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Genetic diversity analysis in rapeseed (*Brassica juncea* L.)

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Abstract
The Present investigation were conducted during 2010- 2011 at the Research Farm of Janta Vedic College, Baraut, Baghpat (U.P.). The thirty nine genotypes of Indian mustard (*Brassica juncea* L. Czern and Coss) were shown in a Randomized block Design (RBD) with three replication at the Research Farm. Five Competitive plants from each plot were randomly selected from all three rows for recording data. Observations of all the characters were recorded on single plant basis except for days to flowering and days to maturity. Average of these selected five plants in respect of different plant characters were used for statistical analysis. The data were recorded for the following characters namely, Days to 50% flowering, Days to 80% maturity, Plant height (cm), Number of primary branches per plant, Number of secondary branches per plant, Length of siliqua (cm), Number of seeds per siliqua, 1000-seeds weight (gm), Biological yield per plant(gm), Harvest index (%), Oil content and Seed yield per plant (gm). All the 39 genotypes were classified in to five clusters. Clusters II had maximum number of genotypes (14) and second larger group of genotypes was in cluster III and V with (9) genotypes each. The cluster I had genotype (6) and minimum genotypes (1) in cluster IV.

Keywords: Indian mustard, plant character, genotypes, clusters

Introduction
Rapeseed-mustard (*Brassica juncea* L.) is the second important oilseed crop of the country after soybean and plays a very significant role in the oil economy by contributing about 30 percent to the total oilseed production. The genus *Brassica* mainly includes *Brassica juncea*, *Brassica carinata* and *Brassica napus* as tetraploid species and *Brassica rapa*, *Brassica nigra* and *Brassica oleracia* as diploid species. *Brassica juncea* is a major winter oil seed crop of India occupying 6.39m ha with total production of 7.41m tones and average productivity of 1104kg/ha (Anonymous, 2010) [2]. India occupies third position among the mustard growing countries in the world in terms of production contributing 14.7% of total world production of rapeseed-mustard is very low compared to world average of 1400 kg/ha. *Brassica juncea* is a predominantly self-fertilized crop with 5-15% cross fertilization (Asthana and Singh, 1973) [3]. Cultivar improvement in *Brassica juncea* has been mostly done through different breeding methodologies to achieve maximum yield potential in this crop. The crops are cultivated in an area of 70 lakh ha with a production of 81 lakh tonnes and with an average yield of 1149 kg/ha (Anon., 2006) [1].

Indian mustard is the second most important source of edible oil after soybean. The oil content of the seeds ranges from 35 to 48 per cent. The oil obtained is the main cooking medium in northern India and cannot be easily replaced by the any other edible oil. The seeds and oil are used as a condiment in the preparation of pickles and for flavouring curries, lubricants, hair oil and medicines. The oil cake is mostly used as a cattle feed. The leaves of young plants are used as green vegetable. The use of mustard oil for industrial purpose is rather limited on account of its high cost.

Though this crop is grown all over the country in one or the other from, however, Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat, Punjab, Haryana, Bihar, Orissa, Himachal Pradesh and West Bengal are the major rapeseed growing states. In terms of area, Rajasthan is the leading state and occupies nearly 50% of the total are and contributes in the same proportion towards the production to the national pool (Anonymous, 2010) [2]. A large number of high yielding area specific varieties have been developed in Indian mustard but unfortunately, in spite of having the varieties with the yield potential of 2.0-2.5t/ha, our national average is very low as compared to the rapeseed growing countries of the west. Moreover, yield level is also not sustainable and fluctuates year after year leading to fluctuation in area and production. The fluctuation is because of many factors like growing of this crop on marginal lands either rain

fed or with limited irrigation facilities, non-availability of resistance/tolerance varieties for biotic and abiotic stresses for difference sowing condition, hence, the yield levels fluctuate year after year.

The major biotic stresses as have been reported in the AICRP Rapeseed Mustard Annual reports are white rust and aphids. The crop is more vulnerable to these biotic stresses when the weather is favourable for pathogens /pests and the chances of their incidence increase further when the temperature at the time of sowing are two major recurrent constrains along with frost which affected this crop intermittently.

Genetic divergence helps the breeder, for identifying diverse genotypes for hybridization to exploit heterosis and to get desirable sergeants and considered to be the important tools in quantifying the genetic divergence in different crops.

Materials and Methods

The present investigation entitled "Studies on Genetic Divergence in Indian mustard (*Brassica juncea* L. Czern and Coss)" were conducted during 2010-2011 at the Research Farm of Janta Vedic College, Baraut, Baghpat (U.P.). The details of the materials and methods are given below:

Experimental Materials

The material for this study consisted of 39 genotypes were obtained from the NBPGR, New Delhi.

Table 1: Total number of genotypes

S. No.	Genotypes	S. No.	Genotypes	S. No.	Genotypes
1	IC9841	14	IC363942	27	IC399857
2	IC10965	15	IC366460	28	IC399853
3	IC10967	16	IC375924	29	IC399854
4	IC10977	17	IC375925	30	IC399877
5	IC11765	18	IC399788	31	IC399878
6	IC320641	19	IC399795	32	IC417020
7	IC320648	20	IC399797	33	IC426336
8	IC329705	21	IC399808	34	IC426357
9	IC335854	22	IC399841	35	IC446900
10	IC347949	23	IC399816	36	IC491257
11	IC360723	24	IC399826	37	IC491283
12	IC360749	25	IC399839	38	IC491313
13	IC360770	26	IC399840	39	IC491330

Experimental details

The thirty-nine genotypes of Indian mustard (*Brassica juncea* L. Czern and Coss) were grown during *rabi* season on 2 Nov. 2010 at Research Farm of Janta Vedic College Baraut, Baghpat (U.P.). Experimental farm is situated at the western boundary of Uttar Pradesh 20°, 6N and 77°,15E, 226.80 meters above the mean sea level.

The soil of experimental plot was heavy loam and represent western plains between Ganga and Yamuna rivers, Climate of the area is semi–arid and subtropical during *rabi* season in 2010-2011.

The thirty-nine genotypes of Indian mustard (*Brassica juncea* L. Czern and Coss) were shown in a Randomized Block Desing (RBD) with three replications at the Research Farm of Janta Vedic College Baraut, Baghpat (U.P.). The length of the row kept 2.5 meters and spacing between the rows 45 cm and between plants 15 cm, respectively.

Observation recorded

Five competitive plants from each plot were randomly selected from all three rows for recording data. Observations of all the characters were recorded on single plant basis except for days to flowering and days to maturity. Average of these selected five plants in respect of different plant characters were used for statistical analysis.

The Data were recorded for the following characters namely, Days to 50% flowering, Days to 80% maturity, Plant height (cm), Number of primary branches per plant, Number of secondary branches per plant, Length of siliqua (cm),Number of seeds per siliqua,1000-seed weight (g), Biological yield per plant (g), Harvest index (%),Oil content and Seed yield per plant (g).

Multivariate analysis

Observation taken on twelve characters were used for multivariate analysis to run this analysis. After testing for the differences between populations for each of the character, a simultaneous test of significant for differences in the mean values of a number of correlated variables with regard to the pooled effect eleven characters (variables) was carried out by using 'V' statistic which in turn utilizes Wilk's Criterion (Wilks, 1932) [4]. The sum of squares and sum of products of error and error + variety were used for this purpose. The estimation of (Wilk's Criterion) was done using the following relationship.

$$We = \frac{(E)}{(E+V)}$$

Where,

'E' was the determinant of error sum of squares and sum of products matrix and (E+V) was the determinant of the error + varieties sum of squares and sum of products matrix.

Multivariate analysis using D^2 statistic (Mahalanobis, 1936) [5] D^2 statistics was used for assessing the genetic divergence between populations. The generalized distance between any two populations is defined as:

$$D^2 = (\lambda_{ij})\ \lambda_i\ \lambda_j$$

Results

The analysis was done in respect of 12 characters including yield and component traits along with flowering and maturity. Their performances in respect of genetics analysis of variance, character association and cluster pattern in relation to all the 12 traits have been judged.

Genetic Divergence

For estimation of genetic divergence, Mahalanobis D^2 technique was used to complete the generalized distance (D^2) for each pair of genotypes as suggested by Rao (1952) [6].

Group Constellation

All the 39 genotypes were classified in to five clusters. The clustering pattern has been presented in Table 2. Cluster II had maximum number of genotypes (14) and second larger group of genotypes was in cluster III and V with (9) genotypes each. The cluster I had genotype (6) and minimum genotypes (1) in cluster IV.

Table 2: Number of genotypes in each cluster

Cluster	No. of Genotypes	Genotypes
I	6	IC399788, IC399795, IC399826, IC399839, IC399853, IC399854
II	14	IC10976, IC10977, IC11765, IC320614, IC329705, IC360723, IC360749, IC399797, IC399808, IC399814, IC399816, IC399857, IC491257, IC491313
III	9	IC10965, IC335854, IC347947, IC360770, IC363942, IC366460, IC417020, IC426336, IC446900
IV	1	IC9841
V	9	IC320648, IC375924, IC375925, IC399840, IC399877, IC399878, IC426357, IC491283, IC491330

Average intra and inter cluster D^2 values

Average intra and inter cluster D^2 values have been presented in Table 3. The intra cluster average D^2 value of cluster I was (2.183), which revealed the minimum genetic diversity among their constituents. The intra cluster average D^2 values of cluster III was (2.928), revealed the maximum genetic diversity among their constituents. The intra cluster average D^2 values of cluster II (2.293), cluster IV (2.301) and cluster V (2.403), revealed that the genetic diversity among their constituents was moderate.

The average inter cluster D^2 values between cluster IV and V (8.759) revealed maximum genetic diversity between these two clusters. The minimum inter cluster average D^2 values was obtained between cluster V and III (2.906) revealed minimum genetic diversity among the genotypes between these two clusters.

Table 3: Intra and inter cluster distance

Clusters	I	II	III	IV	V
I	2.183				
II	3.359	2.293			
III	3.278	3.517	2.928		
IV	8.759	6.517	8.002	2.301	
V	4.040	2.906	3.704	6.946	2.403

Cluster means for different characters

Cluster means for different characters have been presented in Table 4.

The cluster I had highest cluster mean for days to 50% flowering but the lowest cluster mean for number of primary branches per plant (8.54), number of secondary branches per plant (14.43), length of siliqua (3.55), number of seeds per siliqua (13.76), 1000-seed weight (1.88), biological yield per plant (44.92), harvest index (22.97) and seed yield per plant (10.06).

Cluster II had highest cluster mean for plant height (213.98) and oil content (40.79).

The cluster III had highest cluster mean for number of seeds per siliqua (17.25) but lowest cluster mean for days to 75% maturity (124.67) and plant height (179.50).

The cluster IV had highest cluster mean for days to 75% maturity (140.33), number of primary branches per plant (11.43), number of secondary branches per plant (39.00), biological yield per plant (209.80), harvest index (33.29) and seed yield per plant (69.87) but lowest cluster mean for oil content (37.25).

The cluster V had highest cluster mean for length of siliqua (4.79) and 1000-seed weight (4.46) but lowest cluster mean for days to 50% flowering (62.56).

Table 4: Cluster mean values for morpho-physiological traits in39 genotypes of Indian mustard

S. N.	Character	I	II	III	IV	V
1.	Day of 50%flowering	85.00	78.83	67.78	74.33	62.56
2.	Day to 75%maturity	134.61	135.17	124.67	140.33	134.37
3.	Plant height (cm)	186.67	213.98	179.50	189.80	195.03
4.	No. of primary branches/plant	8.54	10.76	9.69	11.47	9.24
5.	No. of secondary branches / plant	14.43	24.45	26.55	39.00	19.90
6.	Length of siliqua	3.55	4.08	3.60	4.57	4.79
7.	No. of seeds/siliqua	13.76	14.16	17.25	16.00	14.47
8.	1000seed weight (g)	1.88	2.96	2.03	3.27	4.46
9.	Biological yield / plant(g)	44.92	95.22	60.06	209.80	75.83
10.	Harvest index	22.97	24.50	23.86	33.29	27.96
11.	Oil content (%)	39.38	40.79	39.87	37.25	39.66
12.	Seed yield /plant	10.06	23.51	13.67	69.87	21.30

Conclusion

In this study, the maximum number of genotypes 14 was observed in cluster II and I had 6 genotypes, cluster III and V had 9 genotypes. However, cluster IV had only one genotype. Cluster III exhibited maximum intra-cluster distance which indicated that this may be used to produce superior hybrid and transgressive segregants. As expected, the minimum intra cluster distance was observed for cluster one. Cluster IV & V and its genotypes were diverse and superior in mean performance for most of the character. Therefore, these genotypes may be used as parents in hybridization program. Thus, genetic divergence analysis indicated the presence of considerable diversity among the material studies.

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