RESEARCH ARTICLE

CORRELATION AND PATH ANALYSIS STUDIES FOR YIELD AND ITS CONTRIBUTING TRAITS IN INDIAN MUSTARD [B*RASSICA JUNCEA* (L.) CZERN & COSS]

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Abstract: Sixty genotypes of Indian mustard [*Brassica juncea* (L.) Czern and Coss] were evaluated in Randomized Block Design during *Rabi* season 2019-20 to study the correlation and path coefficient analysis among fourteen quantitative traits. The correlation of seed yield per plant was observed positive and significant with number of siliquae per plant, harvest index and number of siliquae on main axis. It was positive and non-significant with days to 50% flowering, number of seeds per siliqua, days to maturity, oil content and 1000-seed weight. Positive direct effect towards seed yield per plant was reflected both at genotypic and phenotypic level through harvest index, number of siliquae on main axis, 1000-seed weight, number of seeds per siliqua, oil content, and days to maturity.

Keywords: Crops, Indian mustard, Correlation coefficient, Yield

INTRODUCTION

Rapeseed-mustard group of crops is the major oilseed crop of India. This crop accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop. Among the oilseed crops, Rapeseed and mustard is second in production after soybean in India. In India, rapeseed–mustard is grown in diverse agro-climatic conditions ranging from north-eastern/north-western hills to down south under irrigated/rain-fed, timely/late sown and mixed cropping. Since these crops are cultivated mainly in the rainfed and resource scarce regions of the country, their contribution to livelihood security of the small and marginal farmers in these regions is also very important. Rapeseed-mustard crops fit well in the rain-fed cropping system due to its low water requirement. The average contribution of rapeseed-mustard to the total oilseed production in India was 24.3%, during 2018-19 with an average productivity of 1499 kg/ha as compared to 1234 kg/ha of total oilseeds. It is grown in an area of 6.2 million hectares in the country with production of 9.3 million tonnes. In Rajasthan, rapeseed-mustard is cultivated in an area of 2.76 million hectares, which is 57% of total area under oilseeds in the state (4.81 million hectares). It has 63% share in total oil seeds production of the state (7.69 million tonnes) with 4.84 million tonnes of production and 1740 kg/ha of average yield. The major objective of the present-day breeding programmes, therefore, should be higher productivity and greater yield stability. Since Brassica crop in general gives lower yields than cereals, it has led people to believe that Brassica crop may have a lower genetic potential. However, it is indicated that the Brassica crop has a higher genetic potential for yield as compared to cereals. To meet out the present oil requirements, there is an urgent need to increase the yield potential of *Brassica juncea* through genetic interventions. Yield is complex character which dependent on the various yield contributing traits. Thus the study of correlation between yield and its component is of primary importance in formulating the selection criteria under crop improvement. Selection of any desirable trait is generally preformed based on the phenotypic value of the plants. Correlation coefficient provides symmetrical measurement of degree of association between two characters help in understanding the nature and magnitude of association among yield and its components. Direct and indirect effects of independent component traits on yield measured by path coefficient analysis which is fruitful for genetic improvement because direct selection is not effective for low heritable polygenic traits like yield.

MATERIALS AND METHODS

The field experiment was conducted at Agricultural Research Station, Kota, Agriculture University, Kota, Rajasthan. The experimental material for present study consisted of 60 diverse genotypes of Indian mustard. The experiment was laid out in Randomized Block Design (RBD) with three replications. Each genotype was sown in 2 rows of 5.0-meters length, with row to row and plant to plant spacing of 30 cm and 10 cm, respectively. All the recommended agronomic practices for Indian mustard were followed to raise a healthy crop. Data mean recorded on five randomly selected plants. Statistical analyses for the characters *viz*., days to 50 % flowering, days to maturity, plant height (cm), number of primary

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branches per plant, number of secondary branches per plant, length of main axis (cm), number of siliquae per plant, number of siliquae on main axis, length of siliqua (cm), number of seeds per siliqua, 1000-seed weight (g), oil content (%), harvest index (%) and seed yield per plant (g). The mean values of data were used for statistical analysis of correlation and path coefficient as per suggestion by Singh and Chaudhary (1979) and Dewey and Lu (1959), respectively.

RESULT AND DISCUSSION

Correlation studies provide reliable information on nature, extent and the direction of selection. The association of seed yield with other component characters was studied by correlation studies. The genotypic and phenotypic values are presented in Table 1. The correlation estimates at genotypic level (r_g) and phenotypic level (r_p) show close correspondence for all the characters under study. It is evident from the estimates that for most character pairs, the genotypic and phenotypic association were in same direction whereas r_g values recorded higher than r_p values. It indicates the inherent association among the traits.

The estimates of all possible genotypic and phenotypic correlation coefficient showed that estimates of genotypic correlation coefficient were higher than their corresponding phenotypic correlation coefficient indicating that there was an inherent association among the various characters and less influence of environment on phenotypic expression of correlation in Indian mustard. Study of phenotypic correlation showed that seed yield per plant was positively and significantly correlated with harvest index (0.192**), number of siliquae per plant (0.175*) and number of siliquae on main axis (0.154*). However, it was positive and non-significant with days to 50% flowering (0.129), oil content % (0.080), days to maturity (0.066) and number of seed per siliqua (0.029). It revealed negative non-significant correlation with plant height (-0.097), length of siliqua (-0.081), length of main axis (-0.066), number of secondary branches per plant (-0.064) number of primary branches per plant (-0.030) and 1000-seed weight (-0.001).

At genotypic level, seed yield per plant was observed to be positively and significantly correlated number of siliquae per plant (0.250**), harvest index (0.232**) and number of siliquae on main axis (0.226**). The characters like days to 50% flowering (0.135), number of seed per siliqua (0.076), days to maturity (0.072), oil content % (0.064) and 1000-seed weight (0.015) showed positive but non-significant correlation with seed yield. It revealed negative non-significant correlation with plant height (-0.133), length of main axis (-0.132), length of siliqua (-0.118), number of primary branches per plant (-0.111) and number of secondary branches per plant (-0.093). Correlation study revealed that number of siliquae per plant harvest index and number of siliquae on main axis exerted positive and significant correlation with seed yield per plant both at genotypic and phenotypic levels. Thus, it can be inferred that selection based on any one of these characters either alone or in combination, will result in identifying high yielding strains. These characters were indicating their true relationship with yield and similar findings have been given by the other authors like, Lodhi *et al.* (2014), Rout *et al.* (2018) and Kumari *et al.* (2019). On the other hand, plant height, length of main axis, length of siliqua, number of primary branches per plant and number of secondary branches per plant, showed negative non-significant correlation with seed yield per plant both at genotypic and phenotypic level. These findings resemble with the results obtained by Islam *et al.* (2016), Bineeta Devi (2018), Rout *et al.* (2018), Bhattarai (2019) and Kumari *et al.* (2019). Positive but non-significant correlation with seed yield per plant was exhibited by days to 50% flowering, days to maturity, number of seed per siliqua, oil content and 1000-seed weight (at genotypic level).

Table 1: Estimates of correlation coefficient for genotypic (G) and phenotypic (P) levels among fourteen quantitative characters in Indian mustard

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Length of main axis (cm)	Number of siliquae per plant	Number of siliquae on main axis	Length of siliqua (cm)	Number of seeds per siliqua	1000-seed weight (g)	Oil content (%)	Harvest index (%)	Seed yield per plant (g)
Days to 50% flowering	G	**1.000**													
	P	**1.000**													
Days to maturity	G	0.318**	**1.000**												
	P	0.300**	**1.000**												
Plant height (cm)	G	0.222**	0.128	**1.000**											
	P	0.179*	0.107	**1.000**											
Number of primary branches per plant	G	-0.137	-0.133	-0.203**	**1.000**										
	P	-0.091	-0.105	-0.090	**1.000**										

Number of secondary branches per plant	G	-0.059	-0.251**	-0.118	0.539**	**1.000**									
	P	-0.043	-0.210**	-0.038	0.438**	**1.000**									
Length of main axis (cm)	G	-0.057	-0.048	0.258**	-0.213**	-0.420**	**1.000**								
	P	-0.050	-0.024	0.300**	-0.138	-0.234**	**1.000**								
Number of siliquae per plant	G	0.039	-0.230**	0.070	0.275**	0.364**	-0.115	**1.000**							
	P	0.031	-0.145	0.090	0.205**	0.311**	-0.050	**1.000**							
Number of siliquae on main axis	G	0.077	0.074	0.183*	-0.121	-0.264**	0.249**	0.271**	**1.000**						
	P	0.049	0.054	0.109	-0.088	-0.190*	0.105	0.085	**1.000**						
Length of siliqua (cm)	G	-0.197**	0.024	0.087	0.125	-0.002	0.173*	-0.045	-0.015	**1.000**					
	P	-0.162*	0.022	0.096	0.054	-0.006	0.120	0.018	0.024	**1.000**					
Number of seeds per silique	G	0.108	0.091	0.097	-0.103	-0.180*	0.194**	0.143	0.135	0.113	**1.000**				
	P	0.070	0.050	-0.009	-0.072	-0.130	0.062	0.010	0.067	0.047	**1.000**				
1000-seed weight (g)	G	-0.119	-0.091	-0.092	0.138	-0.014	0.186*	0.060	0.091	0.442**	-0.353**	**1.000**			
	P	-0.117	-0.090	-0.045	0.111	-0.020	0.162*	0.024	0.054	0.352**	-0.245**	**1.000**			
Oil content (%)	G	0.086	0.103	-0.127	0.195**	0.138	0.321**	0.189*	-0.094	0.261**	0.172*	0.142	**1.000**		
	P	0.077	0.088	-0.144	0.160*	0.114	0.174*	0.151*	-0.119	0.177*	0.120	0.120	**1.000**		
Harvest index (%)	G	0.001	-0.239**	-0.082	0.000	-0.043	0.172*	0.404**	0.044	0.386**	0.048	0.173*	0.099	**1.000**	
	P	-0.003	-0.219**	-0.067	0.009	-0.036	0.077	0.244**	0.057	0.289**	0.009	0.157*	0.091	**1.000**	
Seed yield per plant (g)	G	0.135	0.072	-0.133	-0.111	-0.093	-0.132	0.250**	0.226**	-0.118	0.076	0.015	0.064	0.232**	**1.000**
	P	0.129	0.066	-0.097	-0.030	-0.064	-0.066	0.175*	0.154*	-0.081	0.029	-0.001	0.080	0.192**	**1.000**

*, ** Significant at 5 and 1 % levels, respectively

Association of characters determined by correlation co-efficient may not provide an exact picture of the relative importance of direct and indirect influence of each of yield components on seed yield per plant. In order to find out a clear picture of the inter-relationship between seed yield per plant and other yield attributes, direct and indirect effects were worked out using path analysis. Estimation of direct and indirect effect of path co-efficient analysis for *Brassica juncea* is presented in Table 2. Positive direct effect on seed yield per plant was reflected both at genotypic and phenotypic level through days to maturity (rg = 0.0759, rp = 0.0890), number of siliquae on main axis (rg = 0.2667, rp = 0.1343), number of seeds per siliqua (rg = 0.1384, rp = 0.0023), 1000-seed weight (rg = 0.1907, rp = 0.0236), oil content % (rg = 0.2678, rp = 0.0758) and harvest index (rg = 0.3956, rp = 0.1930). On the other hand, plant height (rg = -0.0048, rp = -0.0921), number of primary branches per plant (rg = -0.1213, rp = -0.0274), length of main axis (rg = -0.4213, rp = -0.0762) and length of siliqua (rg = -0.3602, rp = -0.1358) showed direct and negative effect towards seed yield. Therefore, the characters exhibited positive direct effects on seed yield should be preferred while making selection for improvement of seed yield and more emphasis should be given to these traits with greater magnitude of positive direct effect than those with smaller magnitude. The similar results were also obtained by Shekhawat *et al*. (2014), Dawar *et al*. (2018), Rout *et al*. (2018) and Roy *et al*. (2018). The indirect effects via any other trait were found lesser than the direct effect. Positive direct effects of these traits on seed yield per plant indicated their importance in determining this complex character and therefore, should be kept in mind while practicing selection aimed at the improvement of seed yield. The indirect effects of these characters were found lesser than the magnitudes of the direct effect on seed yield per plant which indicated that these characters were affecting the seed yield per plant directly. Similar result also reported by Priyamedha *et al*. (2013), Shekhawat *et al*. (2014) and Rout *et al*. (2018).

Table 2. Path coefficient analysis showing the direct and indirect effect of different characters on seed yield at genotypic and phenotypic level in Indian mustard

Characters		Days to 50 % flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Length of main axis (cm)	Number of siliquae per plant	Number of siliquae on main axis	Length of siliqua (cm)	Number of seeds per siliqua	1000-seed weight (g)	Oil content (%)	Harvest index (%)	Correlation with seed yield per plant
Days to 50% flowering	G	**-0.0402**	-0.0128	-0.0090	0.0055	0.0024	0.0023	-0.0016	-0.0031	0.0079	-0.0044	0.0048	-0.0035	0.0000	0.135
	P	**0.0735**	0.0221	0.0131	-0.0067	-0.0032	-0.0037	0.0023	0.0036	-0.0119	0.0051	-0.0086	0.0057	-0.0002	0.129
Days to maturity	G	0.0242	**0.0759**	0.0097	-0.0101	-0.0190	-0.0363	-0.0175	0.0057	0.0018	0.0069	-0.0069	0.0079	-0.0181	0.072
	P	0.0267	**0.0890**	0.0095	-0.0093	-0.0187	-0.0021	-0.0129	0.0048	0.0019	0.0045	-0.0080	0.0078	-0.0195	0.066
Plant	G	-0.0011	-0.0006	**-0.0048**	0.0010	0.0006	-0.0012	-0.0003	-0.0009	-0.0004	-0.0005	0.0004	0.0006	0.0004	-0.133

height (cm)	P	-0.0165	-0.0099	**-0.0921**	0.0083	0.0035	-0.0277	-0.0083	-0.0101	-0.0088	0.0009	0.0042	0.0133	0.0062	-0.097
Number of primary branches per plant	G	0.0166	0.0161	0.0247	**-0.1213**	-0.0654	0.0259	-0.0334	0.0146	-0.0152	0.0126	-0.0167	-0.0237	-0.0001	-0.111
	P	0.0025	0.0029	0.0025	**-0.0274**	-0.0120	0.0038	-0.0056	0.0024	-0.0015	0.0020	-0.0030	-0.0044	-0.0002	-0.030
Number of secondary branches per plant	G	0.0056	0.0241	0.0114	-0.0519	**-0.0963**	0.0405	-0.0350	0.0254	0.0002	0.0173	0.0014	-0.0137	0.0042	-0.093
	P	0.0033	0.0158	0.0029	-0.0330	**-0.0752**	0.0176	-0.0234	0.0143	0.0005	0.0098	0.0015	-0.0086	0.0027	-0.064
Length of main axis (cm)	G	0.0242	0.0201	-0.1089	0.0899	0.1771	**-0.4213**	0.0484	-0.1051	-0.0727	-0.0817	-0.0786	-0.1351	-0.0726	-0.132
	P	0.0038	0.0018	-0.0229	0.0105	0.0178	**-0.0762**	0.0038	-0.0080	-0.0091	-0.0047	-0.0124	-0.0133	-0.0059	-0.066
Number of siliquae per plant	G	-0.0016	0.0095	-0.0029	-0.0114	-0.0150	0.0048	**-0.0414**	-0.0112	0.0019	-0.0059	-0.0025	-0.0078	-0.0167	0.250**
	P	0.0047	-0.0219	0.0136	0.0310	0.0471	-0.0076	**0.1514**	0.0128	0.0027	0.0016	0.0036	0.0229	0.0370	0.175*
Number of siliquae on main axis	G	0.0206	0.0199	0.0487	-0.0322	-0.0704	0.0665	0.0724	**0.2667**	-0.0040	0.0360	0.0244	-0.0250	0.0119	0.226**
	P	0.0066	0.0073	0.0147	-0.0119	-0.0256	0.0140	0.0114	**0.1343**	0.0033	0.0089	0.0072	-0.0161	0.0076	0.154*
Length of siliqua (cm)	G	0.0710	-0.0088	-0.0313	-0.0451	0.0009	-0.0622	0.0163	0.0054	**-0.3602**	-0.0406	-0.1593	-0.0941	-0.1389	-0.118
	P	0.0220	-0.0029	-0.0130	-0.0074	0.0008	-0.0163	-0.0024	-0.0033	**-0.1358**	-0.0064	-0.0477	-0.0241	-0.0393	-0.081
Number of seeds per silique	G	0.0150	0.0126	0.0134	-0.0143	-0.0249	0.0268	0.0198	0.0187	0.0156	**0.1384**	-0.0489	0.0238	0.0067	0.076
	P	0.0002	0.0001	0.0000	-0.0002	-0.0003	0.0001	0.0000	0.0002	0.0001	**0.0023**	-0.0006	0.0003	0.0000	0.029
1000-seed weight (g)	G	-0.0226	-0.0173	-0.0176	0.0262	-0.0027	0.0356	0.0114	0.0174	0.0843	-0.0673	**0.1907**	0.0271	0.0329	0.015
	P	-0.0028	-0.0021	-0.0011	0.0026	-0.0005	0.0038	0.0006	0.0013	0.0083	-0.0058	**0.0236**	0.0028	0.0037	-0.001
Oil content (%)	G	0.0230	0.0277	-0.0340	0.0523	0.0369	0.0859	0.0506	-0.0251	0.0700	0.0460	0.0380	**0.2678**	0.0264	0.694**
	P	0.0058	0.0067	-0.0109	0.0121	0.0087	0.0132	0.0115	-0.0091	0.0135	0.0091	0.0091	**0.0758**	0.0069	0.715**
Harvest index (%)	G	0.0003	-0.0944	-0.0323	0.0002	-0.0171	0.0682	0.1600	0.0176	0.1525	0.0190	0.0683	0.0390	**0.3956**	0.232**
	P	-0.0005	-0.0424	-0.0129	0.0017	-0.0069	0.0149	0.0471	0.0109	0.0559	0.0017	0.0304	0.0176	**0.1930**	0.192**

*, ** Significant at 5% and 1 % levels, respectively

Residual Effect = 0.20670 (Genotypic)

Residual Effect = 0.29358 (Phenotypic)

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