.204	0.069	-0.060	0.106	0.034	-0.012	-0.205	-0.065	0.129	-0.114
No. of seed/siliquae	-0.172	0.007	0.091	0.102	0.001	-0.079	0.101	0.067	-0.018	0.768	-0.016	-0.249	0.040	0.004	-0.475	-0.020	-0.150	0.001
1000-seed weight	-0.062	-0.002	-0.036	-0.138	-0.002	-0.002	0.076	-0.023	0.040	-0.040	0.303	0.052	-0.011	0.003	0.029	-0.007	-0.163	0.017
Oil content	0.121	0.010	0.190	-0.098	-0.001	-0.045	-0.007	-0.030	-0.015	-0.131	0.011	1.461	-0.053	-0.002	-1.027	0.071	-0.294	0.162*
Methionine content	0.077	0.005	0.134	-0.029	0.001	-0.143	0.083	-0.050	0.025	-0.110	0.012	0.277	-0.281	0.028	0.022	-0.023	-0.049	-0.022
Tryptophan content	-0.005	-0.003	-0.142	0.084	0.000	-0.104	-0.047	-0.014	0.041	0.050	0.013	-0.042	-0.129	0.060	0.193	-0.187	-0.022	-0.254**
Protein content	0.080	0.003	0.252	-0.073	0.001	0.057	0.201	0.022	-0.023	0.202	-0.005	0.830	0.003	-0.006	-1.808	0.181	0.270	0.187**
Harvest-index	0.039	-0.004	0.200	-0.037	0.002	-0.043	0.107	-0.051	0.018	-0.021	-0.003	0.139	0.009	-0.015	-0.440	0.744	0.334	0.978**
Biological yield/plant	0.040	0.013	0.392	0.153	0.000	-0.068	0.124	0.051	0.020	0.089	0.038	0.332	-0.011	0.001	0.377	-0.192	-1.295	0.065

Resi-0.0473

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

**Table 2d:** Phenotypic path coefficient of F<sub>2</sub> for 18 characters in L x T fashion in Indian mustard

Characters	Days to 50% flowering	Days to Maturity	Plant height	No. of Primary Branches /plant	No of secondary Branches /plant	Leaf area Index	Length of Main raceme	Siliqua on main raceme	No. of Siliqua/ plant	No. of Seeds/ siliqua	1000-Seed weight	Oil content	Methionine content	Tryptophan content	Protein content	Harvest-Index	Biological yield / plant	Seed yield/plant
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Days to 50% flowering	0.0113	-0.0008	-0.0052	0.0055	-0.0015	-0.0019	-0.0001	0.0011	-0.0009	-0.0041	0.0014	-0.0007	0.0013	0.0000	-0.0007	-0.0705	-0.0076	-0.073
Days to maturity	-0.0012	0.0073	0.0018	-0.0015	0.0018	0.0014	0.0007	-0.0005	0.0000	-0.0024	-0.0004	0.0005	-0.0007	0.0000	0.0000	-0.0452	0.0191	-0.019
Plant height	-0.0010	0.0002	0.0607	-0.0056	0.0008	0.0023	0.0021	0.0006	-0.0003	-0.0010	-0.0007	0.0008	-0.0016	-0.0001	0.0015	0.1696	0.0554	0.284**
No. of primary branches/plant	0.0021	-0.0004	-0.0118	0.0292	0.0008	0.0023	-0.0006	0.0010	0.0014	-0.0023	-0.0029	-0.0002	0.0005	0.0001	-0.0011	-0.0508	0.0211	-0.012
No. of primary branches/plant	0.0013	-0.0010	-0.0038	-0.0019	-0.0127	0.0003	-0.0007	0.0006	-0.0006	0.0023	0.0024	0.0002	0.0008	0.0000	-0.0004	-0.1484	0.0042	-0.157*
Leaf area index	-0.0017	0.0008	0.0110	0.0052	-0.0003	0.0129	0.0001	-0.0014	0.0016	-0.0025	0.0000	0.0002	-0.0031	0.0001	-0.0004	0.0576	0.0184	0.099
Length of main raceme	-0.0001	0.0005	0.0109	-0.0014	0.0008	0.0001	0.0114	0.0004	-0.0013	-0.0021	0.0017	0.0000	-0.0014	0.0000	0.0019	0.1480	0.0235	0.193**
No. of siliqua on main raceme	0.0015	-0.0004	0.0046	0.0036	-0.0010	-0.0023	0.0006	0.0078	-0.0022	-0.0048	-0.0014	-0.0005	0.0025	0.0000	0.0006	-0.1777	0.0258	-0.143*
No. of siliquae/plant	0.0011	0.0000	0.0020	-0.0041	-0.0008	-0.0021	0.0015	0.0018	-0.0097	-0.0012	-0.0028	0.0002	0.0014	-0.0001	0.0007	-0.0735	-0.0128	-0.098
No. of seed/siliquae	0.0023	0.0009	0.0030	0.0034	0.0015	0.0016	0.0012	0.0019	-0.0006	-0.0199	-0.0005	-0.0006	0.0016	0.0000	0.0014	-0.0222	0.0028	-0.022
1000-seed weight	0.0011	-0.0002	-0.0030	-0.0055	-0.0020	0.0000	0.0013	-0.0008	0.0018	0.0006	0.0150	0.0001	-0.0005	0.0000	0.0003	-0.0061	0.0149	0.017
Oil content	-0.0015	0.0007	0.0093	-0.0011	-0.0004	0.0006	0.0000	-0.0008	-0.0004	0.0023	0.0003	0.0051	-0.0018	0.0000	0.0006	0.0567	0.0253	0.095
Methionine content	-0.0012	0.0004	0.0077	-0.0012	0.0008	0.0031	0.0012	-0.0016	0.0011	0.0026	0.0006	0.0007	-0.0127	0.0002	0.0001	-0.0245	0.0057	-0.017
Tryptophan content	0.0004	-0.0003	-0.0077	0.0031	-0.0002	0.0021	-0.0006	-0.0004	0.0018	-0.0008	0.0007	0.0000	-0.0056	0.0005	-0.0009	-0.2302	0.0039	-0.234**
Protein content	-0.0007	0.0000	0.0081	-0.0028	0.0004	-0.0005	0.0019	0.0004	-0.0006	-0.0025	0.0004	0.0003	-0.0001	0.0000	0.0112	0.1073	-0.0126	0.110
Harvest-index	-0.0008	-0.0004	0.0108	-0.0016	0.0020	0.0008	0.0018	-0.0015	0.0008	0.0005	-0.0001	0.0003	0.0003	-0.0001	0.0013	0.9527	-0.0425	0.924**
Biological yield/plant	-0.0004	0.0007	0.0159	0.0029	-0.0003	0.0011	0.0013	0.0010	0.0006	-0.0003	0.0011	0.0006	-0.0003	0.0000	-0.0007	-0.1916	0.2111	0.043

Resi-0.0867

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

yield/plant (0.4829), tryptophan content (0.0087), number of secondary branches/plant (0.0063), protein content (0.0053), number of siliquae/plant (0.0048), length of main raceme (0.0017), oil content (0.0015), while high order of negative direct effect on seed yield/plant exhibited by number of siliquae on main raceme (-0.0131) followed by plant height (-0.0128), 1000-seed weight (-0.0072), number of seeds/ siliquae (-0.0039), days to 50% flowering (-0.0035), days to maturity (-0.0027), methionine content (-0.0013), number of primary branches/plant (-0.0011). Harvest-index exerted high order of positive indirect effect on seed yield/plant *via* tryptophan content (0.0046) followed by plant height (0.0026), protein content (0.0019), number of siliquae/plant (0.0021), number of secondary branches/plant (0.0017), days to 50% flowering (0.0009), days to maturity (0.0007), length of main raceme (0.0006), oil content (0.0006) at phenotypic level. Estimates of residual effect was 0.00148.

In F<sub>2</sub>'s High order of positive direct effect on seed yield/plant exhibited by harvest index (0.9527) followed by biological yield/plant (0.2111), plant height (0.0607), number of primary branches/plant (0.0292), 1000-seed weight (0.0150), leaf area index (0.0129), length of main raceme (0.0114), days to 50% flowering (0.0113), protein content (0.0112), number of siliquae on main raceme (0.0078), days to maturity (0.0073), oil content (0.0051), while number of seeds/ siliquae (-0.0199) followed by number of secondary branches/plant (-0.0127), methionine content (-0.0127), number of siliquae/plant (-0.0097) exhibited high order of direct negative effect on seed yield/plant, and harvest-index exhibited high order of positive indirect effect on seed yield/plant *via* plant height (0.0108) number of secondary branches/plant (0.0020), length of main raceme (0.0018), protein content (0.0013), leaf area index (0.0008), number of siliquae/plant (0.0008), oil content (0.0003), tryptophan content (0.0003) at phenotypic level among parents + F<sub>2</sub>'s. Estimates of residual effect was Resi-0.0867.

Similar results also reported by Kalyar *et al.*, (2015)<sup>[8]</sup>, Rajeev *et al.*, (2016)<sup>[9]</sup>, Mohan *et al.*, (2017)<sup>[10]</sup>.

### Genotypic path

High order of positive direct effect on seed yield/plant exhibited by harvest-index (1.0900) followed by biological yield/plant (0.4400), protein content (0.0300), tryptophan content (0.0127), oil content (0.0100), number of primary branches/plant (0.0055), methionine content (0.0033), days to 50% flowering (0.0012), while high order of negative direct effect on seed yield/plant by plant height (-0.0211), number of siliquae on main raceme (-0.0182), number of seeds/ siliquae (-0.0131), days to maturity (-0.121), 1000-seed weight (-0.0095), leaf area index (-0.0082), number of siliquae/plant (-0.0078), number of secondary branches/plant (-0.0028), days to 50% flowering (-0.0012) and high order of positive indirect effect on seed yield/plant exerted by harvest-index *via*, protein content (0.0207) followed by tryptophan content (0.0072), oil content (0.0054), plant height (0.0054), days to maturity (0.0045), number of primary branches/plant (0.0026), methionine content (0.0013), days to 50% flowering (0.0004) at genotypic level among parent + F<sub>1</sub>'s. Estimates of residual effect was Resi-0.00185.

High order of positive direct effect on seed yield/plant was exerted by oil content (1.461) followed by plant height (0.894), number of seeds/ siliquae (0.768), harvest-index (0.744), number of primary branches/plant (0.666), length of main raceme (0.657), 1000-seed weight (0.303), number of siliquae on main raceme (0.224), tryptophan content (0.060), days to maturity (0.038), while high order of negative direct effect on seed yield/plant exhibited by protein content (-1.808), biological yield/plant (-1.295), leaf area index (-0.564), days to 50% flowering (-0.531), methionine content (-0.281), number of

siliquae/plant (-0.204), number of secondary branches/plant (-0.011) and harvest-index exerted high order positive indirect effect on seed yield/plant *via*, biological yield/plant (0.334) followed by plant height (0.200), oil content (0.139), length of main raceme (0.107), days to 50% flowering (0.039), number of siliquae/plant (0.018), methionine content (0.009), number of secondary branches/plant (0.002) at genotypic level among parents + F<sub>2</sub>'s. Estimates of residual effect was Resi-0.0473. Similar result also reported by Rout *et al.*, (2018)<sup>[11]</sup>, Pal *et al.*, (2019)<sup>[12]</sup>, Yadav *et al.*, (2021)<sup>[13]</sup>.

### References

1. Anonymous. Report on mustard production in India; c2023.
2. Anonymous. USDA; c2023.
3. Dewey DR, Lu KH. Correlation and path coefficient analysis of component of crested wheat grass seed production. *J Agron.* 1959;57(3):515-518.
4. Wright S. Correlation and causation. *J Agric Res.* 1921;20(7):557-585.
5. Goyat BG, Singh DS, Avtar R, Singh A. Estimation of selection parameters in the elite gene pool of Indian mustard [*Brassica juncea* (L.) Czern & Coss.]; c2012.
6. Ara S, Afroz S, Noman MS, Bhuiyan MSR, Zia MIK. Variability, correlation and path analysis in F<sub>2</sub> progenies of inter-varietal crosses of Brassica rapa. *J Environ Sci Nat Res.* 2013;6(1):217-220.
7. Tahira T, Abdul Rashid AR, Khan MA, Muhammad Amjad MA. Seed yield improvement in mustard [*Brassica juncea* (L.) Czern & Coss] via genetic parameters; heritability, genetic advance, correlation and path coefficient analysis; c2014.
8. Kalyar A, Salim J. Genetic evaluation and characterization for yield and related traits in mustard (*Brassica juncea*). *Res J Agric Environ Manag.* 2015;4(2):082-087.
9. Rajeev K, Gaurav SS, Jayasudha S, Hitesh K. Study of correlation and path coefficient analysis in germplasm lines of Indian mustard (*Brassica juncea* L.). *Agric Sci Digest.* 2016;36(2):92-96.
10. Mohan S, Yadav RK, Tomar A, Singh M. Utilization of selection parameters for seed yield and its contributed traits in Indian mustard (*Brassica juncea* L. Czern & Coss). *The Pharma Innovation J.* 2017;6(8):306-309.
11. Rout S, Kerkhi SA, Chauhan C. Character association and path analysis among yield components in Indian mustard [*Brassica juncea* (L.) Czern and Coss]. *Int J Curr Microbiol App Sci.* 2018;7(1):50-55.
12. Pal S, Dubey N, Avinash H, Khan S, Reddy PJ. Estimation of genetic variability, correlation and path analysis for yield and yield contributing characters in Indian mustard (*Brassica juncea* L.). *J Pharmacogn Phytochem.* 2019;4:102-105.
13. Yadav BS, Sharma HK, Yadav AP, Ram B. Correlation and path analysis in Indian mustard (*Brassica juncea* L.) for seed yield and attributing traits; c2021.
14. Lavanya K, Srikanth T, Padmaja D. Correlation and path coefficient analysis among yield and yield contributing traits in Indian mustard (*Brassica juncea* L.). *The Pharma Innovation J.* 2022;11(2):2926-2928.
15. Evangelin KM, Yadav AP, Olive B, Lavanya G. Inter-relationship and path coefficient analysis among quantitative traits in Indian mustard (*Brassica juncea* L. Czern and Coss). *J Pharmacogn Phytochem.* 2023;12(1):562-565.
16. Chaturvedi VD, Maurya KN, Upadhyay DK, Singh PK, Chaubey S. Genetic diversity for yield and its contributing components in Indian mustard [*Brassica juncea* (L.) Czern & Coss.]. *J Pharm Innov.* 2021;10:748-754.