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Genetic Divergence Studies in Ajwain (*Trachyspermum ammi* L.) Genotypes

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A B S T R A C T

Knowledge of genetic divergence provides us a sound scientific basis for the selection of genotypes to be used in hybridization programme for further improvement. A field experiment was conducted during *Rabi* season, 2014-15 at Main Experiment Station (Vegetable Research Farm), N. D. U. A. & T., Kumarganj, Faizabad (U.P.) India, to estimate genetic divergence among the 30 genotypes of ajwain for ten characters by using Mahalanobis D^2 analyses. The genotypes under study grouped into six clusters. Among the six clusters, cluster IV was the largest, comprising of 7 genotypes. The inter-cluster distance was larger than the intra-cluster distance suggesting wider genetic diversity among the genotypes of different groups. The maximum and minimum intra- cluster distances were found in cluster IV (83.61) and cluster VI (29.15), respectively. The inter-cluster D^2 values was maximum between the cluster III and IV (198.03) indicating wide range of genetic diversity between these two clusters. The maximum cluster mean was observed in cluster VI for seed yield/plant (36.44) along with number of branches/plant (10.45). The characters like test weight (32.41%), number of umbellets per umbel (20.46%) and days to maturity (17.01%) contributed maximum to genetic divergence and hence played a major role in improvement of ajwain.

Introduction

Trachyspermum ammi L. Syn. *Carum copticum*, commonly known as Bishop's weed or ajowan or ajwain, cultivated as herbaceous herb belonging to the family Apiaceae and vastly grows in Egypt, Iran, Pakistan, Afghanistan, and India as well as European region (Shojaaddini *et al.*, 2008). In India, it's cultivated in Madhya Pradesh, Uttar Pradesh, Gujarat, Rajasthan, Maharashtra, Bihar and West Bengal (Anonymous, 1999-2011). The total area and production of ajwain in India are about 0.024 Mha and 0.014 Mt, respectively with 0.58 tonnes per hectare productivity (Anonymous, 2016-17). Usually greyish brown seeds or fruits of ajwain are considered for medical and nutritional purposes (Chauhan *et al.*, 2012). It has been used as culinary spice worldwide and resembles thyme. Fruits were widely administered as a food flavouring agent and as a digestive stimulant (Jeet *et al.*, 2012). Genetic divergence is an essential prerequisite factor in any crop improvement programme to identify potential parents for hybridization and to achieve high yielding variety (Marker and Krupakar, 2009). The knowledge of

morphological variability, its nature and magnitude are essential for selecting genetically divergent parents to obtain the desirable recombinant in the segregating generations upon crossing. Hence, the present study was therefore undertaken to provide information on nature and magnitude of genetic diversity among promising 30 ajwain genotypes.

Materials and Methods

The experimental materials consisted of 30 diverse germplasm lines was laid in Randomized Block Design with three replications during *Rabi* season, 2014-15 at Main Experiment Station (Vegetable Research Farm), Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad, India (26.47° North latitude and 82.12° East longitudes at an altitude of 113 m above the mean sea level). The plot size was of 0.6 m x 1.80 m with row to row spacing of 45 cm and plant to plant spacing of 20 cm. All the recommended package of practices was followed to raise a healthy crop. The observations were recorded on five randomly selected plants from each genotype in each replication for the characters *viz*., plant height (cm), number of branches per plant, number of umbels per plant, number of umbellates per umbel, weight of grains per umbel (g), test weight (g) and seed yield per plant (g), while for germination (%), days to 50% flowering and days to maturity, the data were recorded as whole plot basis. Genetic divergence was estimated using D^2 statistics of Mahalanobis (1936), while method of cluster composition was done as per Tocher's method as described by Rao (1952).

Results and Discussion

The study of genetic divergence among the 30 genotypes of ajwain was carried out using Mahalanobis D^2 statistics. The analysis of variance revealed that highly significant differences among the genotypes (Table 1) for all the traits under study depicting greater diversity in the existing material. Genetic diversity among the genotypes could be due to factors like heterogeneity, genetic architecture of the populations and developmental traits as described by Murty and Arunachalam (1966).

Grouping of genotypes into various clusters

Thirty genotypes were grouped into six different non over lapping clusters as per Tocher's method as described by Rao (1952). Cluster IV had highest number of genotypes (7) followed by cluster I and III had 6 genotype each whereas, cluster II and VI had 4 genotypes each while, cluster V had 3 genotypes (Table 2). Similar finding were also recorded in coriander (Bhandari and Gupta, 1993; Srivastava *et al.,* 2000; Singh *et al.,* 2012 and Meena *et al.,* 2014).

The grouping pattern of genotypes was observed to be random, indicating that geographical diversity and genetic divergence were unrelated. Such observation has been reported by Rasul *et al.,* (2004). The absence of relationship between genetic diversity and geographical distance indicates that forces other than geographical origin such as exchange of genetic stock, genetic drift, spontaneous mutation, natural and artificial selection are responsible for genetic diversity. Therefore, selection of genotypes for hybridization should be based on genetic divergence rather than geographic divergence (Mehta *et al.,* 2004).

Average intra- and inter cluster distances

The estimates of intra- and inter cluster values represented by D^2 values (Table 3). The intra-cluster distance ranged from 29.15 (Cluster VI) to 83.61 (cluster IV).

Table.1 Analysis of variance (mean sum of squares) for 10 characters in azwain

Sl. No.	Characters	Source of variation		
		Replication	Treatments	Error
	d. f.	2	29	58
1.	Germination (%)	1.741	52.004**	4.762
2.	Days to 50% flowering	7.811	52.958**	20.339
3.	Number of branches per plant	0.000	4.274**	0.220
4.	Number of umbels per plant	0.238	7.148**	1.969
5.	Number of umbellets per umbel	0.976	26.592**	0.757
6.	Weight of grains per umbel (g)	0.002	0.071**	0.002
7.	Plant height (cm)	0.170	17.854**	5.245
8.	Days to maturity	0.652	304.851**	12.851
9.	Test weight (g)	0.022	0.600**	0.014
10.	Seed yield per plant (g)	2.534	24.615**	6.062

*, **Significant at P<0.05 and P<0.01, respectively

Table.2 Clustering pattern of 30 genotypes of ajwain (Tocher's method)

Clusters	No. of genotypes	Genotypes
I	6	NDAZ-1, NDAZ-2, NDAZ-21, NDAZ-3, NDAZ-9, NDAZ-29
II	4	NDAZ-4, NDAZ-18, NDAZ-8, NDAZ-23
III	6	NDAZ-16, NDAZ-25, NDAZ-17, NDAZ-24, NDAZ-28, NDAZ-27
IV	7	NDAZ-6, NDAZ-11, NDAZ-13, NDAZ-19, NDAZ-12, NDAZ-14, NDAZ-15
V	3	NDAZ-7, GA-1, NDAZ-10
VI	4	NDAZ-22, NDAZ-26, NDAZ- 5, NDAZ-20

Table.3 Average intra (bold) and inter-cluster D^2 values for six clusters in 30 genotypes of ajwain (Tocher's method)

Clusters	I	II	III	IV	V	VI
I	**72.10**	148.27	116.63	142.22	192.80	122.16
II		**47.26**	116.61	181.14	177.03	108.95
III			**75.50**	198.03	193.65	129.80
IV				**83.61**	154.18	117.45
V					**49.88**	83.50
VI						**29.15**

*****Bold diagonal values indicate intra cluster distance, rest of the values show the inter cluster distances.

Table.4 Mean values of clusters for 10 characters in 30 genotypes of ajwain (Tocher's method)

Characters / Clusters	Germination (%)	Days to 50 % flowering	Number of branches per plant	Number of umbels per plant	Number of umbellets per umbel	Weight of grains per umbel (g)	Plant height (cm)	Days to maturity	Test weight (g)	Seed yield per plant (g)
I	90.48	97.16	9.77	34.13	17.53	1.35	106.63	169.20	2.341	31.61
II	91.83	96.83	9.80	34.51	19.88	0.92	106.45	172.28	2.822	34.10
III	85.43	94.88	8.85	32.63	16.80	1.17	106.51	187.04	2.766	34.36
IV	90.77	98.71	8.57	33.96	19.66	1.14	107.71	170.56	1.806	33.34
V	88.97	92.55	8.51	33.64	25.48	1.20	108.22	183.86	2.336	32.07
VI	90.85	91.00	10.45	34.50	21.01	1.18	107.56	185.76	2.206	36.44

Table.5 Percent contribution of different traits towards divergence of 30 germplasm lines of ajwain

Sl. No.	Characters	Per cent contribution
1.	Germination (%)	3.91
2.	Days to 50% flowering	0.00
3.	Number of branches per plant	8.97
4.	Number of umbels per plant	0.46
5.	Number of umbellets per umbel	20.46
6.	Weight of grains per umbel (g)	12.87
7.	Plant height (cm)	0.69
8.	Days to maturity	17.01
9.	Test weight (g)	32.41
10.	Seed yield per plant (g)	3.22

Among the six clusters, the intra- cluster distance was maximum in cluster IV (83.61) followed by cluster III (75.50) and cluster I (72.10), while the minimum intra- cluster distance was observed in cluster VI (29.15) followed by cluster II (47.26). Similar kind of results in coriander was also reported by several researchers (Srivastava *et al.,* 2000; Palanikumar *et al.,* 2012; Dyulgerov and Dyulgerova, 2013 and Meena *et al.,* 2014). The intra -cluster values are lesser than the inter- cluster values which indicates the homogenous and heterogenous nature of the genotypes within and between the clusters, respectively.

The maximum inter-cluster distance was observed between cluster III and clusters IV (198.03) followed by cluster III and V (193.65), cluster I and clusters V (192.80), whereas the minimum inter-cluster distance was observed between Cluster V and VI (83.50) indicating close relationship among the genotypes belonging to these clusters. These results are in agreement with the findings of Palanikumar *et al.,* (2012) Dyulgerov and Dyulgerova (2013) and Meena *et al.,* (2014) in coriander. Hence, inter mating between the genotypes included in these clusters could be expected to give transgressive segregates in the advanced generation as suggested by Kalloo *et al.,* (1980).

Mean value of the clusters

The diversity among the genotypes was also substantiated by the considerable amount of variation among cluster means for different characters which might be the reason for large inter cluster distances. The cluster means of 30 genotypes showed that the mean values of the clusters varied in magnitude for all the 10 characters (Table 4). Cluster VI (36.44) was the highest seed yielder followed by cluster III (34.36). Regarding test weight, cluster II (2.82) showed highest performance followed by cluster III (2.76). Highest number of umbels per plant was produced in the genotypes cluster II (34.51) followed by the genotypes under cluster VI (34.50). Number of umbellets per umbel was highest in cluster V (25.48) whereas, weight of grains per umbel was highest in cluster I (1.35). Cluster II (91.83) was found maximum germination percentage while, cluster VI (91.00) was found best as minimum days for days to 50% flowering is desirable.

Thus, the maximum cluster mean was observed in cluster VI for seed yield/plant along with number of branches/plant, while Cluster V for number of umbellets per umbel and plant height; cluster II for number of umbels per plant and test weight. These clusters could be regarded as useful sources of gene for important yield component traits. However, Cluster VI had lowest number of days to appearance of 50% flowering, while Cluster I had earliest appearance of days to maturity which could be helpful for breeding an early plant type. Hence, it can be suggested from the present study that a high yielding early flowering type with number of branches of branches per plant could be bred by utilizing the genotypes from cluster VI as parents in the future breeding programme. Similar observations were also reported by Bhandari and Gupta (1993), Srivastava *et al.,* (2000), Singh *et al.,* (2012), Dyulgerov and Dyulgerova (2013) and Meena *et al.,* (2014) in coriander.

Character contribution towards divergence

An assessment of relative maximum contribution of 10 characters towards total genetic divergence (Table 5) was recorded in test weight (32.41%) followed by number of umbellets per umbel (20.46%), days to maturity (17.01%), weight of grains per umbel (12.87%) and number of branches per

plant (8.97%),while germination percentage (3.91%), seed yield per plant (3.22%), plant height (0.69%), and number of umbels per plant (0.46%) have the least contribution. Our results are in accordance with the findings of Patel *et al.,* (2000), Palanikumar *et al.,* (2012) and Meena *et al.,* (2014) in coriander.

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