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Inter-relationship and path coefficient analysis among quantitative traits in Indian mustard (*Brassica juncea* L. Czern and Cos)

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Abstract

Present investigation was carried out with ten genotypes of Indian mustard to study the inter-relationship and path coefficient analysis among eleven quantitative traits in Indian Mustard. These ten genotypes were evaluated in randomized block design with three replications during *Rabi*, 2021-2022. Inter-relationship analysis among the quantitative characters revealed that the genotypic correlation coefficient in most cases were higher than their phenotypic correlation coefficient indicating the association was largely due to genetic reason. At both genotypical levels, the significant positive correlation was observed for number of siliqua/plant with seed yield/plant and the non- significant positive correlation was observed for days to maturity, 1000 seed weight and number of secondary branches/plant with seed yield/plant. Path coefficient analysis revealed that the high positive direct effect by number of secondary branches/plant, number of seeds/siliqua, number of siliqua/plant and plant height on seed yield/plant and high negative direct effect by harvest index, number of primary branches/plant and days to maturity. These traits can be used in selection criteria for crop improvement programme in Indian Mustard.

Keywords: Correlation coefficient, Indian mustard (*Brassica juncea* L. Czern and Cos), Inter-relationship, path coefficient analysis, quantitative traits

Introduction

Indian mustard (*Brassica juncea* L. Czern and Cos) belongs to the family Brassicaceae (Cruciferae). It is a natural amphidiploid with chromosome number (2n=36). *Brassica juncea* derived from interspecific hybridization between the diploid progenitors *Brassica rapa* (AA, 2n = 20) and *Brassica nigra* (BB, 2n = 16). The evolutionary relationship exists among the six crop Brassica species. This involves three basic diploid species *B. rapa, B. nigra* and *B. oleracea.* Pairwise hybridization between these diploid species followed by chromosome doubling led to the evolution of the basic diploid level and development of the three amphiploid species *B. napus, B. carinata* and *B. juncea.* (UN, 1935). It is the third most important oil seed crop in the World and second most important oil seed crop in the country India. It is predominantly a self- pollinated crop but out-crossing does occur up to 30% under natural conditions, depending upon wind and bee activities. It is an important rabi season crop extensively gown as rain- fed as well as under irrigated conditions. (Rakow and Woods, 1987.) Mustard is one of the major sources of oil and oil meal in India. Hence, it is highly imperative to focus on increasing the seed yield through various breeding methodologies. Knowledge of the interrelationship among various characters help in proper planning of the breeding programme. Path coefficient analysis plays an important role in measuring the direct and indirect effects of various independent traits on a dependent trait. (Dewey and Lu, 1959) [7].

Materials and Methods

Ten genotypes of Indian mustard which were collected from Directorate of Rapeseed -Mustard Research (DRMR), Bharatpur. The field trail was carried out at Field Experimentation Centre of Department of Genetics and plant breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. during Rabi, 2021-22. The plot size for genotype was 1.0 m^2. 45 cm row to row distance and 15 cm plant to plant distance was maintained. Data was collected from five randomly selected plants except for days to 50% flowering and days to maturity which was on plot basis. The data was recorded among 11 quantitative traits *viz*; days to 50% flowering, days to maturity, number of secondary branches/plant, number of primary branches/plant, number of siliqua /plant, number of seeds /siliqua, biological yield/plant (g), plant height (cm), harvest index (%), 1000 seed weight (g) and Seed yield/plant (g). Correlation coefficient analysis was given by Al-Jibouri *et al.* (1958) [4]. Before attempting to improver any character, it is necessary to understand its effect on other characters.

Wright (1921) [21] developed path coefficient analysis to assist the partition correlation into direct and indirect effects of independent variables on dependent variables. Path coefficient analysis was first proved in plant selection by Dewey and Lu (1959) [7] and it has been applied to every plant.

Results and Discussion

Seed yield/plant is a complex character that is influenced by a number of factors, thus selecting based on a simple connection without considering the component characters is ineffective. As a result correlation combined with path analysis provide a better understanding of the cause and effect of relationship between quantitative traits. Thus, it plays a critical role in any Plant Breeding programme.

In the present investigation, correlation coefficient analysis at genotypic level revealed that, seed yield/plant exhibited positive significant association with number of siliqua/plant (0.794**), plant height (0.498*),harvest index (0.429*) and days to 50% flowering (0.410*) while it showed positive non-significant association with days to maturity (0.0468), 1000 seed weight (0.0445) and number of secondary branches/plant (0.0324). Seed yield/plant exhibited negative significant association with number of primary branches/plant (-0.552*), while it showed negative non-significant association with biological yield/plant (-0.0721) and number of seeds/siliqua (-0.0707). Correlation coefficient analysis at phenotypic level revealed that, seed yield/plant exhibits positive significant association with number of siliqua/plant (0.626**) while it shows positive non-significant association with harvest index (0.3290), plant height (0.2894), days to 50% flowering (0.2350), number of secondary branches/plant (0.1321), number of seeds/siliqua (0.1066), 1000 seed weight (0.0458),days to maturity (0.0176) and biological yield/plant (0.0150). Seed yield/plant exhibits negative non-significant association with number of primary branches/plant (-0.2416). Singh *et al.* (2011) [19] also reported that days to 50% flowering had significant positive association with seed yield at both phenotypic and genotypic level. These indicates that these traits can be considered for direct selection.

Genotypic path coefficient analysis revealed that the number of secondary branches/plant (0.8648), number of seeds/siliqua (0.6690), number of siliqua/plant (0.5063), plant height (0.3617), days to 50% flowering (0.3253), biological yield/plant (0.0699) and 1000 seed weight (0.0092) showed direct positive effect on seed yield/plant while harvest index (-0.2318), number of primary branches/plant (-0.2215) and days to maturity (-0.1772) showed negative direct effect on seed yield/plant. Phenotypic path coefficient analysis revealed that the number of secondary branches/plant (0.6969), number of seeds/siliqua (0.5822), number of siliqua/plant (0.4473), days to 50% flowering (0.4232), plant height (0.4017) and biological yield/plant (0.0841) showed direct positive effect on seed yield/plant while harvest index (-0.2313), days to maturity (-0.2113), number of primary branches/plant (-0.1167) and 1000 seed weight (-0.0004) showed negative direct effect on seed yield/plant. The positive direct effect of days to flowering, number of branches per plant, on seed yield per plant were also reported by Rout *et al.* (2018) [16] and Rathod *et al.* (2013) [15], while positive direct effect of 1000-seed weight on seed yield per plant was also recorded by Roy *et al.* (2018) [17].

The value of studies on inter-relationship and path analysis between various quantitative characters of the plant population is very great indeed, as it furnishes to the plant breeder with an easy and fairly reliable means of isolating high yielding and better-quality genotypes from the breeding material reported.

Table 1: Estimation of genotypic correlation coefficient for 11 quantitative traits in 10 Indian mustard

Traits	Days to fifty percent flowering	Days to maturity	Number of primary branches/plant	Number of secondary branches/ plant	Number of siliqua/ plant	Number of seeds/ siliqua	Plant height (cm)	Biological yield/ plant	Harvest Index (%)	1000 seed wt (g)	Seed yield / plant
Days to fifty percent flowering	1.0000	-0.524*	0.1062	0.0746	0.468*	-0.423*	0.482*	-0.3162	0.800**	-0.0405	0.410*
Days to maturity		1.0000	-0.2043	0.768**	-0.3266	0.2831	0.825**	0.925**	-0.562*	-0.0783	0.0468
Number of primary branches/plant			1.0000	0.3032	-0.0948	-0.412*	-0.431*	-0.0886	-0.0698	-0.748**	-0.552*
Number of secondary branches/plant				1.0000	-0.2975	-0.1944	0.584**	0.527*	-0.3153	-0.0482	0.0324
Number of siliqua/plant					1.0000	0.1162	-0.1393	-0.2994	0.512*	-0.508*	0.794**
Number of seeds/ siliqua						1.0000	-0.1555	0.1986	-0.2261	0.1002	-0.0707
Plant height (cm)							1.0000	0.718**	-0.0958	0.685**	0.498*
Biological yield / plant								1.0000	0.810**	0.411*	-0.0721
Harvest Index (%)									1.0000	-0.413*	0.429*
1000 seed wt. (g)										1.0000	0.0445
Seed yield / plant											1.0000

Table 2: Estimation of phenotypic correlation coefficient for 11 quantitative traits in Indian mustard

Traits	Days to fifty percent flowering	Days to maturity	Number of primary branches/ plant	Number of secondary branches/ plant	Number of siliqua /plant	Number of Seeds/ Siliqua	Plant height (cm)	Biological yield/ plant	Harvest Index (%)	1000 seed wt. (g)	Seed yield / plant
Days to fifty percent flowering	1.0000	-0.0943	-0.0238	-0.0755	0.2260	-0.2920	0.0086	-0.1025	0.2567	0.1145	0.2350
Days to maturity		1.0000	-0.0922	0.504*	-0.1271	0.1725	0.408*	0.575**	-0.3228	0.1775	0.0176
Number of primary branches/plant			1.0000	0.3520	-0.0363	-0.2740	-0.2209	-0.0577	-0.0172	-0.448*	-0.2416
Number of secondary branches/plant				1.0000	-0.2455	-0.1017	0.462*	0.468*	-0.1964	-0.0214	0.1321
Number of siliqua/plant					1.0000	0.0817	-0.1019	-0.2256	0.416*	-0.3529	0.626**
Number of seeds/siliqua						1.0000	-0.1262	0.1638	-0.1212	0.1410	0.1066

Plant height (cm)							1.0000	0.420*	-0.0025	0.2030	0.2894
Biological yield /plant								1.0000	-0.757**	0.1734	0.0150
Harvest Index (%)									1.0000	-0.1132	0.3290
1000 seed wt. (g)										1.0000	0.0438
Seed yield /plant(g)											1.0000

Table 3: Direct and indirect effects of quantitative traits on seed yield/plant at genotypic level

Traits	**Days to fifty percent flowering**	**Days to maturity**	**Number of primary branches/ plant**	**Number of secondary branches/ plant**	**Number of siliqua/ plant**	**Number of seeds/ siliqua**	**Plant height (cm)**	**Biological yield/ plant**	**Harvest Index (%)**	**1000 seed wt (g)**	**Seed yield/ plant**
Days to fifty percent flowering	0.3253	-0.1703	0.0345	0.0243	0.1523	-0.1374	0.1568	-0.1029	0.2601	-0.0132	0.410*
Days to maturity	0.0928	-0.1772	0.0362	-0.1360	0.0579	-0.0501	-0.1789	-0.1774	0.0995	0.0139	0.0468
Number of primary branches/plant	-0.0235	0.0453	-0.2215	-0.0672	0.0210	0.0912	0.0955	0.0196	0.0155	0.1656	-0.552*
Number of secondary branches/plant	0.0645	0.6640	0.2622	0.8648	-0.2573	-0.1681	0.5052	0.4553	-0.2726	-0.0417	0.0324
Number of siliqua/ plant	0.2371	-0.1654	-0.0480	-0.1506	0.5063	0.0588	-0.0705	-0.1516	0.2590	-0.2574	0.794**
No.of seeds/siliqua	-0.2827	0.1894	-0.2756	-0.1300	0.0777	0.6690	-0.1040	0.1329	-0.1513	0.0670	-0.0707
Plant height (cm)	0.1744	0.3653	-0.1560	0.2113	-0.0504	-0.0563	0.3617	0.2598	-0.0346	0.2478	0.498*
Biological yield /plant	-0.0221	0.0700	-0.0062	0.0368	-0.0209	0.0139	0.0502	0.0699	-0.0566	0.0287	-0.0721
Harvest Index (%)	-0.1853	0.1302	0.0162	0.0731	-0.1186	0.0524	0.0222	0.1878	-0.2318	0.0957	0.429*
1000 seed wt (g)	-0.0004	-0.0007	-0.0069	-0.0004	-0.0047	0.0009	0.0063	0.0038	-0.0038	0.0092	0.0445
Seed yield /plant	0.410*	0.0468	-0.552*	0.0324	0.794**	-0.0707	0.498*	-0.0721	0.429*	0.0445	1.0000
Partial R^2	0.1332	-0.0083	0.1222	0.0280	0.4019	-0.0473	0.1802	-0.0050	-0.0995	0.0004	

Table 4: Direct and indirect effects of quantitative traits on seed yield/plant at phenotypic level

Traits	**Days to fifty percent flowering**	**Days to maturity**	**Number of primary branches/ plant**	**Number of secondary branches/ plant**	**Number of siliqua/ plant**	**Number of seeds/siliqua**	**Plant height (cm)**	**Biological yield/plant**	**Harvest Index (%)**	**1000 seed wt (g)**	**Seed yield/ plant**
Days to fifty percent flowering	0.4232	-0.0399	-0.0101	-0.0319	0.0956	-0.1236	0.0037	-0.0434	0.1086	0.0484	0.2350
Days to maturity	0.0199	-0.2113	0.0195	-0.1066	0.0269	-0.0364	-0.0862	-0.1215	0.0682	-0.0375	0.0176
Number of primary branches/plant	0.0028	0.0108	-0.1167	-0.0411	0.0042	0.0320	0.0258	0.0067	0.0020	0.0523	-0.2416
Number of secondary branches/plant	-0.0526	0.3515	0.2453	0.6969	-0.1711	-0.0709	0.3218	0.3258	-0.1369	-0.0149	0.1321
Number of siliqua/ plant	0.1011	-0.0569	-0.0162	-0.1098	0.4473	0.0366	-0.0456	-0.1009	0.1860	-0.1578	0.626**
Number of seeds/siliqua	-0.1700	0.1004	-0.1595	-0.0592	0.0476	0.5822	-0.0735	0.0953	-0.0706	0.0821	0.1066
Plant height (cm)	0.0035	0.1639	-0.0887	0.1855	-0.0409	-0.0507	0.4017	0.1686	-0.0010	0.0816	0.2894
Biological yield /plant	-0.0086	0.0484	-0.0049	0.0393	-0.0190	0.0138	0.0353	0.0841	-0.0637	0.0146	0.0150
Harvest Index (%)	-0.0594	0.0747	0.0040	0.0454	-0.0962	0.0280	0.0006	0.1751	-0.2313	0.0262	0.3290
1000 seed w.t (g)	0.0000	-0.0001	0.0002	0.0000	0.0001	-0.0001	-0.0001	-0.0001	0.0000	-0.0004	0.0438
Seed yield /plant	0.2350	0.0176	-0.2416	0.1321	0.626**	0.1066	0.2894	0.0150	0.3290	0.0438	1.0000
Partial R^2	0.0994	-0.0037	0.0282	0.0921	0.2801	0.0621	0.1163	0.0013	-0.0761	0.0000	

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