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THE ESTIMATION OF HERITABILITY, ASSOCIATION AND SELECTION CRITERIA FOR YIELD COMPONENTS IN MUSTARD (*BRASSICA JUNCEA*)

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The present investigations were planned to determine the best selection criteria for yield improvement in mustard (*Brassica juncea*). Ten genotypes of *Brassica juncea* were sown in a Randomized Complete Block Design with four replications at Oilseeds Research Institute, Faisalabad during the years 2006 and 2007. At phenotypic level, seed yield per plant had significant positive correlation with oil %age while highly significant positive correlation with plant height and silique length. The genetic correlation was positive and highly significant with plant height, branches per plant, silique length, weight of 1000 seed and oil %age. A positive and highly significant genetic relationship was found between plant height and branches per plant, silique length and seeds per silique, oil %age and 1000 seed weight. Path coefficient revealed that the plant height and silique length had direct positive contribution towards seed yield per plant because these traits possessed high $h^2_{B.S}$, significant positive correlation and maximum positive direct effects with yield.
Keywords: *Brassica juncea*, correlation, mustard, oilseed, yield.

INTRODUCTION

Brassica juncea is one of the most important species of Oilseeds Brassica in Pakistan. Early maturity, non-shattering type, heat and pest resistance are the special feature of this crop. On the other hand, low yield potential of the released cultivar is a continuous threat for its expansion and sustainable production. The complex inheritance of yield is a constraint in launching a breeding strategy for genetic improvement of crops. Yield is quantitative trait and is dependent on many other ancillary parameters which are mostly inherited quantitatively. The different morphological traits vary in their relationship with yield in terms of their nature as well as magnitude, though they show a continuous variation and are influenced by environment (Yadava *et al.*, 2011).

The component which has high heritability and positive correlation with yield can be used in the indirect selection for yield. Sandhu and Gupta (1996) found positive and significant correlations of seed and oil yield with plant height, primary branches and pods per plant, but days to 50% flowering and seed weight exhibited a negative correlation with yield. Khubli and Pant (1999) indicated positive correlation of seed yield with pods per plant, pod length, seeds per pod, 1000 seed weight and harvest index in Indian mustard. Larik and Rajput (2000) reported strong positive correlation of seed yield with plant height, branches per plant, pods per plant and seeds per pod in both *B. juncea* and *B. napus* species. Thus, one way to improve the yield is to select genotype on the basis of closely related yield component. Ali *et al.* (2002) and Yadava *et al.* (2011) showed that yield under drought stress can be improved through selection of genotype for number of fruits per plant while direct selection for yield under this environment will get zero genetic gain. The simple correlation analysis could not fully explain the relationship among the characters. Therefore, path coefficient analysis is suggested to exploit for more and complete determination of impact of independent variable on dependent one. It helps the breeder to explain direct and indirect effects and had extensively been used in breeding work in different crop species by various researchers (Shalini *et al.*, 2000; Yadava *et al.*, 2011). The present investigations were planned to estimate heritability, association and selection criteria for yield components in mustard (*Brassica juncea*).

MATERIALS AND METHODS

The experiment was conducted in the research area of Oilseeds Research Institute, Faisalabad during the years 2006 and 2007. The ten varieties/strain of *Brassica juncea* with different genetic background were selected for this study. These genotypes were sown in a randomized complete block design (RCBD) with four replications. Each plot consisted of 6m long 4 rows for each entry. Seeds were planted with the help of a seed drill and the distance between rows was kept 45cm. Normal agronomic and cultural practices were applied to the experiment throughout the growing season. At maturity randomly selected plants were tagged to record data for plant height (cm), branches per plant, seeds per silique, 1000 seed weight (g), oil contents (%) and yield per plant (g).

The analysis of variance was performed on each measured trait as proposed by Steel and Torrie (1980). The heritability of a population is the proportion of observable differences between individuals that is due to genetic differences. Factors including genetic, environmental and random chance can all contribute to the variation between individuals in their observable characteristics. Thus heritability estimates were determined by the formula given by Falconer (1989). Genotypic (r_g) and Phenotypic (r_p) correlation coefficients were determined as described by Kwon and Torrie (1964) whereas path coefficients analysis was made according to Dewey and Lu (1959). In path coefficient analysis relationship between variables in multi-variable system is considered. Therefore, in the present investigation, path coefficient analysis was carried out by taking seed yield/plant as dependent variable and other observed traits as independent variables.

RESULTS

The data (Table 1) showed that genotypic mean square for each trait was highly significant except oil %age for which it was only significant. Heritability in broad sense ($h^2_{B.S}$) calculated for various trait (Table 1) showed that silique length, plant height and seed yield have high values i.e. 95, 70 and 64 respectively.

The phenotypic correlations (Table 2) are listed between the seven characters, 28% of them are statistically significant at 1% level with absolute values ranging from 0.32 to 0.56. The highest correlation coefficients found were between the plant height, branches per plant and silique length and seeds per silique. Seed yield was only significantly correlated with oil %age while positive and highly significantly correlated with plant height and silique length. Silique length showed positive and significant phenotypic correlation with seeds per silique and 1000 seed weight.

The genetic correlation coefficients between the seven characters are also summarized in Table 2. The genetic correlations of yield per plant turned out to be positive and highly significant with plant height, branches per plant, silique length, 1000 seed weight and oil %age. Similarly a strong positive and highly significant genetic relationship was observed between plant height and branches per plant, plant height and oil %age, 1000 seed weight and oil %age, silique length and seed per silique. 1000 seed weight was positively and significantly correlated with plant height, silique length and seed per silique with correlation coefficient 0.57, 0.51 and 0.51, respectively.

Similarly a negative and highly significant correlation was recorded between branches per plant and silique length, silique length and oil %age.

The data presented in Table 3 revealed the direct and indirect effects of traits in seed yield. Plant height, silique length and oil %age had direct positive contribution toward seed yield per plant. The indirect effect of plant height via branches per plant (-1.482), silique length (-0.279) seeds per silique (-0.0239) and 1000 seed weight (-0.892) were negative while it was positive through oil %age (0.765). A negative direct effect (-1.585) was observed by branches per plant, seeds per silique (-0.309) and 1000 seed weight (-1.560). However, positive indirect effect of branches per plant via plant height (2.204) seeds per silique (0.001) and oil %age (0.704) made the association positive and highly significant with yield per plant. Silique length contributed negative indirect effect through plant height (-0.4354), seeds per silique (-0.2392), 1000 seed weight (-0.7968) and oil %age (-0.195). Except 1000 seed weight all the other traits via seeds per silique exerted positive indirect effects.

Table 1. Average performance of lines/varieties of (*Brassica juncea* L.)

Sr. No.	Entry Name	Plant height (cm)	Branches/ plant	Silique length (cm)	Seeds/ silique	1000 seed weight (g)	Oil (%)	Yield/ plant (g)
1.	RBJ-96024	225.63	7.95	4.17	13.75	3.213	30.93	29.31
2.	RBJ-96026	202.79	7.95	3.97	12.70	3.149	27.26	17.00
3.	RBJ-97001	236.71	9.15	4.35	14.55	3.282	29.58	25.75
4.	RBJ-99026	225.58	7.60	4.21	13.35	3.243	30.57	23.32
5.	RBJ-2K034	226.12	8.35	4.11	14.55	3.200	32.05	19.16
6.	RBJ-02019	224.51	8.65	3.97	13.60	3.251	30.34	21.50
7.	RBJ-03046	268.28	10.60	3.88	13.05	3.228	33.55	24.52
8.	RBJ-03047	230.55	10.35	4.09	13.65	3.192	31.76	27.49
9.	RBJ-03050	246.97	10.35	4.09	13.75	3.226	31.84	24.20
10.	Khanpur Raya	235.18	9.05	3.99	13.10	3.241	32.33	20.76
11.	Mean value	232.23	9.0	4.083	13.605	3.22	31.021	23.30
12.	Mean square	1155**	4.861**	3.785**	1.446**	0.005**	12.103*	57.118**
13.	LSD 5 %	15.39	1.76	0.297	0.853	0.046	3.13	3.88
14.	CV %	4.57	13.52	5.01	4.33	0.85	9.96	11.48
15.	$h^2_{B.S}$	69.86	32.92	95.00	49.06	50.00	28.60	63.59

Table 2. Genotypic and Phenotypic correlation of various seed yield components with yield in *Brassica juncea* L.

Parameters		Plant height (cm)	Branches /plant	Silique length (cm)	Seeds/ silique	1000 seed weight (g)	Oil (%)	Yield/ plant (g)
Plant height	r_g	1.00	0.94**	-0.19	0.08	0.57**	0.16**	0.44**
	r_p		0.57**	-0.15	0.02	0.35**	0.37	0.35**
Branches/plant	r_g		1.00	-0.39**	0.00	0.19	0.05	0.44**
	r_p			-0.15	0.00	0.07	0.17	0.20
Silique length	r_g			1.00	0.77**	0.51**	-0.29**	0.46**
	r_p				0.57**	0.32**	-0.21	0.37**
Seeds/slique	r_g				1.00	0.51**	0.08	0.30
	r_p					0.27*	0.15	0.23
1000 seed weight	r_g					1.00	0.53**	0.46**
	r_p						0.04	0.19
Oil %age	r_g						1.00	0.42**
	r_p							0.26*

Table 3. Path coefficient analysis of *Brassica juncea* lines/varieties.

Parameters	Plant height (cm)	Branches /plant	Silique length (cm)	Seeds/ silique	1000 seed weight (g)	Oil (%)	Yield/ plant (g)
Plant height	**2.36**	-1.48	-0.28	-0.02	-0.89	0.77	0.44**
Branches /plant	2.20	**-1.58**	-0.59	0.00	-0.29	0.70	0.44**
Silique length	-0.44	0.62	**1.52**	-0.24	-0.80	-0.20	0.47**
Seeds/ silique	0.18	0.01	1.17	**-0.31**	-0.80	0.05	0.30
1000 seed weight	1.35	-0.29	0.77	-0.19	**-1.56**	0.35	0.46**
Oil % age	2.70	-1.67	-0.44	-0.02	-0.82	**0.67**	0.41**

A negative indirect effect of branches per plant and seeds per silique on 1000 seeds weight was observed while positive indirect effect via plant height (1.347), silique length (0.773) and oil %age (0.349) on 1000 seed weight made the association positive and highly significant.

Oil %age is the only trait in this study which exerted positive in direct effect via plant height. However it contributed negative indirect effect via branches per plant, silique length, seeds per silique and 1000 seed weight.

DISCUSSION

The presence of variability is the prerequisite for any breeding program. The wide range of phenotypic variability estimated for all the traits except oil %age showed that these traits can be utilized for developing new high yielding mustard varieties. Similarly high heritability estimate of silique length and plant height made them important traits for selection. Gosh *et al.* (2001) also showed that the traits showing high heritability are under the control of additive genes and can be successfully utilized for plant selection on the basis of phenotypic performance.

Correlation studies are also of great interest to plant breeders in determining the traits that are correlated with main breeding objectives. In these studies both genotypic and phenotypic correlations were determined. The correlation studies revealed that the most important traits for use as indirect selection for yield are plant height, branches per plant, silique length, seed weight and oil %age. Almost similar results are given by Rai *et al.* (2005) while Yadava *et al.* (2011) reported that 1000 seed weight was positively correlated with silique length 1000 seed weight and total siliquae/plant also had higher phenotypic and genotypic direct effect on seed yield/plant, revealing that indirect selection for these traits would be effective in improving seed yield. Hence different correlation of traits in this and previous study revealed that material studied is of diverse in nature and information derived would help in designing different selection strategies. The correlation studies in the present experiment also showed strong positive and highly significant genetic relationship occurred between plant height and branches per plant, plant height and oil %age, 1000 seed weight and oil %age, silique length and seeds per silique. Our findings are in agreement with the earlier findings of Mahla *et al.* (2003). Moreover, in our findings most of the correlated pair of characters, genotypic and phenotypic association were in the same direction. The genotypic estimates were higher than phenotypic estimates indicating that an inherited association occurred between traits. Path coefficient analysis splits the correlation coefficient into direct and indirect effects. It reveals whether the association of the traits with yield is due to their direct effect or is a consequence of their indirect effect via other traits. In this investigations, the most effective traits towards increasing yield is found to be silique length, plant height and oil %age because they exerted positive direct effect on seed yield per plant. It is observed that branches per plant, silique length and 1000 seed weight exerted negative direct effects. Plant height and silique length exerted negative indirect effects via seeds per silique and 1000 seed weight. These results are in partial agreement with the earlier findings of Verma and Mahto (2005) but contradictory to Mahla *et al*. (2003). In their report path analysis revealed that number of branches per plant is the most pronounced character contributing directly toward yield and other yield parameters contributed indirectly through this character. Whereas our findings depicted positive indirect effect of oil %age via plant height and its negative indirect effect via branches per plant, silique length, seeds per silique and 1000 seed weight which confirmed the earlier findings of Agrawal and Nair (2003).

CONCLUSION

Silique length and plant height were the variables with maximum potential for selection for seed yield improvement because these traits possessed high $h^2_{B.S}$, significant positive correlation and maximum positive direct effects with yield.

REFERENCES

Agrawal, A.P. and S.K. Nair. 2003. Genotypic path analysis for oil and seed yield in Mustard. Indian Agri. 47:151-156.

Ali, N., F. Javidfar and A.A. Attary. 2002. Genetic variability, correlation and path analysis of yield and its components in winter rapeseed (*Brassica napus* L.) Pak. J. Bot.,34:145-150.

Dewey, D.R. and R.H. Lu. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron. J. 51:515-518.

Falconer, D.S. 1989. Introduction to quantitative genetics. 3rd edn. Long Man Scientific and Technical, UK.

Ghosh, S.K. and S.C. Gulati. 2001. Genetic variability and association of yield components in Indian mustard (*Brassica juncea L*.). Crop Res. Hisar 21:345-349.

Khulbi, S.K. and D.P. Pant. 1999 Correlation and path-coefficient analysis of yield and its components in Indian mustard. Crop Res.Hisar. 17:371-375.

Kwon, S.H. and J.H. Torrie. 1964. Heritability and inter-relationship among traits of two soybean population. Crop Sci. 4:196-198.

Larik, A.S. and L.S. Rajput. 2000. Estimation of selection indices in Brassica juncea L., and Brassica napus L. Pak. J. Bot. 32:323-330.

Mahla, H.R., S.J. Jambhulkar, D.K. Yadar and R. Sharma. 2003. Genetic variability, correction and path analysis in Indian mustard (*Brassica Juncea* (L.) Czern and Coss). Indian J. Genetics and Plant Breeding 63:171-172.

Rai, S.K., A. Verma and D.D. Pandey. 2005 Character association analysis in Indian mustard (*Brassica juncea* L.). Genetic variability. Czern and Coss). Annals of Agri. Bio. Research. 10:29-34.

Sandhu, S.K. and V. P. Gupta. 1996 Genetic divergence and correlation studies in Brassica species. Crop Improvement 23:253-256.

Shalini, S., R.A. Sheriff, R.S. Kulkarni and P. Venkantarmana. 2000. Correlation and path analysis of India mustard germplasm. Research on Crop in India 1:226-229.

Verma, A.K. and J.I. Mahto. 2005. Correlation and Causation study in Indian mustard. J. Res. Birsa Agri. University 17:91-94.

Yadava, D.K., S.C. Giri, M. Vignesh, S. Vasudev, A.K. Yadav, B. Dass, R. Singh, N. Singh, T. Mohapatra and K.V. Prabhu. 2011. Genetic variability and trait association studies in Indian mustard (*Brassica Juncea*) Indian J. Agri. Sci. 81:712-6.