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CHARACTER ASSOCIATION STUDIES AMONG YIELD AND ITS COMPONENT CHARACTERS IN INDIAN MUSTARD (*BRASSICA 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 with two replications during 2011-2012 *rabi* season to study character association for 13 yield and its component characters. There was positive, significant and strong correlation of seed yield per plant with number of siliqua per plant (rg=0.799 and rp=0.782), test weight (rg=0.596 and rp=0.588) and number of seeds per siliqua (rg=0.299 and rp=0.320) while, it was negatively and significantly correlated with days to 50% flowering (rg= -0.368 and rp= -0.282) and days to maturity (rg= -0.308 and rp= -0.253). Out of these characters, days to 50% flowering was significantly and positively correlated with days to maturity (rg=0.611 and rp=0.472) and it was also correlated significantly with test weight (rg= -0.288) but in negative sense and at genotypic level only, while correlation between days to maturity and number of seeds per siliqua (rg= -0.343 and rp= -0.275) was negative and significant. According to path analysis, number of siliqua per plant (0.694), test weight (0.509) and number of seeds per siliqua (0.470) have positive and high direct effects with seed yield per plant, indicating importance of these characters and can be strategically used to improve the seed yield per plant of Indian mustard.

INTRODUCTION

Oil and fats are essential items in human diet since they provide energy; improve taste and palatability of food. Oilseed crops are next to cereals in production of agricultural commodities in India, which occupy a place of prime importance in Indian economy. 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 popularly known as rai, raya or laha in India. It is largely a self-pollinated crop (85-90 %). Mustard seeds contain about 38-42 % oil, which is golden yellow, fragrant and considered among the healthiest and most nutritional cooking medium. The oil cake is by-product after extraction of oil, which is used as manure and also as an excellent animal/poultry feed.

In India, it is mainly grown in Gujarat, Rajasthan, Uttar Pradesh, Madhya Pradesh, Punjab, Haryana and Assam. India with an area of 6.51 million hectares, 7.67 million metric tonnes production and 1179 kg/ha productivity ranks second in area and third in production in rapeseed-mustard scenario of the world in 2010-2011 (Anonymous, 2011). Looking to the average productivity, it is quite clear that still there is a considerable scope for increasing yield potential of rapeseed–mustard crop through the genetic improvement. To accomplish success in Indian mustard improvement programme, it requires studying the character association like correlation and path analysis among yield and its component traits.

Correlation measure the level of dependence traits and out of numerous correlation coefficients it is often difficult to determined the actual mutual effects among traits (Ikanovic *et al.*, 2011). The estimates of correlations alone may be often misleading due to mutual cancellation of component traits and when the indirect associations become complex, path coefficient analysis is the most effective mean to find out direct and indirect causes of association among the different variables. So, it becomes necessary to study path coefficient analysis, which takes into account the casual relationship in addition to degree of relationship (Mahajan *et al.*, 2011). In such case, path coefficient analysis is an important technique for partitioning the correlation coefficient into direct and indirect effect of independent variables on dependent variable. Ikanovic *et al.* (2011) concluded that even if correlation values are similar for certain pairs of traits, direct effects for some of them and especially indirect effects via other traits can differ for some traits. It is therefore, correlation as well as path coefficient may be important tools for the breeder to enhancing the seed yield of Indian mustard. Keeping the above facts in view, the present investigation aimed to assess the degree of association and to determine the direct and indirect influences of yield and its attributing characters.

MATERIALS AND METHODS

The present field experiment was conducted at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during *rabi* season of the year 2011-12. The experimental material for present study consisted of 60 diverse genotypes of Indian mustard, which were received from Directorate of Rapeseed-Mustard Research (DRMR), Bharatpur and S.D.A.U., Sardarkrushinagar (Gujarat). Experiment was laid out in randomized block design with two replications. Each plot consisted of a single row of 18 plants. Inter and intra row spacing was kept 40 and 15 cm, respectively. The recommended package of practices was adopted to raise a good crop. The phenological characters *viz.*, days to 50 % flowering and days to maturity were recorded on plot basis. For other traits, the observations were recorded on five randomly selected competitive plants in each genotype in each replication. For quality traits like oil and protein content, the observations were recorded on randomly selected sample of seeds from each genotype. The replication wise mean values were used for statistical analysis. Oil and protein content were estimated by using Near Infrared Reflectance Spectroscopy (NIRS) (Kumar *et al.*, 2003). The correlation coefficients at genotypic and phenotypic level were computed according to Hazel *et al.* (1943). Path coefficient analysis was done by using correlation coefficients as suggested by Dewey and Lu (1959). Genotypic correlation coefficients of 12 variables with seed yield per plant were used to estimate the path coefficients for the direct effects of various independent characters on yield.

RESULTS AND DISCUSSION

Correlation coefficients (Table 1) were estimated between seed yield and other traits under study revealed that seed yield per plant showed high association with number of siliqua per plant (r_g=0.799 and r_p=0.782) at both the genotypic and phenotypic levels. Other characters showing positive and highly significant association with seed yield, were test weight (r_g=0.596 and r_p = 0.588) and number of seeds per siliqua (r_g=0.299 and r_p = 0.320). Hence, these characters should be given due consideration while selecting for increasing yield. While, seed yield per plant was negatively and significantly correlated with days to 50% flowering (rg= -0.368 and rp= -0.282) and days to maturity (rg= -0.308 and rp= -0.253). Out of these characters, days to 50% flowering was significantly and positively correlated with days to maturity (rg=0.611 and rp=0.472) and it was also correlated significantly with test weight (rg= -0.288) but in negative sense and at genotypic level only, while correlation between days to maturity and number of seeds per siliqua (rg= -0.343 and rp= -0.275) was negative and significant. Oil and protein content showed no significant association with seed yield. Positive and significant association of seed yield per plant with number of siliquae per plant and test weight was also reported by earlier studies of Patra *et al.* (2006). Highly positive correlation between silique per plant and yield per plant was also reported by Khayat *et al.* (2012) and Hasan *et al.* (2014).

Plant height was positively and significantly correlated with length of main branches (rg= 0.578 and r_p = 0.340), number of secondary branches per plant (rg=0.477), test weight (rg=0.342) and days to 50% flowering (rg=0.296) while it was negatively and significantly correlated with number of seeds per siliqua (rg= -0.381) and siliqua length (rg= -0.333). Number of primary branches per plant was positively and significantly correlated with length of main branches (rg=0.319 and rp=0.256), number of secondary branches per plant (rg=0.319) and number of siliqua per plant (rg=0.257) while it was negatively and significantly correlated with days to 50% flowering (rg= -0.366 and rp= -252). Number of seeds per siliqua was positively and significantly associated with siliqua length (rg=0.292) and length of main branch (rg=0.270) while it's negative and significant association with number of secondary branches per plant (rg= -0367 and rp= -0.2833). Test weight was positively and significantly correlated with number of secondary branches per plant (rg=0.300 and rp=0.277) while it's negative and significant correlation with protein content (rg= -0.513 and rp= -0.389) and oil content (rg= -0.288). Positive and significant correlation was also found between oil content and protein content (rg=0.270) while negative and significant correlation were found between days to maturity and siliqua length (rg= -0.253). Positive and significant correlation of siliqua length with plant height and seeds per siliqua and negative and significant correlation of days to maturity with seeds per siliqua were also reported earlier by Hasan *et al.* (2014). Selection would be helpful in simultaneous improvement in these traits for yield improvement of Indian mustard. Rest of characters with non-significant correlation could be improved independently without affecting others.

In present study, path coefficient was computed for seed yield per plant taking remaining 12 independent characters. The residual effect (R=0.0024) indicating that most of variability of seed yield per plant could be explained by the characters under consideration. Path coefficient analysis (Table 2) revealed that number of siliqua per plant (0.694) and test weight (0.509) in that order, followed by number of seeds per siliqua (0.470), showed positive direct effect and significant association with seed yield per plant. The direct effect of plant height (0.099) was low but its association with seed yield was positive because of positive and high indirect effect through test weight (0.174). The direct effect of number of primary branches per plant (-0.004) was also low in magnitude and negative in direction while the direct effect number of secondary branches per plant (0.074) was low in magnitude and positive in direction, but their indirect effects through number of siliqua per plant (0.136) were high in magnitude and positive in direction. The direct effects of length of main branch (-0.082) were negative but its indirect effect through number of siliqua per plant (0.187) was high, similarly the direct effect of siliqua length (-0.018) was negative but its indirect effect through number of seeds per siliqua (0.137) was high. Days to 50% flowering contributed negative correlation with seed yield per plant and its direct effect (-0.092) on seed yield per plant was also negative. While days to maturity showed

Table 1: Genotypic and phenotypic correlations among different characters in Indian mustard

Character		Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches per plant	No. of secondary branches per plant	Length of main branch (cm)	Number of siliquae per plant	Siliqua length (cm)	Number of seeds per siliqua	Test weight (g)	Seed yield per plant (g)	Oil content (%)	Protein content (%)
Days to 50% flowering	r_g	1.000	0.611**	0.296*	-0.366**	-0.111	-0.233	-0.215	-0.162	-0.218	-0.288*	-0.368**	-0.071	-0.114
	r_p	1.000	0.472**	0.016	-0.252*	-0.109	-0.206	-0.149	-0.186	-0.229	-0.197	-0.282*	-0.027	-0.018
Days to maturity	r_g		1.000	-0.156	-0.065	-0.134	-0.237	-0.241	-0.253*	-0.343**	-0.095	-0.308*	-0.043	-0.177
	r_p		1.000	-0.057	-0.018	-0.112	-0.216	-0.195	-0.132	-0.275*	-0.113	-0.253*	-0.021	-0.183
Plant height (cm)	r_g			1.000	0.146	0.477**	0.578**	0.067	-0.333**	-0.381**	0.342**	0.085	0.049	-0.107
	r_p			1.000	0.040	0.219	0.340**	0.027	-0.154	-0.207	0.187	0.035	-0.008	-0.117
No. of primary branches per plant	r_g				1.000	0.319*	0.319*	0.257*	-0.112	-0.204	-0.083	0.070	0.224	0.143
	r_p				1.000	0.230	0.256*	0.243	-0.036	-0.146	-0.064	0.046	0.169	0.091
No. of secondary branches per plant	r_g					1.000	0.242	0.196	-0.168	-0.367**	0.300*	0.206	0.159	-0.087
	r_p					1.000	0.199	0.155	-0.140	-0.283*	0.277*	0.184	0.038	-0.066
Length of main branch (cm)	r_g						1.000	0.270*	-0.064	-0.025	0.158	0.238	0.074	-0.078
	r_p						1.000	0.239	-0.041	-0.017	0.150	0.209	0.046	-0.097
Number of siliquae per plant	r_g							1.000	-0.047	0.046	0.184	0.799**	-0.055	0.073
	r_p							1.000	-0.078	0.071	0.196	0.782**	-0.090	0.049
Siliqua length (cm)	r_g								1.000	0.292*	-0.015	0.029	-0.216	0.018
	r_p								1.000	0.243	-0.076	-0.005	0.014	0.056
Number of seeds per siliqua	r_g									1.000	-0.214	0.299*	0.120	0.033
	r_p									1.000	-0.137	0.320*	0.067	0.031
Test weight (g)	r_g										1.000	0.596**	-0.288*	-0.513**
	r_p										1.000	0.588**	-0.202	-0.389**
Seed yield per plant (g)	r_g											1.000	-0.137	-0.216
	r_p											1.000	-0.119	-0.67
Oil content (%)	r_g												1.000	0.270*
	r_p												1.000	0.234
Protein content (%)	r_g													1.000
	r_p													1.000

Table 2: Genotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on seed yield in Indian mustard

Character	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches per plant	No. of secondary branches per plant	Length of main branch (cm)	Number of siliquae per plant	Siliqua length (cm)	Number of seeds per siliqua	Test weight (g)	Oil content (%)	Protein content (%)	Genotypic correlation seed yield per plant
Days to 50% flowering	-0.092	0.077	0.029	0.002	-0.008	0.019	-0.149	0.003	-0.102	-0.147	0.002	-0.001	-0.368**
Days to maturity	-0.056	0.126	-0.016	0.000	-0.010	0.019	-0.167	0.005	-0.161	-0.048	0.001	-0.002	-0.308*
Plant height (cm)	-0.027	-0.020	0.099	-0.001	0.035	-0.047	0.046	0.006	-0.179	0.174	-0.001	-0.001	0.085
No. of primary branches per plant	0.034	-0.008	0.014	-0.004	0.023	-0.026	0.178	0.002	-0.096	-0.042	-0.006	0.001	0.070
No. of secondary branches per plant	0.010	-0.017	0.047	-0.001	0.074	-0.020	0.136	0.003	-0.173	0.152	-0.004	-0.001	0.206
Length of main branch (cm)	0.021	-0.030	0.057	-0.001	0.018	-0.082	0.187	0.001	-0.012	0.080	-0.002	-0.001	0.238
Number of siliquae per plant	0.020	-0.030	0.007	-0.001	0.014	-0.022	0.694	0.001	0.021	0.093	0.001	0.001	0.799**
Siliqua length (cm)	0.015	-0.032	-0.033	0.000	-0.012	0.005	-0.032	-0.018	0.137	-0.008	0.006	0.000	0.029
Number of seeds per siliqua	0.020	-0.043	-0.038	0.001	-0.027	0.002	0.032	-0.005	0.470	-0.109	-0.003	0.000	0.299**
Test weight (g)	0.027	-0.012	0.034	0.000	0.022	-0.013	0.127	0.000	-0.101	0.509	0.008	-0.005	0.596**
Oil content (%)	0.007	-0.005	0.005	-0.001	0.012	-0.006	-0.038	0.004	0.056	-0.146	-0.027	0.003	-0.137
Protein content (%)	0.011	-0.022	-0.011	-0.001	-0.006	0.006	0.051	0.000	0.015	-0.261	-0.007	0.010	-0.216

*, ** - Significant at 5 % and 1 % level respectively; Residual effect = 0.0024.

negative and significant association with seed yield per plant but its direct effect (0.126) on seed yield per plant was high and positive. The similar results were also obtained by Gangapur *et al.* (2009), Singh and Singh (2010), Hasan *et al.* (2014) and Mekonnen *et al.* (2014).

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