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Estimates of genetic variability, correlation and path analysis in Indian mustard (*Brassica juncea* L)

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Abstract

Present investigation was undertaken to study the genetic variability, correlation and path analysis of twelve quantitative traits in 20 Indian mustard (*Brassica juncea*) genotypes. The analysis of variance showed significant difference among genotypes for all the characters studied. High estimate of heritability coupled genetic advance as percentage of mean was observed for seed yield per plant, 1000 seed weight, biological yield, siliqua per plant. High genotypic and phenotypic coefficient of variation are studied for seed yield per plant, biological yield per plant, 1000 seed weight, harvest index. Seed yield per plant showed significant positive genotypic correlation with biological yield per plant, number of primary branches and seeds per siliquae. Path coefficient at phenotypic and genotypic level reveled that have direct positive effect on seed yield per plant for that biological yield, primary branches, seeds per siliqua, days to 50 % flowering, siliqua per plant, harvest index, days to maturity.

Keywords: *Correlation, genetic variability, heritability, path analysis*

Introduction

Indian mustard [*Brassica juncea* (L.) Czern & Coss] is an important oil seed crop which is popularly known as rai, raya or laha in India. It is an important *Rabi* season oilseed crop in India and occupies a premier position due to its high oil content. It plays a major role in catering to edible oil demand of the country. The genus *Brassica*, belongs to Cruciferae or Brassicaceae family and includes six cultivated species. Among those, *B. nigra* (n=8), *B. oleraceae* (n=9), *B. rapa* (n=10) are diploids. Rest of the three, namely *B. carinata* (n=17), *B. napus* (n=19) and *B. juncea* (n=18) are amphidiploids (Nagaheru and Nagaheru, 1935). Indian mustard is a natural amphidiploid (2n=36) of *B. rapa* (2n=20) and *B. nigra* (2n=16). It originated in Asia with its major center of diversity in China (Vaughan, 1977). It was introduced in India from China and from where it spread to Afghanistan and other countries. It is largely self-pollinated crop (85-90%). However, owing to insects, especially the honeybees, the extent of cross-pollination varies from 4.0 to 16.6 % (Rambhajan *et al*., 1991). Rapeseed-mustard is a crop of temperate region, which requires relatively cool temperature. Mustard seeds contain about 38-42 % oil, which is golden yellow, fragrant and considered among the healthiest and most nutritional cooking medium. It is also utilized as a condiment, for medicinal uses and has industrial applications. Mustard meal or cake is also nutritious and contains about 12 % oil and 38 to 42 % protein (Nagraj, 1995). Indian oilseed types contain primarily 3-butenyl glucosinolate in their seeds and vegetative tissue, while *B. juncea* from China contains only 2-propenyl (allyl) glucosinolate, and only trace amounts of 3-buteny glucosinolate. Rapeseed-mustard is the third important oilseed crop in the world after soybean, and oil palm. The major rapeseed-mustard producing countries are Canada, China, Germany and France. Oilseeds occupy a place of prime importance in Indian economy which is evident from the impact created by yellow revolution. India is the third largest producer of mustard seed contributing around 11 % of world's total production. India with an area of 6.78 mha, 9.12 mt production and 1345 kg/ha productivity ranks second in area and third in production in rapeseed-mustard scenario of the world (Anonymous, 2020). Rajasthan is the largest producer of rapeseed-mustard followed by Uttar Pradesh, Haryana, Madhya Pradesh, West Bengal, Gujarat and Assam. Rajasthan state ranks first both in area and production. The area, production and productivity of rapeseed-mustard in Uttar Pradesh was 12.25 lakh ha, 17.10 lakh tonnes and 1185 kg/ha, respectively (Anonymous, 2020). In Uttar Pradesh, rapeseed-mustard is mainly cultivated in Agra, Mathura, Aligarh, Kanpur, Auraiya, Unnao and Hatras. Mathura is the largest rapeseed-mustard producing district in terms of area, production, and productivity. The crop improvement in rapeseed-mustard is complex in nature due to a complex nature of inheritance of yield and its attributes.

The availability of genetic variation is advantageous for crop improvements. Such types of variability brought about by a group of genes which have a small individual effect, can be studied through quantitative measurement. The genetic facts are inferred from observation on phenotypes. Because phenotype is determined by the interaction of genotype and environment, non-genetic factors have a significant impact on genetic variation. As a result, multiple genetic indices such as heritability, genetic progress, and others must be used to assess exploitable variability. A study like this appears to be critical for planning genetic improvements in Indian mustard.

Materials and Methods

A field experiment was undertaken with twenty genotypes of Indian mustard during at research farm of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (UP) during *Rabi* 2021-22. The plant material (20 genotypes) was sown at row-to-row distance of 45 cm and plant to plant distance of 10 cm in a randomized complete block design with three replications. The recommended agronomic packages of practices were followed. Observations were recorded on five randomly selected plants in each genotype and replication for different thirteen traits. These traits were computed on basis of mean data after computing for each character was subjected to standard method of analysis of variance following Singh and Choudhary (1985). Phenotypic and genotypic coefficient of variation, heritability (broad sense) and genetic advance as percent of mean were estimated by the formula al suggested by Burton (1952) and Johanson *et. al*. (1955). The genotypic correlation coefficients were estimated according to the formula given by Singh and Choudhary (1985). While path analysis was carried out using the genotypic correlation coefficient to know direct and indirect effects of the components on yield as suggested by Wright (1921) and illustrated by Dewey and Lu (1957).

Results and Discussion

The analysis of variance revealed significant differences among the twelve genotypes for all the twelve quantitative traits presented (Table 1). The perusals of data revealed that phenotypic variance was higher than the corresponding genotypic variance for all the traits studies. This indicated the influences of environmental factor on these traits. Data presented in Table 2 showed maximum values of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were recorded for seed yield per plant, biological yield per plant, 1000 seed weight and harvest index. These results are well sported by similar findings by Singh *et al*. (2011), Singh *et al*. (2018). Kumar *et al*. (2019) reported high values for PCV and GCV for the biological yield per plant and seed yield per plant. High heritability (broad sense) was observed for high estimate of heritability coupled genetic advance as percentage of mean was observed for seed yield per plant, 1000 seed weight, biological yield, silliqua per plant. High genotypic and phenotypic coefficient of variation are studied for seed yield per plant, biological yield per plant, 1000 seed weight, harvest index. High heritability together with high genetic advance was an indicative of additive gene effects, and high heritability associated with low genetic advance was indication of dominance and epistatic effects. These results are in conformity with those obtained

Table 1: Analysis of variance for 12 characters in Indian mustard

Source	Mean sum of square		
	Replication	Treatment	Error
Degree of freedom	2	19	38
Days to 50 % flowering	0.12	39.7**	0.62
Days to maturity	1.03	94.8**	0.48
Plant height (cm)	312	553**	37.5
Primary branches	0.24	1.65**	0.34
Secondary branches	6.49	16.0**	3.02
Siliquae per plant	785	4568**	748
Seeds per siliqua	4.68	5.64**	2.04
1000 seeds weight (g)	33.8	252**	22.6
Biological yield (g)	1.63	23.36**	1.4
Harvest index (%)	0.14	1.48**	0.06
Oil content (%)	0.38	6.23**	0.2
Seed yield per plant (g)	3.39	15.71**	0.67

** denotes significant at 1 % level of significance

Table 2. Genetic variability parameters for seed yield and its contributing characters in Indian mustard

Characters	GCV (%)	PCV (%)	H(bs) (%)	Genetic advance	Genetic Advance as % of mean
Days to 50 % flowering	7.18	7.34	95.24	7.26	14.43
Days to maturity	4.21	4.26	98.49	11.46	8.62
Plant height (cm)	5.85	6.46	82.08	24.47	10.98
Primary branches/ plant	8.26	10.96	56.17	1.02	12.68
Secondary branches/plant	9.34	12.18	58.77	3.28	14.75
Siliqua per plant	9.18	11.56	62.99	58.34	15.09
Seeds per siliqua	7.18	1181	36.97	1.37	8.99
Biological yield (g)	17.02	19.35	77.16	15.82	30.76
Harvest index (%)	11.84	12.93	83.85	5.10	22.33
Test weight (g)	15.91	16.27	89.47	1.34	29.90
Oil content (%)	3.48	3.46	90.90	2.78	6.18

Table 3a: Genotypic correlation between different yield and yield related traits of Indian mustard

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches / plant	Secondary branches / plant	Siliqua / plant	Seeds / siliqua	Biological yield (g/ plant)	Harvest index (%)	Test weight (g)	Oil content (%)
Days to maturity	0.68**	1.00									
Plant height (cm)	0.25	0.10	1.00								
Primary branches/ plant	0.11	-0.05	0.29*	1.00							
Secondary branches/plant	-0.32*	0.04	-0.28*	-0.24	1.00						
Siliqua/plant	0.15	0.10	0.08	0.74**	-0.34**	1.00					
Seeds/siliqua	-0.06	0.08	0.23	0.07	0.45**	0.40**	1.00				
Biological yield (g/plant)	0.32*	0.28*	-0.49**	0.18	-0.37**	0.24	-0.24	1.00			
Harvest index (%)	-0.15	-0.06	-0.51**	0.13	0.32*	0.14	0.16	0.09	1.00		
Test weight (g)	0.01	-0.09	0.11	0.13	0.47**	-0.19	-0.16	-0.17	0.27*	1.00	
Oil content (%)	-0.08	0.23	0.10	0.18	0.01	0.29*	0.09	-0.15	-0.02	-241	1.00
Seed yield (g/plant)	0.23	0.00	-0.41**	0.26*	-0.06	0.19	0.26*	0.49**	0.10	-0.12	-0.43**

* and ** denotes significant at 5 % and 1 % level of significance, respectively

Table 3b: Phenotypic correlation between different yield and yield related traits of Indian mustard

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches / plant	Secondary branches / plant	Siliqua / plant	Seeds / siliqua	Biological yield (g/ plant)	Harvest index (%)	Test weight (g)	Oil content (%)
Days to maturity	0.66**	1.00									
Plant height (cm)	0.25	0.10	1.00								
Primary branches/ plant	0.08	-0.05	0.24*	1.00							
Secondary branches/ plant	-0.28	0.04	-0.20*	-0.18	1.00						
Siliqua/plant	0.12	0.08	0.10	0.62**	-0.24**	1.00					
Seeds/siliqua	-0.01	0.07	0.21	0.02	0.31**	0.29**	1.00				
Biological yield (g/plant)	0.26*	0.26*	-0.43**	0.15	-0.29*	0.23	-157	1.00			
Harvest index (%)	-0.14	-0.05	-0.48**	0.09	0.28*	0.11	0.14	0.05	1.00		
Test weight (g)	0.00	-0.08	0.12	0.12	0.42**	-0.17	-0.12	-0.16	0.26*	1.00	
Oil content (%)	-0.07	0.22	0.08	0.16	0.01	0.26*	0.04	-0.14	-0.02	-0.23	1.00
Seed yield (g/plant)	0.21	0.00	-0.38**	0.24*	-0.06	0.19	0.23*	0.49**	0.09	-0.12	-0.42**

* and ** denotes significant at 5 % and 1 % level of significance, respectively

Table 4a: Direct (diagonal) and indirect effects of yield components on seed yield per plant at phenotypic level in mustard genotypes

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches / plant	Secondary branches / plant	Siliqua / plant	Seeds / siliqua	Biological yield (g/ plant)	Harvest index (%)	Test weight (g)	Oil content (%)	Seed yield (g/ plant)
Days to maturity	0.36	0.24	0.09	0.03	-0.10	0.05	-0.01	0.11	-0.05	0.00	-0.03	0.21
Days to maturity	-0.05	-0.07	-0.01	0.00	0.00	-0.01	0.00	-0.02	0.00	0.01	-0.02	0.00
Plant height (cm)	-0.22	-0.09	-0.90	-0.22	0.18	-0.09	-0.18	0.39	0.43	-0.11	-0.08	-0.38**
Primary branches/ plant	0.05	-0.03	0.14	0.58	-0.10	0.36	0.01	0.09	0.05	0.07	0.09	0.24*
Secondary branches/ plant	0.04	-0.01	0.03	0.03	-0.16	0.04	-0.05	0.05	-0.04	-0.07	0.00	-0.06
Siliqua/plant	-0.02	-0.02	-0.02	-0.11	0.04	-0.18	-0.05	-0.04	-0.02	0.03	-0.05	0.19
Seeds/siliqua	-0.02	0.04	0.12	0.01	0.18	0.17	0.59	-0.09	0.08	-0.07	0.02	0.23*
Biological yield (g/plant)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.49**
Harvest index (%)	0.05	0.02	0.19	-0.04	-0.11	-0.04	-0.05	-0.02	-0.38	-0.10	0.01	0.09
Test weight (g)	0.00	0.00	0.00	0.00	0.01	-0.01	0.00	-0.01	0.01	0.03	-0.01	-0.12
Oil content (%)	0.03	-0.08	-0.03	-0.06	0.00	-0.09	-0.01	0.05	0.01	0.08	-0.36	-0.42*

* and ** denotes significant at 5 % and 1 % level of significance, respectively

Table 4b: Direct (diagonal) and indirect effects of yield components on seed yield per plant at genotypic level in mustard genotypes

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches / plant	Secondary branches / plant	Siliqua / plant	Seeds / siliqua	Biological yield (g/ plant)	Harvest index (%)	Test weight (g)	Oil content (%)	Seed yield (g/ plant)
Days to maturity	0.62	0.42	0.16	0.07	-0.20	0.09	-0.04	0.20	-0.09	0.00	-0.05	0.23
Days to maturity	-0.43	-0.63	-0.06	0.03	-0.02	-0.06	-0.05	-0.17	0.04	0.06	-0.15	0.00
Plant height (cm)	0.08	0.03	0.31	0.09	-0.08	0.03	0.07	-0.15	-0.15	0.03	0.03	-0.41**
Primary branches/ plant	0.01	-0.01	0.03	0.12	-0.03	0.09	0.01	0.02	0.02	0.01	0.02	0.26*
Secondary branches/plant	-0.37	0.04	-0.32	-0.28	0.17	-0.39	0.53	-0.43	0.38	0.54	0.01	-0.06
Siliqua/plant	0.06	0.04	0.03	0.31	-0.14	0.42	0.17	0.10	0.06	-0.08	0.12	0.19
Seeds/siliqua	0.02	-0.03	-0.08	-0.02	-0.17	-0.15	-0.37	0.09	-0.06	0.06	-0.03	0.26*
Biological yield (g/plant)	0.20	0.18	-0.32	0.12	-0.24	0.15	-0.15	0.64	0.06	-0.11	-0.10	0.49**
Harvest index (%)	-0.01	0.00	-0.02	0.01	0.02	0.01	0.01	0.00	0.05	0.01	0.00	0.10
Test weight (g)	0.00	0.07	-0.09	-0.09	-0.35	0.15	0.12	0.13	-0.20	-0.76	0.18	-0.12
Oil content (%)	0.04	-0.11	-0.05	-0.09	-0.01	-0.14	-0.04	0.07	0.01	0.11	-0.48	-0.43**

* and ** denotes significant at 5 % and 1 % level of significance, respectively

by Acharya and Pati (2008), Singh and Singh (2010), Singh *et al*. (2011) and Yadava *et al*. (2011).

In the present study, the genotypic correlation coefficients were higher in magnitude than their respective phenotypic correlation coefficients for most of the traits indicating the depression of phenotypic expression by the environmental influence. Seed yield per plant was found to be positively and significantly correlated with biological yield per plant, number of primary branches and seeds per silliqua. (Table 3a and 3b). Such findings have been also observed by Prasad and Patil (2018), Lakra *et al.* (2020), Nandi *et al.,* (2021). However, seed yield was negatively and significantly correlated with plant height and oil content.

The estimates of correlation coefficient, although, indicate inter-relationship of different traits, but it does not furnish information on cause and effect. Under such situation path analysis helps the breeder to identify the index of selection. Biological yield, primary branches, seeds per siliqua, days to 50 % flowering, siliqua per plant, harvest index and days to maturity showed the highest positive direct effect on seed yield per plant (Table 4a and 4b). Therefore, considering these traits as selection criteria will be advantageous in bringing improvement in Indian mustard. These results are in conformity with the findings of Pandey and Singh (2005), Verma *et al*. (2008) and Kumar *et al*. (2019).

Conclusion

The material studied is of diverse nature and information emanated would help in designing the selection methodology which can further be used in the breeding programme for improvement of seed yield.

References

Acharya NN and Pati P. 2008. Genetic variability, correlation and path analysis in Indian mustard (*B. juncea*). *Env Ecol* **26**: 2165-2168.

Anonymous 2020. Agricultural Statistics at a Glance, Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India.

Burton GW. 1952. Quantitative inheritance in grasses. *Proc 6th Int Grassland Congress* **1**: 227-283.

Dewey DR and Lu KH. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron J* **51**: 515-518.

Johnson HW, Robinson HF and Comstock RE. 1955. Genotypic and phenotypic correlation in soybean and their implication in selection. *Agron* **47**: 477-483.

Kumar N, Sarkar S and Bhattacharyya PK. 2019. Association studies for yield components in mustard (*B. juncea* and *B. rapa)* in Gangetic alluvium zone of West Bengal. *J Pharmacogn Pphytochem* **8**:3057-3063.

Lakra A, Tantuway G, Tirkey AE and Srivastava K. 2020. Genetic variability and trait association studies in Indian mustard (*B. juncea*). *Int J Curr Microbio App Sci* **9**: 2556-2563.

Nagaharu U and Nagaharu N. 1935. Genome analysis in *Brassica* with special reference to the experimental formation of *B. napus* and peculiar mode of fertilization. *Jap J Bot* **7**: 389-452.

Nagraj G. 1995. Quality and utility of oilseeds. Directorate of Oilseeds Research, Hyderabad. *Technical Bulletin*, pp.10.

Nandi S, Rout S, Sur B, Chakraborty M, Hijam L, Roy SK and Gupta A. 2021. Assessment of genetic parameters, trait association and diversity analysis in Indian mustard (*B. juncea*). *Biol Forum* **13**: 95-109.

Pandey S and Singh Basudeo. 2005. Inter character association and path analysis in Indian mustard (*B. juncea*). *Adv Plant Sci* **18**: 511-514.

Prasad Ganesh. and Patil BR. 2018. Genetic variability and heritability studies for yield and attributes in Indian mustard. *J Pharmacogn Pphytochem* **7**: 519-522.

Rambhajan, Chauhan YS and Kumar K. 1991. Natural cross pollination in Indian mustard. *Cruciferae Newsl* **14/ 15**: 24-25.

Singh RK and Choudhary BD. 1985. Variance and covariance analysis. Biometrical Method in Quantitative Genetic Analysis. *Kalyani Publisher*, Ludhiana pp. 39-68.

Singh VK, Sen R, Kumar N, Saini RK and Singh SP. 2018. Genetic variability parameters studies in mustard (*B. juncea*). *J Pharmacogn Pphytochem* **8**: 2142-2144.

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

Singh SK and Singh AK. 2010. Inter-relationship and path analysis for seed yield in Indian mustard. *Indian J Ecol* **37**: 8-12.

Vaughan JG. 1977. A multidisciplinary study of the taxonomy and origin of *Brassica* crops. *Biol Sci* **27**: 35-40.

Verma R, Sharma R and Sharma SK. 2008. Association studies among yield and its component characters in Indian mustard (*B. juncea*). *Ind J Genet Plant Breed* **68**: 87-89.

Yadava DK, Giri SC, Vignesh M, Vasudev, Sujata, Yadav KA, Dass B, Singh R, Singh N, Mohapatra T and Prabhu KV. 2011. Genetic variability and trait association studies in Indian mustard (*B. juncea*). *Ind J Agril Sci* **81**: 712-716.