



## Genetic diversity analysis in coriander (*Coriandrum sativum*) varieties

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### ABSTRACT

Twenty four varieties of coriander (*Coriandrum sativum* L.), developed by different centres which located at diverse eco-geographical origins of the country, were undertaken in present investigations to determine divergence for seed yield and its 10 component traits. Tocher method of hierarchical cluster analysis was applied to group the varieties. Varieties were grouped into four clusters. All varieties were grouped in four clusters that showed narrow genetics base of Indian varieties. Intra-cluster distance was highest in cluster III followed by cluster II, IV and I. The maximum inter-cluster distance was between clusters III and I are 17.91 and 3.86 respectively. The varieties in cluster I were Hisar Sugandh, Hisar Anand, RCr-20, RCr-435, RCr-436, RCr-446, RCr-684, Swathi, Sadhana, Sindhu, Sudha, Rajendra Swati, GCr-1, GCr-2, CO-1, CO-2, CO-3, CO-4. The variety falling in cluster II is JD-1. The varieties falling in cluster III were NRCSS ACr-1, RCr-41 and Azad Dhan-1. The varieties falling in cluster IV were Hisar Surubhi and Pant Haritma. Among the 10 characters studied for genetic divergence, days to 50% flowering contributed the maximum accounting for 49.64% of total divergence, followed by test weight (17.03%).

**Key words:** Coriander, *Coriandrum sativum*, D<sup>2</sup> statistic, Genetic divergence

Coriander (*Coriandrum sativum* L.) is an important seed spice crop which belongs to apiaceae family having wide uses as a culinary herb, it has been grown and used for hundreds of years to add flavours (Hacskaylo 1996). Coriander leaves are used to garnish soup and meat dishes. They are rich in vitamin A, B<sub>2</sub> (riboflavin), C and fibers. The dried seeds are used in stews, cuisine, sweet breaks and cakes. This crop performs well on sodic soil in arid and semi-arid regions (Singh *et al.* 2000, 2003b). India is the largest producer, consumer and exporter of coriander. It is mainly cultivated in the states of Rajasthan and Gujarat with a sizable acreage in Madhya Pradesh, Haryana, Punjab, Uttar Pradesh, Andhra Pradesh and Bihar. The development of new varieties mainly, governed by the magnitude of genetic diversity and the extent of variability available for the desired characters. The availability of genetic variability among varieties is the most important for judicious selection and breeding to desired plant genotypes. Crosses between genetically diverse parents would manifest more heterosis than crosses of between closely related parents (Hung *et al.* 2012, Shukla and Singh 2002). The use of D<sup>2</sup> statistics of multivariate analysis gives an understanding of genetic diversity in the coriander. D<sup>2</sup> measures the degree of diversity and determines the relative proportion of each component

traits to the total divergence. Information on these aspects in coriander is limited and hence the need for identifying the genotypes having better performance for yield and quality traits and which belong to diverse parents. The present investigations were undertaken to determine the genetic diversity in 24 varieties of coriander.

### MATERIALS AND METHODS

The present study was carried out during 2010-12 at the experimental fields of National Research Centre on Seed Spices Ajmer in *rabi* season (26° 27' 0" N, 74° 38' - 1" E and 486 meter above sea level). The studies were carried out with 24 released varieties of coriander in India (Table 1). These varieties are developed by different centres situated at different agro-ecological zones, thus have different genetical background and diverse geographical region.

This experiment was laid in randomized block design with three replications. Plot were 2m long and 3m wide. Six rows spaced 0.5m apart. Plant spacing within rows were maintained 0.1m.

The observations were recorded on days to 50% flowering, plant height, number of branches per plant, diameter of umbel, umbels per plant, umbellate per umbel, seeds per umbellate, seeds per umbel, test weight and yield per plot. Genetic divergence analysed for the 2 years data through Indostat version 8.5. The genetic divergence was estimated using the D<sup>2</sup> statistics Mahalanobis (1936) and the genotypes was grouped into clusters by following the Tocher's method described by Rao (1952).

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Table 1 Details of coriander varieties

Varieties	Place & State	Topography
Hisar Sugandh	Hisar, Haryana	29°10'N75°43'E29.17°N 75.72°E <sup>[2]</sup> . It has an average elevation of 212 metres (695 feet).
Hisar Surbhi	Hisar, Haryana	29°10'N75°43'E29.17°N 75.72°E <sup>[2]</sup> . It has an average elevation of 212 metres (695 feet).
Hisar Anand	Hisar, Haryana	29°10'N75°43'E29.17°N 75.72°E <sup>[2]</sup> . It has an average elevation of 212 metres (695 feet).
RMt-41	Jobner, Rajasthan	26°58'N75°23'E26.97°N 75.38°E <sup>[1]</sup> . It has an average elevation of 400 metres (1312 feet).
RMt-435	Jobner, Rajasthan	26°58'N75°23'E26.97°N 75.38°E <sup>[1]</sup> . It has an average elevation of 400 metres (1312 feet).
RMt-436	Jobner, Rajasthan	26°58'N75°23'E26.97°N 75.38°E <sup>[1]</sup> . It has an average elevation of 400 metres (1312 feet).
RMt-684	Jobner, Rajasthan	26°58'N75°23'E26.97°N 75.38°E <sup>[1]</sup> . It has an average elevation of 400 metres (1312 feet).
RMt-20	Jobner, Rajasthan	26°58'N75°23'E26.97°N 75.38°E <sup>[1]</sup> . It has an average elevation of 400 metres (1312 feet).
RMt-446	Jobner, Rajasthan	26°58'N75°23'E26.97°N 75.38°E <sup>[1]</sup> . It has an average elevation of 400 metres (1312 feet).
Swathi	Guntur, Andhra Pradesh	16.20° N 80.27 E. It has an average elevation of
Sadhana	Guntur, Andhra Pradesh	16.20° N 80.27 E. It has an average elevation of
Sindhu	Guntur, Andhra Pradesh	16.20° N 80.27 E. It has an average elevation of
Sudha	Guntur, Andhra Pradesh	16.20° N 80.27 E. It has an average elevation of
Rajendra Swathi	Dholi, Bihar	20.90°N 86.08°E. It has an average elevation of 56 meter
Azad Dhanial-1	Kanpur, Uttar Pradesh	26.46°N 80.33 E. It has an average elevation of 126 meter
GCr-1	Jagudan, Gujarat	23°0.40N 72°0.30E. It has an average elevation of 81 meter
GCr-2	Jagudan, Gujarat	23°0.40N 72°0.30E. It has an average elevation of 81 meter
CO-1	Coimbatore, Tamil Nadu	11.16 N 76°58.21E. It has an average elevation of 411.2 meter
CO-2	Coimbatore, Tamil Nadu	11.16 N 76°58.21E. It has an average elevation of 411.2 meter
CO-3	Coimbatore, Tamil Nadu	11.16 N 76°58.21E. It has an average elevation of 411.2 meter
CO-4	Coimbatore, Tamil Nadu	11.16 N 76°58.21E. It has an average elevation of 411.2 meter
Pant Haritma	Pant Nagar, Uttarakhand	28.97° N 79.41°E. It has an average elevation of 243.8 meter
NRCSS ACr-1	Ajmer, Rajasthan	26° 27' 0" N, 74° 38' -1" E. and 486 meter above sea level
JD-1	Jabalpur, Gwalior	

## RESULTS AND DISCUSSION

The analysis of variance showed highly significant differences among the varieties for all the characters studied. The pooled divergence for all the characters within the varieties tested by the Wilk's criterion ( $X^2$  51258 df = 230\*\*) was significant. Hence, the analysis of genetic divergence among varieties used in the study was considered significant. The multivariate analysis based on  $D^2$  values among 24 varieties revealed that all the varieties can be grouped into four clusters. Among these, cluster I consisted of 18 varieties developed at Haryana, Rajasthan, Andhra Pradesh, Bihar, Gujarat and Tamil Nadu, followed by clusters II consisted 1 varieties from Madhya Pradesh, clusters III contains 3 varieties from Rajasthan and Uttar Pradesh and clusters IV is having 2 varieties from Haryana and Uttarakhand) (Table 2). The results indicated that genetic divergence is not related to main geographical cultivation

area of the particular crop and may possibly be due to diversity of their pedigree along with natural and directional selection pressure only for certain agronomic traits. Similar results were also reported by Mathur (1992), Kole & Mishra (2002) in coriander, Choudhary *et al.* (2013) in fenugreek and Meena *et al.* (2010) in fennel. Genetic drift and selection forces under diverse environments could cause greater diversity than geographical distance (Bhati 1970, Kole *et al.* 2003). The inter-cluster distances were greater than intra-cluster distances, revealing considerable amount of genetic diversity among the genotypes. Cluster I showed maximum intra-cluster distance. Intra-cluster distance is the main criterion for selection of genotypes using  $D^2$  analysis (Fig 1).

The intra-cluster  $D^2$  values ranged from 3.86 to 5.69, the maximum was in cluster IV (5.96) followed by III (4.83) and I (3.86) (Table 3). Inter cluster distance ranged

Table 2 Distribution of 24 varieties of coriander in four clusters based on  $D^2$  values

Cluster	Varieties	No. of varieties
I	Hisar Sugandh (Haryana), Hisar Anand (Haryana), RCr-20 (Rajasthan), RCr-435 (Rajasthan), RCr-436 (Rajasthan), RCr-446 (Rajasthan), RCr-684 (Rajasthan), Swathi (Andhra Pradesh), Sadhana (Andhra Pradesh), Sindhu (Andhra Pradesh), Sudha (Andhra Pradesh), Rajendra Swathi (Bihar), GCr-1 (Gujarat), GC-2(Gujarat), CO-1 (Tamil Nadu), CO-2 (Tamil Nadu), CO-3 (Tamil Nadu), CO-4 (Tamil Nadu)	18
II	JD-1 (Madhya Pradesh)	1
III	NRCSS ACr-1 (Rajasthan), RCr-41(Rajasthan) and Azad Dhanial-1 (Uttar Pradesh)	3
IV	Hisar Surubhi (Haryana) and Pant Haritma (Uttarakhand)	2

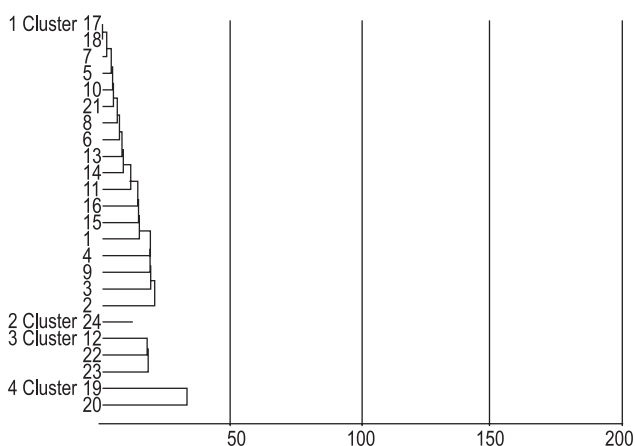


Fig 1 Dendrogram base on 10 traits of coriander by Tocher method 1,Sindhu, 2,Swathi, 3,Sadhana, 4,Sudha, 5,GC-2, 6,GCr-1, 7,RCr-684, 8,RCr-446, 9,RCr436, 10,RCr-435, 11,RCr-20, 12,RCr-41, 13,CO-1, 14,CO-2, 15,CO-3, 16,CO-4, 17,Hisar Anand, 18,Hisar Sugandh, 19,Hisar Surubhi, 20,Pant Haritma, 21,Rajendra Swathi, 22,NRCSS ACr-1, 23,Azad Dhania-1, 24,JD-1.

Table 3 Inter and intra cluster distances of four cluster in coriander

Cluster	I	II	III	IV
I	3.86	5.83	17.91	11.40
II		0.00	14.65	9.86
III			4.83	9.40
IV				5.69

Table 4 Cluster mean values for 10 characters in coriander

Cluster	Days 50% flowering	Plant height (cm)	No. of branches	Diameter of umbel (cm)	Umbel/plant (cm)	Umbellate/umbel	Seed/umbellate	Seed/umbel	Test weight (g)	Yield/plot (g)
I	61.13	32.00	5.32	3.85	37.00	4.39	6.54	32.13	10.89	35.37
II	62.00	46.13	7.07	4.33	45.00	5.33	7.67	42.00	9.41	66.67
III	86.33	59.04	10.29	4.00	73.44	4.67	8.67	42.56	7.01	105.56
IV	81.00	42.53	6.63	3.83	43.50	4.83	7.17	39.17	8.11	33.33

from 3.86 to 17.91. The maximum inter cluster distance was observed between cluster I  $\times$  III (17.91) followed by I  $\times$  IV (11.40), I  $\times$  II (5.38) suggesting wide diversity between these groups. Hence inter-mating between cultivars included in these clusters may give high heterotic response and there by better segregants. However, low inter cluster distance noticed between I  $\times$  II (0.00) clusters have low genetic diversity, intensive selection for agronomically important characters and similarity in percentage might be cause of narrow genetic diversity and uniformity between these clusters (Singh *et al.* 2003b).

The mean performance of each cluster for all traits is presented in Table 4. Based on cluster means, greater ranges of mean values among the cluster were recorded for different characters. The result is in agreement with Singh *et al.* (2005) who reported a wide range of variation in different characters of coriander. Cluster II was characterized by low

mean values for diameter of umbel (4.00 cm), umbel/plant (4.67), test weight (7.01g), number of primary branches plant (10.29 g), yield/pot (105.56 gm) and days to 50% flowering (61.13) which separated this cluster from rest of the clusters.

The contribution of individual characters to the divergence was worked out in terms of number of times it appeared first, days to 50% flowering (49.64%) contributed maximum towards genetic divergence, followed by test weight (17.03), plant height (14.13), yield/plot (5.80), umbel/plant (4.71), diameter of umbel (3.62) and number of branches (2.90). Clusters means for 10 characters revealed that genotypes included in cluster II and III showed maximum yield/plot and cluster III and IV showed maximum means for days to 50% flowering (Table 5).

Table 5 Contribution of various characters to divergence in coriander

Character	Times ranked 1 <sup>st</sup>	Contribution %
Days 50% flowering	137	49.64
Plant height (cm)	39	14.13
No. of branches	8	2.90
Diameter of umbel(cm)	10	3.62
Umbel/plant(cm)	13	4.71
umbellate/umbel	2	0.72
Seed/umbellate	0	0.00
Seed/umbel	4	1.45
Test weight (g)	47	17.03
Yield/plot(g)	16	5.80

Clustering pattern was also confirmed by canonical analysis. The random distribution of cultivars was evident from different clusters. Grouping pattern did not show any relationship between genetic divergence and geographical diversity which has always been the point of discussion (Singh 1991, Singh *et al.* 2003b). Genetic drift and selection in different environments could cause greater genetic divergence than geographical distance.

In conical analysis the 50% flowering contributed maximum divergence in vector I and vector II followed by number of branches and plant height in vector I while seed per umbel and test weight in vector II (Table 6). Out of total diversity of uncorrelated Y variant, 88.54 percent was account by first three canonical roots and these 5.96 percent was contributed by first two vectors indicating that the differentiation for the traits was nearly competed in 3 phases (Fig 2).

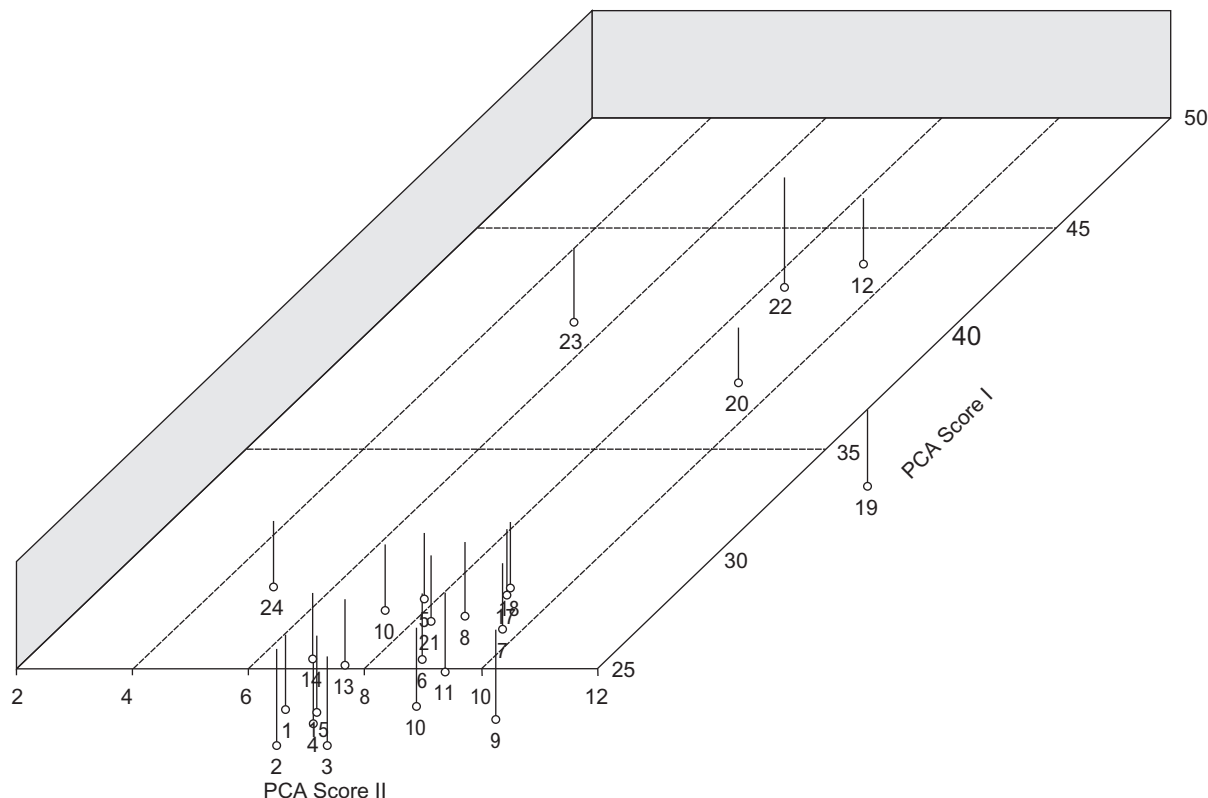


Fig 2 3D plot diagram for PC-I and PC-II in 24 varieties of coriander

Table 6 Conical vectors for different characters in coriander

Characters	Conical		
	I	II	III
Days 50% flowering	0.666	0.587	0.191
Plant height (cm)	0.307	-0.563	-0.054
No. of branches	0.377	-0.124	0.211
Diameter of umbel(cm)	-0.319	-0.030	0.384
Umbel/plant(cm)	0.101	0.008	0.226
umbellate/umbel	0.019	-0.269	-0.153
Seed/umbellate	0.140	-0.217	-0.022
Seed/umbel	-0.056	0.122	0.134
Test weight (g)	-0.313	0.043	0.676
Yield/Plot(g)	0.291	-0.429	0.464
Percent Variation expected	88.5	5.96	2.34
Cumulative Variation expected	88.5	94051	96.8

It can, therefore be concluded from the present study that hybridization among genotypes of these clusters combinations is expected to enhanced variability in coriander for the targeted traits. This will provide an opportunity to select better recombinants for various characters and thereby creating large variability for these characters in coriander.

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