Journal of Experimental Agriculture International

Volume 46, Issue 5, Page 406-412, 2024; Article no.JEAI.114992
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Path and Genetic Divergence Analysis of Mustard [*Brassica juncea* (L.) Czern & Coss.] Genotypes

Rishabh Gupta [a++], Ajeet Kumar Gupta [a++], Niharika Yaduvanshi [b++], Aman Srivastava [a++], Jay Singh [c++*], S.C. Vimal [a#] and Piyusha Singh [a†]

[a] Department of Genetics and Plant Breeding, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya, Uttar Pradesh -(224229), India.
[b] Department of Genetics and Plant Breeding, Chandra Shekhar Azad University of Agriculture and Technology Kanpur, Uttar Pradesh -(208002), India.
[c] Department of Seed Science and Technology, Chandra Shekhar Azad University of Agriculture and Technology Kanpur, Uttar Pradesh -(208002), India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2024/v46i52391

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/114992

Original Research Article

Received: 16/01/2024
Accepted: 20/03/2024
Published: 28/03/2024

ABSTRACT

The present investigation consisting of seeds of 72 genotypes with 3 check varieties (Varuna, Kranti, NDR-8501) were used for experimentation under Augmented Block Design in Indian mustard germplasm/genotypes was carried out during 2019-20 on the Student Instructional Farm

---

[++] *Research Scholar;*
[#] *Professor;*
[†] *Assistant Professor;*
**Corresponding author: E-mail: singhjay57346@gmail.com;*

Acharya Narendra Deva University of Agriculture & Technology Kumarganj Ayodhya (U.P.) India. The characters studies were Days to 50 % flowering**,** Days to maturity, Plant height (cm), Number of primary branches/plants, Number of secondary branches/plants**,** Length of main raceme (cm)**,** Number of silique in main raceme, Number of seeds/siliquae**,** 1000-seed weight (g) and Seed yield/plant (g). The highest positive direct effect on seed yield per plant exhibited by 1000 seed weight (0.2512) followed by length of main raceme (0.2189), the highest positive indirect effect on seed yield per plant was exhibited length on main raceme (0.0477) *via* seed pre-silique fallowed by the number of siliquae on main raceme (0.0332) *via* secondary branches per plant. The maximum intra-cluster distance was estimated in case of Cluster VI (2.652) followed by cluster I (2.520), Cluster IV (2.352), cluster III (2.329), cluster VIII (2.148). The highest inter-cluster distance was observed between cluster IV and VI (4.417) followed by cluster III and VI (4.270), VI and VIII (4.251), cluster I and VII (4.156). The maximum cluster mean was found in cluster I (9.21) for seed yield per plant followed by cluster III (8.67) and cluster VII (8.50).

Keywords: Augmented; cluster; direct effect; germplasm.

1. INTRODUCTION

Botanically, the genus *Brassica* has six species (*B. nigra, B. oleracea B. campestris, B. carinata, B. juncea and B. napus)* among them first three species are elementary and diploid with 2n=16, 18 and 20 and other three species are tetraploid having 2n=34, 36 and 38. All these crops are grown under wide range of agro-climatic conditions. Indian mustard or brown mustard (rai) was originally introduced from China into North-Eastern India, from where it had spread to Afghanistan *via* Punjab, Eastern Afghanistan, together with adjoining North- Western India. Indian mustard is a fairly high remunerative crop and a major source of high-quality edible oil. The oil of rapeseed-mustard serves as a very good cooking medium and dietary fat of majority of population in Northern, North-Western, Central, Eastern and North-Eastern states. It is also most common medium of pickling and food preserving. Mustard is used as sources of oil, vegetable condiments and fodder [1,2]. The oil content in mustard varies from 38% to 46% and average oil recovery is around 38% to 39%. The seeds are highly nutritive containing 38-57% erucic acid, 5-13% linolic acid and 27% oleic acid. After oil extraction, the remaining part of the seed is used to produce rapeseed/mustard meal an important component of cattle and poultry feed. The leaves of young plants are used as green vegetables.

Brassica is high in dry matter digestibility *i.e.,* 85-95% in contrasts with good alfa-alfa, at 70%. Its leaves contain 18-25% crude protein, while the root contain about 10% crude protein due to their rich nutritional contains, these leaves and root crops have been commonly grown as nutritional fodder crops for sheep and cattle. The knowledge about the factors responsible for high yield is a difficult problem as yield is a complex character and an interactive effect multiplication of different traits. Therefore, for attainment of high yield level, the breeder is required to simplify this complex situation. Thus, the study of correlation between yield and its components is of prime importance in formulating the selection criteria. Selection is generally based on the phenotypic values of a character which partly determined by genotypes which is heritable, and partly by environment which is non-heritable.

2. MATERIALS AND METHODS

The present investigation was carried out during 2019-20 on the Student Instructional Farm Acharya Narendra Deva University of Agriculture & Technology Kumarganj Ayodhya (U.P.) India. Narendra Nagar is situated between $26^{0}47'$ N latitude, $82^{0}12'$ E longitude, and at an altitude of 113 m above the mean sea level. The climate of district Ayodhya is semi-arid with hot summer and cold winter. Nearly 80 percent of total rainfall is received during the monsoon (only up to September) with a few showers in the winter. The character studies were Days to 50 % flowering**,** Days to maturity, Plant height (cm), Number of primary branches/plants, Number of secondary branches/plants**,** Length of main raceme (cm)**,** No. of silique in main raceme Number of seeds/siliquae**,** 1000-seed weight (g), and Seed yield/plant (g). Data recorded on the above characters were subjected to estimate the Genetic divergence analysis.

1. Analysis was carried out according to Dewey and Lu [**3**].
2. Non-hierarchical Euclidean cluster analysis [4,5].

2.1 Experimental Details

The experiment was conducted to evaluate 72 germplasm under partially reclaimed soil conditions in an Augmented Block Design. The experimental field was divided into six blocks and in each block, there were 12 entries along with three checks. Each plot consists of a 4-meter-long bed with plant-to-plant spacing of 15 cm and 45 cm between the two rows. Recommended cultural practices were followed to raise a good crop.

3. RESULTS AND DISCUSSION

3.1 Path Coefficient Analysis

The path coefficient was carried out for among 10 characters to estimate the direct and indirect effects on seed yield per plant. The direct and indirect effects of different characters on seed yield per plant are depicted in Table 1.

The highest positive direct effect on seed yield per plant exhibited by 1000 seed weight (0.2512) followed by length of main raceme (0.2189) and negative direct effect on primary branches pre plant (-0.3462) followed by no. of siliqua on main raceme (-0.1650) and days to maturity (-0.1026). the direct effect of rest of the characters were found very low. The highest positive indirect effect on seed yield pre plant was exhibited length on main raceme (0.0477) *via* seed pre siliqua fallowed by number of siliquae on main raceme (0.0332) via secondary branches per plant. The highest negative indirect effect on seed yield pre plant was exerted by primary branches pre plant (-0.1333) *via* secondary branches pre plant fallowed by number of siliquae on main raceme (-0.972) *via* length on main raceme. The remaining estimates of the indirect effect on the present study were too low be considered. The residual effect observed was 0.0790 which indicates that's some of the characters which might contribute to yield have not been considered in the study.

The path coefficient analysis found highly significant direct effect in character length of main raceme, 1000-seeds weight, seed per siliqua. The indirect effect found highly significant seed yield per plant with 1000-seed weight length of main raceme with number of siliquae. The result obtained under present investigation accordance with earlier report that Shweta Om Prakash [6], Ompal et al. [7], Gupta et al. [8], Kumar et al. [9], Singh, J. [10].

3.2 Genetic Divergence Analysis

The non-hierarchical Euclidean cluster analysis was labouring to study the genetic divergence exiting among 72 mustard genotype collection on the basis of 10 quantitative characters. The pseudo-F-test revealed that 8 cluster arrangements were most appropriate for grouping the 72 genotypes. Therefore the 72 genotypes were accepted to be grouped in to 8 clusters in given in Table 2.

Cluster V emerged with highest number of entries as it was constituted by 16 entries followed by Cluster II and III having 12 genotypes, cluster VI having 10 genotypes cluster IV and VIII had 8 genotypes, cluster I having 6 genotype and cluster VII had 3 genotypes respectively. The estimate inter and intra cluster distance for 8 cluster are presented Table 3. The maximum intra cluster distance was estimated in case of Cluster VI (2.652) followed by cluster I (2.520), Cluster IV (2.352), cluster III (2.329), cluster VIII (2.148) and cluster II (2.136), The lowest intera cluster value was found for cluster V (2.090) and cluster VII (2.023).

The highest inter cluster distance was observed between the cluster IV and VI (4.417) Fallowed by cluster III and VI (4.270), VI and VIII (4.251), cluster I and VII (4.156) The minimum inter cluster was observed between I and VI (2.718) fallowed by cluster II and VIII (2.778) and cluster V and VIII (2.792). The cluster mean for 10 characters are subjected in Table 4. The maximum cluster mean for days to 50% flowering was recorded for cluster VIII (61.24) the lowest cluster mean was recorded in case of cluster I (56.12) while remaining showed moderate mean for days to 50% flowering. The highest cluster mean for days to maturity was observed in case of cluster IV (134.06) fallowed by cluster VII (123.67) and cluster VIII (131.06), the lowest cluster mean for days to maturity was recorded in cluster II (126.89) the cluster VI (3.43) was observed was highest cluster mean for primary branches per plant followed by cluster VII (3.20) and cluster VIII (3.10) the lowest cluster mean was recorded in cluster IV (1.98). The rest of the cluster was recorded medium cluster mean for primary branches per plant. The result obtained under present investigation accordance with earlier reports Singh et al. [7] Meena et al. [11], Singh et al. [12-13].

Table 1. Direct and indirect effect of different characters on grain yield/plant in Indian mustard

Character	Days to 50 % flowering	Days to maturity	Primary branches per plant	Secondary branches per plant	Plant height (cm)	Length of main raceme	Number of siliquae on main raceme	1000 seed weight(g)	Seed /siliqua	Seed yield per plant (g)
Days to 50 % flowering	0.0407	-0.0423	-0.0512	-0.0023	0.0050	-0.0566	-0.0064	0.0169	0.0020	-0.094
Days to maturity	0.0168	-0.1026	0.0348	0.0033	-0.0016	-0.0418	-0.0006	0.0078	0.0038	-0.080
Primary branches per plant	0.0060	0.0103	-0.3462	-0.0146	0.0177	0.0186	-0.0071	-0.0129	0.0006	-0.328**
Secondary branches per plant	0.0025	0.0091	-0.1333	-0.0378	0.0070	-0.0144	0.0332	-0.0005	-0.0005	-0.135
Plant height (cm)	0.0031	0.0024	-0.0921	-0.0040	0.0664	0.0637	-0.0427	-0.0690	0.0040	-0.068
Length of main raceme(c. m.)	-0.0105	0.0196	-0.0295	0.0025	0.0193	0.2189	-0.0972	-0.0290	0.0041	0.098
Number of siliquae on main raceme	0.0016	-0.0004	-0.0149	0.0076	0.0172	0.1289	-0.1650	-0.0318	0.0040	-0.053
1000 seed weight (g)	0.0027	-0.0032	0.0178	0.0001	-0.0182	-0.0253	0.0209	0.2512	-0.0024	0.244*
Seed/siliqua	0.0044	-0.0206	-0.0101	0.0010	0.0140	0.0477	-0.0346	-0.0313	0.0189	-0.011

*Residual = 0.0790, *, ** significant at 5% and 1% levels, respectively*

Table 2. Clustering pattern of 72 mustard genotypes on the basis of non-hierarchical Euclidean cluster analysis

Clusters	No of genotypes	Genotypes
I	6	UND-17-31, SIVT-17-113, SIVT-17-66, SIVT-16-38, SIVT-17-81, NDN-16-22
II	12	SIVT-17-121, SIVT-16-63, SIVT-17-126, SIVT-17-19, SIVT-16-73, UND-17-11, SIVT-16-33, SIVT-16-86, SIVT-16-44, SIVT-17-20,
III	12	SIVT-17-74, SIVT-17-89, SIVT-16-38, SIVT-17-103, UDN-17-24, SIVT-17-90, SIVT-15-2, SIVT-17-28, NDR-17-11, SIVT17-71, SIVT-17-65, SIVT-16-9
IV	8	SIVT-17-43, SIVT-17-33, UDN-17-13, SIVT-17-66, NDR-17-1, SIVT-17-45, SIVT-17-73, SIVT-17-20
V	16	SIVT-16-74, UDN-17-24, SIVT-17-32, SBG-17-34, SIVT-16-63, SIVT-16-35, SIVT-17-22, SIVT-16-82, NDN-17-10, SBG-17-30, SIVT-16-84, SIVT-17-104, SIVT-17-61, SIVT-17-62, UDN-17-05, SIVT-16-22
VI	10	NDN-17-03, NDN-16-22, SIVT-17-84, SIVT-17-109, SIVT-17-87, SIVT-16-37, SIVT-16-42, SIVT-16-84, SIVT-17-144, SIVT-17-72
VII	3	NDN-17-19, UDN-17-39, SIVT-17-120
VIII	8	UDN-17-20, SIVT-17-124, UDN-17-15, SIVT-17-63, SIVT-17-132, SIVT-16-86, NDN-16-14, SIVT-16-14

Table 3. Estimates of average intra and inter-cluster distances for the Eight clusters in Indian mustard

Clusters	I	II	III	IV	V	VI	VII	VIII
I	**2.520**	3.310	2.981	3.611	2.718	2.894	4.156	4.149
II		**2.136**	2.928	3.857	2.343	3.258	3.317	2.778
III			**2.329**	3.817	3.225	**4.270**	3.796	3.317
IV				**2.352**	2.927	**4.417**	3.464	3.557
V					**2.090**	2.500	3.041	2.792
VI						**2.652**	3.992	**4.251**
VII							**2.023**	3.640
VIII								**2.148**

Bold figures indicate the intra-cluster distances

Table 4. Estimate of average intra and intre-cluster distances for the Eight clusters in Indian mustard

Character	Days to 50 % flowering	Days to maturity	Primary branch per plant	Secondary branch per plant	Plant height (cm)	Length of main raceme (cm)	Number of siliquae on main raceme	1000 seed weight(g)	Seed/siliqua	Seed yield per plant (g)
I	56.12	127.83	2.23	5.93	153.53	57.00	43.72	4.55	11.44	9.21
II	56.53	126.89	2.95	8.19	153.61	45.44	34.18	4.40	11.57	7.85
III	56.30	128.19	2.31	6.65	140.59	48.26	34.75	5.31	10.92	8.67
IV	59.85	134.06	1.98	4.89	147.64	46.30	41.33	4.46	13.64	8.20
V	58.15	129.40	3.08	5.88	164.30	49.95	40.21	4.71	12.51	8.05
VI	57.14	126.90	3.43	7.92	158.49	60.63	46.95	4.52	12.86	7.84
VII	57.33	132.67	3.20	8.80	152.90	49.73	32.90	4.77	16.07	8.50
VIII	61.24	131.06	3.10	8.69	154.45	44.41	34.45	4.80	9.91	8.21

The maximum cluster mean was recorded in cluster VII (8.80) followed by cluster VIII (8.69) and Cluster II (8.19) for secondary branches per plant. The lowest cluster mean was found in cluster IV (4.89) the rest of the cluster showed medium cluster for secondary branches per plant. The highest cluster mean for plant hight was observed in case of cluster V (164.30) fallowed by cluster IV (158.49) and cluster VIII (154.45). The lowest cluster mean was recorded in cluster III (140.59). The rest of the cluster showed medium cluster mean for plant hight. The cluster IV (60.63) was recorded highest cluster mean for length of main raceme fallowed by cluster I (57) and cluster V (49.95). The lowest cluster mean was observed in cluster VIII (44.41). The rest of the cluster found medium cluster mean for length of main raceme. The maximum cluster mean was observed in cluster VI (46.95) for number of siliquae on main raceme fallowed by cluster IV (41.33) and cluster V (40.21). The minimum cluster mean was recorded in cluster VII (32.90). The rest of the cluster showed medium cluster mean for number of siliquae on main raceme. The cluster III (5.31) showed highest cluster mean for 1000 -seed weight fallowed by cluster VIII (4.80) and cluster VII (4.77). The lowest cluster mean was observed in cluster II (4.40) fallowed by cluster IV (4.46). rest of the cluster observed medium cluster mean for 1000- seed weight. The highest cluster mean was recorded in cluster VII (16.07) for seed per siliqua fallowed by IV(13.64) and cluster VI (12.86). The lowest cluster mean was found in cluster VIII (9.91) for seed per siliqua. Rest of the cluster observed medium cluster mean for seed per siliqua. The maximum cluster mean was found in cluster I (9.21) for seed yield per plant fallowed by cluster III (8.67) and cluster VII(8.50). The minimum cluster mean was recorded in cluster VI (7.84) fallowed by cluster II (7.85). Rest of the clusters recorded medium cluster mean for seed yield per plant.

3. CONCLUSION

The highest positive direct effect on seed yield/plant exhibited by 1000 seed weight (0.2512) followed by length of main raceme (0.2189), the highest positive indirect effect on seed yield pre plant was exhibited length on main raceme (0.0477) *via* seed pre-silique fallowed by the number of siliquae on main raceme (0.0332) *via* secondary branches per plant. The maximum intra-cluster distance was estimated in case of Cluster VI (2.652) followed by cluster I (2.520), Cluster IV (2.352), cluster III (2.329), cluster VIII (2.148). The highest inter-cluster distance was observed between cluster IV and VI (4.417) fallowed by cluster III and VI (4.270), VI and VIII (4.251), cluster I and VII (4.156). The maximum cluster mean was found in cluster I (9.21) for seed yield per plant followed by cluster III (8.67) and cluster VII (8.50). Indian mustard was improved by utilizing the most positive indirect effect and high cluster analysis. recommended developing a selection technique to choose a high-yielding variety of Indian mustard to enhance it.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Shrivastava A, Tripathi MK, Solanki RS, Tiwari S, Tripathi N, Singh J, Yadav RK. Genetic correlation and path coefficient analysis of yield attributing parameters in Indian mustard. Current Journal of Applied Science and Technology. 2023;42(7):42-58.
2. Chaudhary B, Lavanya GR, Yadav AP, Prajapati DK. Estimates of Genetic Variability, Correlation and Path Analysis in Indian Mustard [*Brassica juncea* (L.) Czern & Coss]. International Journal of Plant & Soil Science. 2023 Jul 27;35(18):1081-9.
3. Dewey DR. and Lu KH., A correlation and path-coefficient analysis of components of crested wheat grass seed production. Agron. Journal. Ed. Indian Council of Agric. Res., New Delhi. 1959;51:515-518.
4. Beale EMC. Euclidean cluster analysis, a paper contributed to 34th session of the International Statistics Institute; 1969.
5. Spark DN., Euclidean cluster analysis. Algorithm. As. 58. Appl. Stats. 1973;22: 126-130.
6. Shweta OP. Correlation and path co-efficient analysis of yield and yield components of Indian mustard [*Brassica juncea* (L.) Czern and Coss]. International Journal of Plant Sciences. 2014;9(2):428-430.
7. Ompal, Kerkhi SA, Chand P, Singh SK, Yadav SK. Study of correlation and path coefficient analysis in Indian mustard [*B. juncea* (L.) Czern & Coss]. Journal Pharmacognosy and Phytochemistry. 2018;7(6):890-894.

8. Gupta Mc, Roy HS. and Bhaduria SS., Genetic variability analysis in F2/F3 population derived Through inter-specific hybridization in oilseed Brassica Electronic Journal Plant Breeding. 2019;10(3):1275 - 1282.
9. Kumar R, Kaur S, Bala K, Kaur S, Sharma L., Assessment of genetic variability, correlation and path analysis for yield traits in f1 hybrids of Indian mustard. Agriways. 2019;7(2):1-7.
10. Singh S, Dwivedi AK, Ashutosh, Kumar O. and Kumar K., Genetic divergence analysis in Indian mustard (*Brassica juncea* L.*)* Int. J. Curr. Microbiol. App. Sci. 2018;7(6):2496-2503.
11. Meena HO, Meena PKP, Singh K, Meena HP, Meena D. Genetic divergence analysis in Indian mustard (*Brassica juncea* L.) Int. J. Curr. Microbiol. App. Sci. 2020;9(10):2185-21 92.
12. Singh S, Singh V, Singh KP, Tripathi RM, and Singh G., Genetic divergence analysis in wheat germplasms (*Triticum aestivum* L.). The Pharma Innovation Journal. 2021; 10(7):770-773.
13. Singh J., Correlation and Path Studies for Seed Yield and Its Attributing Traits in Indian Mustard [*Brassica juncea* (L.) Czern & Coss.] Int. J. Curr. Microbiol. App. Sci. 2020;9(9):620-626.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/114992