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Priya Chaubey
Department of Genetics and Plant Breeding, S.M.M Town Post Graduate College, Ballia, Uttar Pradesh, India

OP Singh
Department of Genetics and Plant Breeding, S.M.M Town Post Graduate College, Ballia, Uttar Pradesh, India

Vishwajeet Yadav
Research Scholar, Department of Agriculture and Biotechnology, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Yashwant Nishad
Department of Genetics and Plant Breeding, S.M.M Town Post Graduate College, Ballia, Uttar Pradesh, India

Corresponding Author:
Priya Chaubey
Department of Genetics and Plant Breeding, S.M.M Town Post Graduate College, Ballia, Uttar Pradesh, India

Correlation and Path coefficient analysis for yield and its associated characters of Indian mustard (*Brassica juncea* L. Czern & Coss)

Priya Chaubey, OP Singh, Vishwajeet Yadav and Yashwant Nishad

Abstract
In the current study, 25 germplasm of Indian mustard were used during the rabi season of 2020–21 at the Research Farm of Nidharia, S.M.M. Town Post Graduate College, Ballia (U.P), India, they were assessed for seed yield and yield attribute components for 14 characteristics. The correlation analysis revealed a substantial and positive relationship between biological yield per plant, seeds per siliquae, siliquae per plant, primary branches per plant, length of the main raceme, and 1000 seed weight, leaf area index, harvest index, and biological yield per plant. The results showed a highly substantial positive correlation between seed yield per plant and the number of siliquae per plant and harvest index. At the genotypic level, path coefficient analysis revealed a strong positive and direct effect of harvest index and biological yield per plant towards seed yield in Indian mustard, as well as a high positive and direct influence of 1000 seed weight.

Keywords: Correlation coefficient, path analysis, seed yield, characters, Indian mustard

Introduction
Rapeseed and mustard are the second-largest oilseed crop worldwide and in India after peanuts. After Canada and China, India is the third-largest producer of rapeseed and mustard, accounting for 12% of global production. *Brassica juncea*, AA BB, (n=18) is an amphidiploid species of the Brassicaceae family that was created by crossing Brassica Nigra (BB), (n=8) Brassica compestris (AA), (n=10), and is known as Indian mustard. It is an upright plant with fibrous roots that stands between 90 and 200 cm tall. Flowers are actinomorphic, bisexual, and have a full whorl. The blossom is yellow, and the majority of the crop is self-pollinated. However, due to an increase in the population of honey bees, five to thirty percent cross-pollination is seen. The fruit of this plant is called siliqua, and the inflorescence is an extended raceme with immature flowers growing toward the top and the inflorescence's axis having infinite development. The leaves are both glabrous and hairy.

Nearly every state in India grows mustard, but the five most important ones-Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, and Gujarat-contribute more than 80% of the country's land and output. As well as being expanded to these states, this crop is also being grown in other southern states with various agro-climatic conditions, including Andhra Pradesh, Tamil Nadu, and Karnataka.

Brassica has a lot of therapeutic qualities and is a great source of vitamins and minerals. They offer significant amounts of soluble fiber, vitamin C, and other nutrients, typically mustard. In northern India, oil is utilized for frying and cooking. Additionally, it is used to make medications, particularly ayurveda, as well as pickles, Chatney, and other foods. Typically, they are produced as alternate feed crops. Brassica crops may be grown for fodder in a variety of climates and soil types. Brassica has a high dry matter digestibility range of 85-95 percent. Because they are so nutrient-dense, leaves and other plant materials provide a superb crop for grazing. It generates a lot of bio-mass, controls weeds, and can increase soil tilth through its root system. It also offers good soil cover in the winter to avoid soil erosion. It is used industrially in the production of soap and in grease and lubricant combinations for various equipment. Young plants' tender leaves are consumed as green vegetables, or sag, and are an excellent source of sulfur and other nutrients for the diet. Even though mustard oil has a high erucic acid content (40-50%), the mustard cake has a high glucosinolate content and a low iodine value, making these factors anti-nutritional. To improve oil quality, high-yielding varieties with beneficial health traits must be developed.

Indians, however, favor it because of its pungency brought on by allyl isothiocyanate.

Oilseed crops are one of the many crops farmed in India and take up 24.65 million hectares, or 12.82 percent of the total area. Oilseed harvests will be produced in a total of 36.57 million tonnes in 2020-2021. Uttar Pradesh (11.18 million hectares), Rajasthan (3.40 million hectares), and Madhya Pradesh are the three states that produce the most rapeseed and mustard (0.98 million hectares).

Because of the intricate nature of how yields and their characteristics are inherited, mustard crop improvement is complicated in nature. The inheritance of the characteristics of mustard shows hints of both additive and non-additive kinds of gene activity. Since autogamy is an adequate additive genetic variation, efforts to improve have primarily focused on the development of pure lines, mutants, and backcross breeding; however, with the advent of biotechnological approaches like somaclones and transgenics, these efforts have become less and less focused. The goal of the crop improvement program is to produce seeds with a steady and larger yield, but breeders also place a strong emphasis on traits like high oil content and low anti-nutritional factors, resistance to aphids, and Alternaria blight, and others.

As the result of a series of events and character combinations, the average response to selection for yield is poor. Therefore, it is important to think about main yield manipulations first. These manipulations involve main yield attributing characteristics like the number of siliquae on the main shoot, the number of seeds per siliquae, test weight, plant height, maturity duration, number of branches per plant, length of the main raceme, length of siliquae, siliquae of per plant, etc. Numerous studies on the genetic diversity, heritability, correlation coefficient, and genetic architecture of mustard crops have been conducted; however, estimates for the eastern half of Uttar Pradesh and the western part of Bihar are still required.

Material and Methods

The field trial was carried out during *Rabi* 2020-21 at Research Farm, of Nidharia, S.M.M Town Post Graduate College, Ballia (U.P). This place is situated between $25^0$45'37''N latitude, $84^0$08'49''E longitude, and at an altitude of 159 m above the mean sea level. The experimental material consisted of 25 diverse genotypes/lines of mustard collected from SVPUAT, Meerut, and DRMR, Bharatpur (Raj.) The experiment was conducted in a Randomized Complete Block Design in three replications. Twenty-five genetically diverse genotypes namely V7 Kranti, KMR-15-2, KMR-16, Laxmi-16, RH-749, RH-406, KH-725, RH-30, V32-KMR, Vardhan, Bhawani, KMR-17-2, KMR-16-5, V19 KMR15-5, Azad Chetna, V33 KMR-19-1, V43 Laxmi, V40 Maya, Type-9, Prasad, V30-KMR-18-1, Rohini, Kaveri, Azad Mahak, Ashirwad were used for analysis. A 4 m^2 plot was used to cultivate each genotype. Each genotype was sown in two rows of five meters each, 40 centimetres apart, with an appropriate plant-to-plant spacing of 15 centimetres. All cultural treatments necessary for a decent mustard yield were used to achieve a healthy and high-quality crop stand. To record the observations on the fourteen characteristics, five competitive plants from each genotype in each replication were chosen at random. The information on 14 characters includes the number of days until 50% flowering, days until maturity, number of primary and secondary branches per plant, length of the main raceme (cm), number of siliquae on the main raceme, number of siliquae per plant, plant height (cm), number of seeds per siliquae, length of siliquae (cm), biological yield per plant (g), harvest index (%), seed yield per plant (g), and weight of 1000 seeds (g). According to Searle's (1961) advice, the genotypic and phenotypic correlation coefficients were calculated using the analysis of variance and covariance by utilizing the route coefficient approach recommended by Wright (1921) [33] and Dewey and Lu (1959) [5] employing seed yield as a dependent variable, the direct and indirect impacts at the genotypic and phenotypic levels were calculated.

Result and Discussion

The main objective must be to discover and choose superior genotypes with desirable characteristics from a wide range of breeding materials in order to properly harness the available variability. In the current study, the phenotypic and genotypic correlation coefficients among fourteen characters were evaluated. Knowledge of the interactions between seed yield and yield components is necessary in order to achieve this. Studying the correlation coefficient will help you create a good selection criterion by allowing you to assess the degree of relationships between various features. The overall effect of the gene that influences both features is pleiotropy or correlation coming from linkage, where other factors boost one and reduce the other of positive correlation or negative correlation.

Correlation co-efficient analysis

The strength of the association is quantified in terms of the correction coefficient, which is the relationship between the two qualities. Whose boundaries range from minus one to one? If a rise in one variable leads to an increase in another, the relationship is positive; if it leads to a drop in another, the relationship is negative. If the growth or decrease of one variable has no effect on the other, the two variables are uncorrelated. Because all phenotypic features are the consequence of the interaction of multiple genetic elements among themselves, as well as their individual and combined interactions with environmental factors, information concerning correlation is extremely valuable to a plant breeder.

Knowledge of correlation aids plant breeders in determining the best technique for improving a characteristic that is not accessible to direct selection and so necessitates the use of indirect selection. It also contains information on how the link has become unavoidable. It also gives data on the associated response to directional selection, which can be utilized to forecast genetic advancement and thus serve as selection indices for more efficient selection.

Phenotypic, genotypic, and environmental correlations are all possible. Genetic and non-genetic impacts are included in phenotypic correlation, which is a relationship between values directly measured on people. Only genetic reasons, such as pleiotropy, linkage, or gene frequency disequilibrium, are taken into consideration in genotypic correlation. Environmental correlation is a relationship between non-genetic variables that occurs when numerous observations are influenced by the same quantity of environmental factors. As a result, information on all three is extremely beneficial to a plant breeder.

At the phenotypic level, correlation coefficients revealed a highly significant positive link between seed yield and the number of siliqua plants per plant and the harvest index. At the genotypic level, the correlation values were also at or above the phenotypic level (Table 1). Therefore, it can be concluded that increasing these qualities by selection, either separately or together, will increase mustard production. The quantity of siliqua per plant and harvest index showed a highly significant positive correlation in the current study, which may be caused by the association of the genes governing these traits.

These findings broadly concur with those of Kumar and Shrivastava (2000) [12] and Singh *et al* (2011) [28]. Days to

50% flowering had an extremely strong positive association with plant height (0.556), length of main raceme (0.461), and number of siliquae (0.323). Days to maturity revealed a strong favourable association with number of siliquae on main raceme (0.335), and biological yield (0.399). Plant height significantly correlated positively with length of main raceme (0.819), number of siliquae on main raceme (0.624), and biological yield per plant (0.550). Number of primary branches showed highly positive correlation with number of secondary branches (0.417), and biological yield (0.325). A highly substantial association between the number of secondary branches and the biological yield was observed (0.373). Length of main raceme showed positive correlation with the number of siliquae on main raceme (0.681), biological yield per plant (0.615), seed yield per plant (0.375) and number of siliquae per plant (0.299). A significantly substantial positive association between the number of siliquae per plant with the biological yield (0.333), and seed yield per plant (0.453). Length of siliquae revelled positive correlation with the number of seed per siliquae (0.456), and biological yield per plant (0.343). A highly substantial association between the number of seeds per siliqua and the seed yield per plant was observed (0.289). Test weight (1000 seed weight) showed a strong positive correlation with harvest index (0.590), and seed yield per plant (0.671). Harvest index showed a highly positive correlation with seed yield per plant was observed (0.694). Therefore, it can be concluded that increasing these qualities by selection, either separately or together, will increase mustard production. Both Roy *et al.* (2015) [21] and Vermai *et al.* (2016) [32] reported results that were comparable.

Seed yield per plant showed a positive and significant association with length of the main raceme, number of siliquae on the main raceme, number of siliquae per plant, number of Seed per siliqua, biological yield, test weight, and harvest index. It revealed that by increasing the value of these traits, seed yield can be drastically increased.

Days to 50 percent blooming with no. of primary branches were correlated with each other and were indirectly responsible for increasing seed output, but since an increase in days to 50 percent flowering is a negative character with respect to a breeding program, it is not advantageous to be considered. The number of primary branches was found to be positively related to test weight, paving the door for increased seed yield by raising either of the two features while monitoring plant height after a specific point. The number of seeds per siliqua had a positive and significant relationship with test weight and harvest index, indicating that a rise in this feature improved test weight and harvest index, resulting in enhanced yield. Test weight was positively significant with harvest index and since these two characters are of great importance and should be taken into consideration at the time of breeding programme. Similar results have been reported by Patel *et al*. (2000) [18], Chaudhary *et al.* (2003) [3], Mahak *et al*. (2003) [15], Sirohi *et al*. (2015) [29] and Gangapur *et al.* (2009) [7], Lodhi *et al.* (2014) [13], Devi *et al.* (2018) [4].

It was shown that there was a highly significant negative link between the number of seeds per siliquae and the days to 50% blooming, the number of seeds per siliquae and the harvest index, the length of the siliqua with the harvest index, and the seed yield per plant, and the harvest index. Based on the estimated genotypic and phenotypic correlations, the breeder may choose the breeding strategy to utilizee so that the desirable correlation can be adjusted by introducing new variability to produce new recombinants and the beneficial correlation can be exploited. Triple test cross and biparental mating might be used to break the undesired correlations or links.

Path coefficient analysis

Using path coefficient analysis, we can separate the observed correlation coefficient into the direct and indirect impacts of the yield components, which gives us a clearer insight into the relationships between the characteristics and helps us create effective selection strategies. Path analysis distinguishes itself from simple correlations by highlighting the causes and their relative importance, whereas the latter just assesses the mutual relationship while disregarding the causation. Wright (1921) [33] created the idea of path coefficient in an effort to statistically analyze the cause and effect in linked variables and critically assessed the actual contribution of individual constituents to the complicated end result at hand, such as yield. The approach recommended by Dewey and Lu (1959) [5] was used to do the path coefficient analysis. With the use of the route coefficient analysis, the correlation coefficients of the numerous research characters were divided in order to reflect the direct and indirect effects of each feature on seed yield. Both the genotypic and phenotypic paths underwent the path coefficient analysis. The remaining eleven qualities were used as independent or contributing variables in the current study, with seed yield per plant acting as the dependent variable (Table 3).

The results of path-coefficient analysis at genotypic level done using simple correlation coefficients among 13 quantitative characters are given in Table-2. The highest positive direct effect on seed yield per plant was observed by harvest index (0.814), biological yield (0.569), test weight (0.229), day to 50% flowering (0.140), length of siliquae (0.134), number of siliquae per plant (0.121) and other characters had considerable positive direct contribution towards seed yield per plant while the days to maturity (0.053), plant height (0.100), number of primary branches and number of seed per siliquae showed considerable negative direct effect on seed yield per plant. The direct effect of remaining characters length of main raceme, number of siliquae on main raceme, number of secondary branches, were found to be too low to be considered any consequence.

At the phenotypic level, the harvest index (0.867) showed the highest order of direct positive influence on seed yield per plant, followed by biological yield per plant (0.577), test weight (0.154), the days to 50% flowering (0.140), the number of siliquae per plant (0.088), number of seed per siliquae (0.65), the number of secondary branches per plant (0.042), the length of the main raceme (0.028), the length of siliqua per plant (0.027), number of siliquae on the main raceme (0.026), number of primary branches (0.025), days to maturity (0.005) and the plant height showed (-0.015). Roy *et al*., (2015) [21] and Bind *et al*., (2014) [2] both reported results that were similar Via biological yield per plant, the number of days to 50% blooming demonstrated an indirect favourable influence. Days to maturity with a favourable direct influence demonstrated a favourable biological yield per plant in an indirect manner. The quantity of siliquae per plant had a positive indirect influence on the harvest index, which had a positive direct effect. Both Patel *et al*. (2000) [18] and Tahira *et al*. (2011) [30] found similar findings.

The quantity of siliquae per plant and test weight were found by route analysis to be significant direct yield contributing features in the current investigation. The most significant indirect yield components were found to be biological yield, number of primary branches, plant height, and number of siliquae on the main raceme. The qualities stated above have worth it since they were taken into account when the selection technique for creating high-yielding mustard varieties was being developed. Helal *et al*. (2014) [8], Verma *et al.* (2008) [31], Shekhawat *et al*. (2014) [24], and Khan *et al*. (2019) [9] all found similar outcomes.

Table 1: Estimation of correlation coefficient for genotypic (rg) and phenotypic (rp) correlation for 14 characters in Indian mustard (*Brassica juncea* Czern & coss)

S.N	Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches	No. of secondary branches	Length of main raceme (cm)	No. of siliquae on main raceme	No. of siliquae per plant	Length of siliquae (cm)	No. of seed per siliquae	Biological yield (g)	1000 seed test weight (g)	Harvest index%	Seed yield per plant
1	Days to 50% flowering	rg	0.099	0.618**	0.042	-0.128	0.492**	0.352**	-0.004	-0.083	-0.366**	0.072	0.254*	0.035	0.258*
		rp	0.107	0.556**	0.042	-0.107	0.461**	0.323**	0.003	-0.054	-0.208	0.083	0.207	0.036	0.247*
2	Days to maturity		rg	0.220	0.287*	0.268*	0.221	0.395**	0.164	0.311**	-0.269*	0.445**	0.172	-0.127	0.260*
			rp	0.198	0.222	0.217	0.216	0.335**	0.163	0.197	-0.135	0.399**	0.124	-0.125	0.197
3	Plant height (cm)			rg	0.138	-0.040	0.879**	0.722**	0.238*	0.214	-0.342**	0.619**	-0.003	-0.302**	0.254*
				rp	0.108	-0.050	0.819**	0.624**	0.207	0.110	-0.171	0.550**	-0.041	-0.255*	0.204
4	No. of primary branches				rg	0.551**	0.252*	0.226*	0.061	0.236*	-0.009	0.396**	-0.171	-0.324**	-0.016
					rp	0.417**	0.205	0.189	-0.002	0.199	0.067	0.325**	-0.132	-0.211	0.052
5	No. of secondary branches					rg	0.109	0.041	0.319**	0.161	0.225*	0.441**	0.028	-0.170	0.225*
						rp	0.075	0.042	0.245*	0.075	0.100	0.373**	-0.006	-0.165	0.144
6	Length of main raceme (cm)						rg	0.751**	0.334**	0.290*	-0.122	0.643**	0.079	-0.159	0.422**
							rp	0.681**	0.299**	0.187	-0.081	0.615**	0.072	-0.143	0.375**
7	No. of siliquae on main raceme							rg	0.510**	0.609**	0.113	0.596**	0.113	0.011	0.553**
								rp	0.432**	0.433**	0.058	0.548**	0.091	0.044	0.510**
8	No. of siliquae par plant								rg	0.003	-0.090	0.362**	-0.094	0.230*	0.543**
									rp	-0.041	-0.070	0.333**	-0.082	0.188	0.453**
9	Length of silique (cm)									rg	0.779**	0.547**	-0.152	-0.279*	0.119
										rp	0.456**	0.343**	-0.032	-0.086	0.188
10	No. of seed per siliquae										rg	0.077	0.224*	0.279*	0.345**
											rp	0.047	0.046	0.237*	0.289*
11	Biological yield (g)											rg	-0.061	-0.517**	0.272*
												rp	-0.034	-0.496**	0.244*
12	1000 seed test weight (g)												rg	0.659**	0.727**
													rp	0.590**	0.671**
13	Harvest index%													rg	0.662**
														rp	0.694**
14	Seed yield per plant														rg
															rp

rg = Genotypic Correlation Coefficient ** Significant at 1% level.
rp = Phenotypic Correlation Coefficient * Significant at 5% level.

Table 2: Path coefficient analysis showing the direct and indirect effect at the genotypic Level of different Quantitative Traits in Indian mustard (*Brassica juncea* Czern & Coss)

Traits	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches	N. of secondary branches	Length of main raceme (cm)	No. of siliquae on the main raceme	No. of siliquae per plant	Length of siliquae (cm)	No. of seed per siliquae	Biological yield (g)	1000 seed test weight (g)	Harvest Index %	Seed yield per plant (g)
Days to 50% flowering	0.140	-0.005	-0.062	-0.002	-0.014	0.042	0.011	0.000	-0.011	0.031	0.041	0.058	0.029	0.258*
Days to maturity	0.014	-0.053	-0.022	-0.012	0.028	0.019	0.013	0.020	0.042	0.023	0.253	0.040	-0.104	0.260*
Plant height (cm)	0.087	-0.012	-0.100	-0.006	-0.004	0.074	0.023	0.029	0.029	0.029	0.353	-0.001	-0.246	0.254*
No. of primary branches	0.006	-0.015	-0.014	-0.041	0.058	0.021	0.007	0.007	0.032	0.001	0.225	-0.039	-0.264	-0.016
No. of secondary branches	-0.018	-0.014	0.004	-0.022	0.106	0.009	0.001	0.039	0.022	-0.019	0.251	0.007	-0.139	0.225*
Length of main raceme (cm)	0.069	-0.012	-0.088	-0.010	0.012	0.084	0.024	0.040	0.039	0.010	0.366	0.018	-0.130	0.422**
No. of siliquae on the main raceme	0.049	-0.021	-0.073	-0.009	0.004	0.063	0.032	0.062	0.081	-0.010	0.339	0.026	0.009	0.553**
No. of silique per plant	-0.001	-0.009	-0.024	-0.003	0.034	0.028	0.016	0.121	0.001	0.008	0.206	-0.022	0.187	0.543**
Length of siliquae (cm)	-0.012	-0.017	-0.022	-0.010	0.017	0.025	0.019	0.000	0.134	-0.066	0.312	-0.035	-0.227	0.119
No. of seed per siliquae	-0.051	0.014	0.034	0.000	0.024	-0.010	0.004	-0.011	0.104	-0.085	0.044	0.052	0.227	0.345**
Biological yield (g)	0.010	-0.024	-0.062	-0.016	0.047	0.054	0.019	0.044	0.073	-0.007	0.569	-0.014	-0.421	0.272*
1000 seed test weight (g)	0.036	-0.009	0.000	0.007	0.003	0.007	0.004	-0.011	-0.020	-0.019	-0.035	0.229	0.536	0.727**
Harvest Index %	0.005	0.007	0.030	0.013	-0.018	-0.013	0.000	0.028	-0.037	-0.024	-0.295	0.151	0.814	0.662**

Residual effect = 0.1138

Bold values show direct and normal values shows indirect effects

Table 3: Path coefficient analysis showing the direct and indirect effect at the phenotypic level of different Quantitative Traits in Indian mustard (*Brassica juncea* Czern & coss)

Traits	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches	No. of secondary branches	Length of main raceme (cm)	No. of siliquae on the main raceme	No. of siliquae per plant	Length of siliquae (cm)	No. of seed per siliquae	Biological yield (g)	1000 seed test weight (g)	Harvest Index %	Seed yield per plant (g)
Days to 50% flowering	0.140	0.001	-0.008	0.001	-0.005	0.013	0.008	0.000	-0.002	-0.013	0.048	0.032	0.031	0.247*
Days to maturity	0.015	0.005	-0.003	0.006	0.009	0.006	0.009	0.014	0.005	-0.009	0.230	0.019	-0.109	0.197
Plant height (cm)	0.078	0.001	-0.015	0.003	-0.002	0.023	0.016	0.018	0.003	-0.011	0.317	-0.006	-0.221	0.204
No. of primary branches	0.006	0.001	-0.002	0.025	0.018	0.006	0.005	0.000	0.005	0.004	0.187	-0.020	-0.183	0.052
No. of secondary branches	-0.015	0.001	0.001	0.011	0.042	0.002	0.001	0.022	0.002	0.007	0.215	-0.001	-0.143	0.144
Length of main raceme (cm)	0.065	0.001	-0.012	0.005	0.003	0.028	0.017	0.026	0.005	-0.005	0.354	0.011	-0.124	0.375**
No. of siliquae on the main raceme	0.045	0.002	-0.009	0.005	0.002	0.019	0.026	0.038	0.012	0.004	0.316	0.014	0.038	0.510**
No. of silique per plant	0.000	0.001	-0.003	0.000	0.010	0.009	0.011	0.088	-0.001	-0.005	0.192	-0.013	0.163	0.453**
Length of silique (cm)	-0.008	0.001	-0.002	0.005	0.003	0.005	0.011	-0.004	0.027	0.029	0.198	-0.005	-0.074	0.188
No. of seed per siliquae	-0.029	-0.001	0.003	0.002	0.004	-0.002	0.002	-0.006	0.012	0.065	0.027	0.007	0.206	0.289*
Biological yield (g)	0.012	0.002	-0.008	0.008	0.016	0.017	0.014	0.029	0.009	0.003	0.577	-0.005	-0.430	0.244*
1000 seed test weight (g)	0.029	0.001	0.001	-0.003	0.000	0.002	0.002	-0.007	-0.001	0.003	-0.020	0.154	0.511	0.671**
Harvest Index %	0.005	-0.001	0.004	-0.005	-0.007	-0.004	0.001	0.017	-0.002	0.015	-0.286	0.091	0.867	0.694**

R Square = 0.9724 residual effect = 0.1660

The contribution of residual effects that influenced seed yield was very low at both genotypic and phenotypic levels indicating that the characters included in the present investigation were sufficient enough to account for the variability in the dependant character i.e. seed yield per plant. A perusal of the above results revealed that harvest index, biological yield per plant, number of secondary branches per plant, number of siliquae per plant and length of siliqua per plant had direct high or moderate positive effect on seed yield. Therefore in order to exercise a suitable selection programme it would be worth to concentrate on these characters for improvement in yield of mustard. Indirect contribution of the traits is mainly due to indirect effects of the character through other component traits. Indirect selection through such traits having high or moderate positive effect on seed yield would also be rewarding in yield improvement.

Reference

1. Anonymous. Economic Survey of India. Economic division, Ministry of Finance, Govt. of India. 2018.
2. Bind D, Singh D, Dwivedi VK. Genetic variability and character association in Indian mustard [*Brassica juncia* (L.) Czerns and cross]. Agric. Sci. Digest. 2014;34(3):183-188.
3. Chaudhary M, Swarnkar GB, Prasad L, Rai G. Genetic variability heritability and genetic advance for quality traits in Indian mustard. (*Brassica juncea* L. Czern. & Coss.). Plant Archieves. 2003;2:27-31.
4. Devi B. Correlation and Path analysis in Indian mustard (*Brassica juncea* L.) in agro-climatic condition of Jhansi (U.P.). Journal of Pharmacognosy and Phytochemistry. 2018;7(1):1678-1681.
5. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheat grass seed production. Argon. J. 1959;51:515-518.
6. Dilip TS, Singh SK, Kumar R. Genetic Variability, Character Association and Path Analysis in Indian mustard. Technofame- AJ Multi Adv Res. 2016;5:50-58.
7. Gangapur DR, Prakash BG, Solinath PM, Kumar R, Roa MS. Correlation and path analysis in Indian mustard (*Brassica juncea* L. Czern & Coss.). Karnataka J of Agri. Sci. 2009;22(5):971-977.
8. Helal MMU, Islam MN, Kadir M, Miah MNN. Genetic variability, correlation and path analysis for selection of mustard (*Brassica juncea*) in Sylhet region. Eco-friendly Agril. J. 2014;7(12):176-181.
9. Khan MA, Rabbani MA, Munir M, Ajmal SK, Malik MA. Assessment of genetic variation within Indian mustard (*Brassica juncea* L.) germplasm using RAPD markers. J Integr. Pl. Biol. 2019;50(4):385-392.
10. Kumar A, Singh M, Yadav RK, Singh P, Lallu. Study of correlation and path coefficient among the characters of Indian mustard (*B. juncea*). The Pharma Innovation J. 2018;7:412-416.
11. Kumar J, Srivastava KK, Yadav RDS. Evaluation of varibility and path analysis for quantitative traits in Indian mustard [*B. juncea* (L.) Czern & Coss.]. Ann. Int. J. 2017;12:836-843.
12. Kumar N, Shrivastava S. Plant ideotype of Indian mustard (*Brassica juncea*) for late sown condition. Indian J. Genet. Plant Breed. 2000;63(4):355.
13. Lodhi B, Thakral NK, Ramavtar, Singh A. Genetic variability, association amd path analysis in Indian mustard (*B. juncea*). J Oilseed Brassica. 2014;5:26-31.
14. MA. Assessment of genetic variation within Indian mustard (*Brassica juncea* L.) germplasm using RAPD markers. J. Integr. Pl. Biol. 2019;50(4):385-392.
15. Mahak RC, Sahu PK, Pradhan B, Das S, Mishra CHP. Character association, path-coefficient and selection indices Indian mustard [*Brassica juncea* (L.). Envi. Eco. 2003;26: 166-170.
16. Mishra R, Singh P, Singh IB, Kumar S. Path analysis of the factors contributing to seed yield in yellow seeded Indian mustard. Farm Sci. J. 1987;2:88-91.
17. Pandey KS, Srivastava KK, Negi S, Khan NA, Singh RK. Variability, traits relationship and path analysis for seed yield and seed quality parameters in Indian mustard (*Brassica juncea* L.). Journal of Oilseed Brassica. 2020;11(1):69-76.
18. Patel KM, Patel PG, Pathak HC. Path analysis in Indian mustard [*B. juncea* (L.) Czern & Coss]. Madras Agricultural Journal. 2000;87:4-6, 330-331.
19. Priyamedha VV, Chauhan JS, Meena ML, Mishra DC. Correlation and path coefficient analysis for yield and yield components in early generation lines of Indian mustard (*B. juncea* L.). Current Adv. Agri. Sci. 2013;5:37-40.
20. Rout S, Kerkhi SA, Chauhan C. Character association and path analysis among yield components in Indian mustard [*B. juncea* (L.) Czern & Coss.]. Int. J. Curr. Microbiol. App. Sci. 2019;7:50-55.
21. Roy SK, Kale VA, Nagnathwar VA. Assessment of genetic variability of rapeseed-mustard germplasm under Terai region of West Bengal. Electronic Journal of Plant Breeding. 2015;6(4):1132-1136.
22. Sanghamitra Rout SA, Kerkhi, Charupriya Chauhan. 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(01):50-55.
23. Searle SR. Phenotypic, genotypic and environmental correlations. Biometrics. 1961;47:474-480.
24. Shekhawat G, Jadeja C, Singh J, Shekhawat RS. Character association studies among yield and its component characters in Indian mustard [*B. juncea* (L.) Czern & Coss.]. The Bio. 2014;9:685-688.
25. Shweta, Prakash O. Correlation and path coefficient analysis of yield and yield components of Indian mustard [*B. juncea* (L.) Czern & Coss.]. Int J Plant Sci. 2019;9:428-430.
26. Singh P, Chauhan S, Mishra L, Shukla C. Character association and path coefficient analysis in Indian mustard. Adv. Agri. Sci. 2014;12:87-93.
27. Singh S, Ashutosh, Dwivedi KA, Kumar O, Kumar K, Verma OP. Study of character association and path analysis in Indian mustard (*Brassica juncea* L.) genotypes. Int. J Curr. Microbiol. App. Sci. 2020;9(2):3218-3223.
28. Singh M, Tomar A, Mishra CN, Srivastava SBL. Genetic parameters and character association studies in Indian mustard. Journal of Oilseed Brassica. 2011;2(1):35-38.
29. Sirohi SPS, Malik S, Kumar K. Correlation and path analysis of Indian mustard [*B. juncea* (L.) Czern & Coss.]. Ann. Agri. Res. 2015;25:491-494.
30. Tahira M, Tahir MS, Saleem U, Hussain M, Saqib M.

The estimation of heritability, association and selection criteria for yield component in mustard (*Brassica juncea*). Pak. J. Agri. Sci. 2011;48(4):251-254.
31. Verma R, Sharma R, Sharma SK. Association studies among yield and its component characters in Indian mustard [*B. juncea* (L.) Czern & Coss.]. Indian J. Gen. Plant Breed. 2008;68:87- 89.
32. Vermai U, Thakral NK, Neeru. Genetic diversity analysis in Indian mustard [*Brassica juncea* (L.) Czern and Coss]. International Journal of Applied Mathematics & Statistical Sciences (IJAMSS). 2016;6(2):2319-3980.
33. Wright S. The method of Path coefficient Ann. Math. Statist. 1921;5:161-215.s