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Dissecting yield and yield-associated traits in Indian mustard (*Brassica juncea* L.): Insights from correlation and path analysis

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Abstract

An experiment was conducted to analyze the correlation and path analysis of 12 quantitative traits in 47 genotypes of Indian mustard (*Brassica juncea* L.), including 13 parent lines, 30 F_1 hybrids, and 4 check varieties. The experimental materials were evaluated in a randomized block design with three replications across three different environments: early sown, timely sown, and late-sown. Pooled correlation analysis revealed that plant height, number of secondary branches, main shoot length, siliqua on the main shoot, and maturity exhibited high positive and significant genotypic correlations with seed yield per plant. Phenotypic correlations showed that the number of primary branches per plant, number of secondary branches per plant, and 1000-seed weight had highly significant positive correlations with seed yield per plant. Furthermore, plant height, number of secondary branches per plant, main shoot length, number of siliqua per plant, and number of seeds per siliqua showed high positive and significant phenotypic correlations with seed yield per plant. Path analysis indicated that the number of secondary branches per plant had the maximum positive direct genotypic effect on seed yield, followed by days to maturity, 1000-seed weight, and plant height. The highest direct phenotypic effect on seed yield per plant was exhibited by the number of secondary branches per plant, followed by 1000-seed weight, days to maturity, and number of primary branches per plant.

Keywords: *Correlation analysis, Indian mustard, path analysis*

Introduction

Brassica juncea L., commonly known as Indian mustard, is a member of the Brassicaceae family, with a chromosome count of 2n = 36. Botanically, it is classified as *Brassica juncea* (L.) Czern. & Coss., characterized by an AABB genome. This allopolyploid species represents over 80% of India's rapeseed-mustard production and is a key player in the country's oilseed industry. Indian mustard, predominantly self-pollinating, does experience an average out crossing rate of 7.5 to 30 percent under natural field conditions. It is chiefly grown as a winter crop in irrigated areas. Yield in Indian mustard is influenced by a complex array of traits, making it crucial to understand how these traits interact to effectively improve crop performance. Identifying and analyzing the relationships between yield and its contributing factors can significantly enhance selection criteria in breeding programs. While correlations between traits are informative, they may not fully capture the indirect effects on seed yield. To address this, path coefficient analysis, as introduced by Wright in 1921, is an essential tool. It breaks down the overall correlation into direct and indirect effects, providing a clearer picture of how traits contribute to yield. In India, a major agricultural hub supporting 26% of the global agricultural workforce on only 12% of arable land, the oilseed sector is crucial. The country ranks fifth worldwide in vegetable oil production, contributing 7.4% to oilseeds, 5.8% to oils, and 6.1% to oil meal, and accounts for 9.3% of global edible oil consumption. Indian oilseed brassica cultivation spans 23.5% of the total oilseed area and yields 24.2% of the production. Despite being the third-largest global producer of oilseed brassica, India still imports 57% of its edible oil; making it the seventh-largest importer of edible oils worldwide (Jat *et al*., 2019).

Materials and Methods

The study utilized 47 Indian mustard genotypes, comprising 13 parental lines and 34 additional genotypes, sourced from the Crop Research Centre of Birsa Agricultural University, Kanke, Ranchi, Jharkhand. These genotypes included 30 F_1 hybrids and 4 check varieties. The experimental design was a Randomized Block Design (RBD) with three replications, and evaluations were conducted across three distinct sowing conditions: early, timely, and late.In each replication, genotypes were planted in plots consisting of four rows, each 2 meters in length. The spacing between plants was standardized at 10 cm, achieved by thinning the plants 18-20 days after sowing. Observations were made on five randomly selected plants randomly at maturity, while days to 50%

flowering and days to maturity were recorded at the plot level. The traits measured included: days to 50% flowering, plant height (cm), number of primary branches per plant, number of secondary branches per plant, siliqua per plant, siliqua length (cm), distance from primary branches to main shoot (cm), main shoot length (cm), days to maturity, number of seeds per siliqua, 1000-seed weight (g), and seed yield per plant (g).

Trait data were compiled and analyzed using standard variance analysis methods as outlined by Panse and Sukhatme (1978). The phenotypic and genotypic coefficients of variation, broad-sense heritability, and genetic advance as a percentage of the mean were calculated using the formulas proposed by Burton (1952) and Johnson *et al.* (1955). To assess the relationships between traits, pooled genotypic correlation coefficients were computed following the method described by Al-Jibouri *et al.* (1958). Additionally, path analysis was performed based on the genotypic correlation coefficients to evaluate the direct and indirect effects of various traits on seed yield, as introduced by Wright (1921) and detailed by Dewey and Lu (1957).

Results and Discussion

Correlation studies are instrumental for plant breeders aiming to identify traits closely associated with primary breeding objectives. The analysis of pooled genotypic and phenotypic correlations across different environments is summarized in Tables 1 and 2, indicating significance at both 1% and 5% levels. The results revealed a highly significant positive genotypic correlation between the number of siliqua per plant and both the number of primary branches per plant (1.057**) and the number of secondary branches per plant (0.825**). Additionally, significant positive genotypic correlations were observed between the number of primary branches per plant (0.511**), the number of secondary branches per plant (0.491**), and the number of siliqua per plant (0.516**) with main shoot length. Seed yield per plant showed a significant positive correlation with the number of primary branches per plant (0.547**), the number of secondary branches per plant (0.526**), and 1000-seed weight (0.355*). The number of seeds per siliqua had a highly significant positive association with the number of primary branches per plant (0.497**) and siliqua length (0.547**), while it was negatively correlated with distance from primary branches to the main shoot (0.366*) (Table 1).

These findings align with previous research by Singh *et al*. (2011), Yadav *et al*. (2011), Singh and Singh (2010), Shweta and Om Prakash (2014) and Bhupendra Singh Yadav *et al*. (2021), who similarly identified significant

Table 1: Genotypic correlations between different quantitative traits of Indian mustard

Charactors	Plant Height (cm)	No. of Primary branches per plant	No. of Secondary branches per plant	No. of Siliqua per plant	Siliqua length (cm)	Point to primary branches (cm)	Main shoot length (cm)	Days to maturity	No. of seeds per Siliqua	1000 seed weight (g)	Seed yield per plant (g)
Days to 50% flowering	0.405 **	0.063	0.231	0.041	-0.337 *	0.043	0.255	0.056	-0.047	0.111	0.129
Days to 50% flowering		0.364 *	0.463 **	0.105	-0.083	0.158	0.149	-0.349 *	0.2499	-0.003	0.273
Plant Height (cm)			1.036 **	1.057 **	0.002	-0.721 **	0.5109 **	-0.371 *	0.4972 **	-0.179	0.5469 **
No. of Primary branches per plant				0.825 **	-0.199	-0.214	0.4911 **	-0.403 **	0.1593	-0.037	0.5257 **
No. of Secondary branches per plant				-0.278	-0.248	0.5159 **	-0.585 **	0.1169	-0.411 **	0.245	
No. of siliqua per plant						-0.023	-0.206	0.272	0.547 **	0.401 **	0.206
Siliqua length(cm)							0.049	0.052	-0.365 *	-0.143	-0.096
Point to primary branches(cm)								-0.101	0.086	0.013	0.272
Main shoot length(cm)									0.003	0.4979 **	0.164
Days to maturity										0.09	0.23
No. of seeds per Siliqua											0.355*

* and ** Significance at 5% and 1% level of significance, respectively.

Table 2: Phenotypic correlations between different quantitative traits of Indian mustard

Charactors	Plant Height (cm)	Primary branches per plant	Secondary branches per plant	Siliqua per plant	Siliqua length (cm)	Point to primary branches (cm)	Main shoot length (cm)	Days to maturity	No. of seeds per Siliqua	1000 seed weight (g)	Seed yield per plant (g)
Days to 50% flowering	0.286 **	0.089	0.204 *	0.024	-0.239 **	-0.004	0.126	0.064	-0.035	0.107	0.103
Plant Height (cm)		0.155	0.331 **	0.209 *	0.034	0.138	0.304 **	-0.276**	0.241 **	-0.008	0.183 *
No. of Primary branches per plant			0.611 **	0.489 **	-0.005	-0.325 **	0.171	-0.178 *	0.241 **	-0.071	0.332 **
No. of Secondary branches per plant			0.749 **	-0.098	-0.284 **	0.385 **	-0.297**	0.095	-0.029	0.432 **	
No. of siliqua per plant					-0.074	-0.285 **	0.375 **	-0.345 **	0.105	-0.252 **	0.219 *
Siliqua length(cm)						-0.028	-0.013	0.229 **	0.436 **	0.298 **	0.15
Point to primary branches(cm)							-0.07	0.042	-0.095	-0.092	-0.116
Main shoot length(cm)								-0.062	0.111	0.016	0.258 **
Days to maturity									-0.044	0.466**	0.147
No. of seeds per Siliqua										0.071	0.179*
1000 seed weight(g)											0.323 **

* and ** Significance at 5% and 1% level of significance, respectively.

Table 3: Direct and indirect effect of yield components on seed yield (Genotypic)

Characters	Days to 50% flowering	Plant Height (cm)	Primary branches / plant (no)	Secondary branches / plant (no)	Siliqua / plant (no)	Siliqua length (cm)	Point to primary branches (cm)	Main shoot length (cm)	Days to maturity	Seeds per siliqua (no)	1000 seed weight (g)	Seed yield per plant (g)
Days to 50% flowering	-0.050	0.052	0.002	0.147	0.001	-0.063	0.002	0.001	0.020	0.001	0.017	0.129
Plant Height (cm)	-0.020	0.128	0.009	0.295	0.002	-0.015	0.007	0.001	-0.126	-0.005	0.000	0.273
No. of Primary branches/plant	-0.003	0.047	0.024	0.660	0.019	0.000	-0.032	0.002	-0.134	-0.010	-0.027	0.546**
No. of Secondary branches/plant	-0.012	0.059	0.025	0.637	0.015	-0.037	-0.009	0.002	-0.145	-0.003	-0.006	0.53 4**
No. of siliqua/plant	-0.002	0.014	0.026	0.525	0.018	-0.052	-0.011	0.002	-0.211	-0.002	-0.062	0.251
Siliqua length(cm)	0.017	-0.011	0.000	-0.127	-0.005	0.187	-0.001	-0.001	0.098	-0.011	0.060	0.213
Point to primary branches(cm)	-0.002	0.020	-0.017	-0.136	-0.004	-0.004	0.044	0.000	0.019	0.007	-0.021	-0.092
Main shoot length(cm)	-0.013	0.019	0.012	0.313	0.009	-0.038	0.002	0.004	-0.036	-0.002	0.002	0.271
Days to maturity	-0.003	-0.045	-0.009	-0.256	-0.011	0.051	0.002	0.000	0.360	0.000	0.075	0.163
No. of seeds per Siliqua	0.002	0.032	0.012	0.101	0.002	0.102	-0.016	0.000	0.001	-0.020	0.014	0.231
1000 seed weight(g)	-0.006	0.000	-0.004	-0.023	-0.007	0.075	-0.006	0.000	0.179	-0.002	0.150	0.355 *

Residual are 0.6401

Table 4: Direct and indirect effect of yield components on seed yield (Phenotypic)

Characters	Days to 50% flowering	Plant Height (cm)	Primary branches / plant (no)	Secondary branches / plant (no)	Siliqua / plant (no)	Siliqua length (cm)	Point to primary branches (cm)	Main shoot length (cm)	Days to maturity	Seeds per siliqua (no)	1000 seed weight (g)	Seed yield per plant (g)
Days to 50% flowering	-0.049	0.012	0.011	0.094	-0.003	-0.009	0.000	0.012	0.012	-0.003	0.025	0.103
Plant Height (cm)	-0.014	0.043	0.020	0.153	-0.021	0.001	0.007	0.029	-0.049	0.018	-0.002	0.183 *
No. of Primary branches per plant	-0.004	0.007	0.128	0.282	-0.050	0.000	-0.016	0.016	-0.032	0.018	-0.016	0.332 **
No. of Secondary branches per plant 0.432 **		-0.010	0.014	0.078	0.461	-0.077	-0.004	-0.014	0.036	-0.053	0.007	-0.007
No. of siliqua per plant	-0.001	0.009	0.062	0.345	-0.103	-0.003	-0.014	0.035	-0.062	0.008	-0.058	0.219 *
Siliqua length(cm)	0.012	0.001	-0.001	-0.045	0.008	0.037	-0.001	-0.001	0.041	0.032	0.069	0.150
Point to primary branches (cm)	0.000	0.006	-0.041	-0.131	0.029	-0.001	0.049	-0.007	0.007	-0.007	-0.021	-0.117
Main shoot length (cm)	-0.006	0.013	0.022	0.178	-0.039	-0.001	-0.003	0.094	-0.011	0.008	0.004	0.259 **
Days to maturity	-0.003	-0.012	-0.023	-0.137	0.035	0.008	0.002	-0.006	0.179	-0.003	0.107	0.147
No. of seeds per Siliqua	0.002	0.010	0.031	0.044	-0.011	0.016	-0.005	0.010	-0.008	0.073	0.016	0.179 *
1000 seed weight (g)	-0.005	0.000	-0.009	-0.014	0.026	0.011	-0.005	0.002	0.083	0.005	0.230	0.324 **

Residual are 0.475

correlations between these traits. The phenotypic correlations revealed significant positive relationships between plant height and the number of secondary branches per plant (0.331**), main shoot length (0.304*), numbersiliqua per plant (0.209*), number of seeds per siliqua (0.241**), and seed yield per plant (0.183*). Main shoot length demonstrated a highly significant positive correlation with the number of secondary branches per plant (0.385**), number of siliqua per plant (0.375**), and seed yield per plant (0.259**) (Table 2). The correlation analysis underscores that key traits for yield selection include plant height, number of primary and secondary branches, number of seeds per plant, and number of siliqua per plant.In most correlated trait pairs, the genotypic and phenotypic associations were consistent in direction, with genotypic correlations generally exceeding phenotypic ones, suggesting a heritable association between traits. This observation corroborates findings by Rameeh *et al*. (2011), Dar *et al*. (2010), Tahira *et al*. (2012) and Bhupendra Singh *et al*. (2021).

Path coefficient analysis provides insight into the direct and indirect effects of traits on seed yield. According to the data (Table 3), the highest positive direct effect was observed for the number of secondary branches per plant (0.637), followed by days to maturity (0.360), 1000-seed weight (0.150), plant height (0.128), distance from primary branches (0.044), number of primary branches per plant (0.024), number of siliqua per plant (0.018), and main shoot length (0.004). Further analysis (Table 4) indicated that the number of secondary branches per plant had the highest positive direct effect on seed yield (0.461), followed by 1000-seed weight (0.230), days to maturity (0.179), number of primary branches per plant (0.128), main shoot length (0.094), number of seeds per siliqua (0.073), distance from primary branches (0.049), plant height (0.043) and siliqua length (0.037).

These results suggest that seed yield per plant has considerable potential for selection due to its high broad-sense heritability (h^2), significant positive correlations, and substantial positive direct effects on yield. Similar conclusions have been drawn by Singh and Singh (2010), Mahla *et al*. (2003) and Kumar *et al*. (2016).

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References

Al-Jibouri HA, Miller PA, Robinson HF. 1958. Genotype and environmental variances and co-variance in upland cotton cross of interspecific origin. *Agron J,* **50**: 633-637.

Burton GW. 1952. Quantitative Inheritance in Grasses in. Proc. *6th Int. Grassland Congress*,**7**: 273-283.

Dar ZA, Wani SA, Zaffar G, Ishfaq A, Wani MA, Habib M, Khan MH, Razvi SM. 2010. Character association and path coefficient studies in Brown sarson (*Brassica rapa* L.). *Res J Agri Sci,* **1**: 153-154.

Dewey DR and Lu KH. 1957. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron J,* **5**: 515-518.

Jat RS, Singh VV, Sharma P, Rai PK. 2019. Oilseed brassica in India: Demand, supply, policy perspective and future potential. OCL **26**: 8.

Johnson HW, Robinson HF, Comstock RE. 1955. Estimates of genetic and environmental variability in soybean. *Agron J,* **47**: 314-318.

Khayat M, Lack Sh, Karami H, 2012. Correlation and path analysis of traits affecting grain yield of canola (*Brassica napus* L.) varieties. *J Basic Appl Sci Res* **2**: 5555-5562.

Kumar Rajeev, Gaurav SS, Jayasudha S, Kumar Hitesh.2016. Study of correlation and path coefficient analysis in germplasm lines of Indian mustard (*Brassica juncea* L.). *Agric Sci Digest,* **36**: 92- 96.

Mahla HR, Jambhulkar SJ, Yadav DK, Sharma R. 2003. Genetic variability, correlation and path analysis in Indian mustard [*Brassica juncea* (L.) Czern. and Coss.]. *Ind J Genet Plant Breed,* **6**: 171-172.

Panse VG and Sukhatme PV. 1978. Statistical methods for Agricultural Workers. ICAR, New Delhi. 235-246.

Rameeh V. 2011. Correlation and path analysis in advanced lines of rapeseed (*Brassica napus*) for yield components. *J Oilseed Brassica,* **2**: 56-60.

Shalini TS, Ram S, Kulkarni RS and Venkataramana P. 2000. Correlation and path analysis of Indian mustard germplasm. *Mysore J Agril Sci,* **1**: 226-229.

Shweta OP. 2014. Correlation and path co-efficient analysis of yield and yield components of Indian mustard [*Brassica juncea* (L.) Czern and Coss]. *Int J Plant Sci,* **2**: 428-430.

Singh SK and Singh AK. 2010. Inter-relationship and path analysis for seed yield in Indian mustard. *Ind J Ecol,* **3**: 8-12.

Singh VK, Singh D and Singh AK. 2011. Genetic divergence for important economic and quality traits in Indian mustard (*Brassica juncea* L. Czern & Coss). *Pantnagar J Res,* **9**: 183-188.

Tahira T, Mahmood MS, Tahir U, Saleem M, Hussain M and Saqib. 2012. The estimation of heritability, association and selection criteria for yield components in mustard (*Brassica juncea*). *Pak J Agri Sci,* **48**: 251-254.

Wright S. 1921. Correlation and causation. *J Agric Res,* **1**: 557-585.

Yadav BS, Sharma HK,Yadav AP, Ram B. 2021. Correlation and path analysis in Indian mustard (*Brassica juncea* L.) for seed yield and attributing traits. *Int J Curr Microbiol App Sci,* **10**: 1761-1768.

Yadava DK, Giri SC, Vignesh M, Vasudev S, Yadav KA, Dass B. 2011. Genetic variability and trait association studies in Indian mustard (*Brassica juncea*). *Ind J Agric Sci,* **8**: 712-716.