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Assessment of genetic diversity for among economic traits in fennel (*Foeniculum vulgare* Mill.)

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ABSTRACT

The experiment was conducted during Rabi (October- 2018 to February- 2019) at Main Experimental Station of Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) with a view to study the extent of genetic divergence among ninety four genotypes of fennel including four checks (AF-1, NDF-5, NDF-12 and RF-101) in Augmented Block Design. The observations was recorded on twelve characters viz. days to 50% flowering (days), plant height (cm), number of primary branches, days to maturity, number of umbels plant-1, number of umbellets umbel-1, number of grains umbellets-1, weight of grains umbel-1 (g), 1000-seed weight (g) and seed yield plant-1 (g). All the ninety four genotypes were grouped into ten diverse clusters. Cluster VI (20) has highest number of genotypes followed by cluster IV, cluster IX (16), cluster III (12), cluster V (10), cluster VII(9), cluster I (5), cluster X (3), cluster VIII (2) and cluster II had one genotype. Maximum inter-cluster distance was observed between clusters II and VII (148.264) which revealed that members of these two clusters (II and VII) are genetically much diverse to each other. The inter-cluster value between cluster II and cluster VIII (147.518) and cluster II and IX (129.573) was very high. The genotype NDF-1, NDF-2, NDF-58, NDF-59 and NDF-55, NDF-60 and NDF-76 was recognized promising genotypes for seed yield plant-1 and other traits. Therefore, they might to be utilizing for varietal improvement programme in fennel.

Keywords: Cluster analysis, Inter and intra cluster, D_2 statistics etc.

1. Introduction

Fennel (*Foeniculum vulgare* Mill. $2n = 2x = 22$) is most emerging and medicinal seed spices crops which belong to family Apiaceae (Umbelliferae). Its commonly vernacular names are sauff (Hindi), Variari (Gujarati), Badishep (Marathi). It is an annual, biennial or perennial aromatic herb, depending on the variety and essential oil of fennel fruits was used for flavoring purpose, cosmetic and pharmaceutical products (Bilia *et al.*, 2000) [1]. It is native of Southern -Europe and Mediterranean region where it has been grown since ancient times. It is now extensively cultivated on large scale in temperate and sub-tropical regions of the worlds like Romania, Russia, Germany, France, Italy, India, Argentina, and United States. It is also grown in Bulgaria, China, Denmark, Egypt, Syria, and Japan. Fennel grown as seed crop in North Indian plains and it is a medicinal plant used as *anti*-spasmodic, appetite stimulant, somatic, diuretic, anti inflammatory, anti diarrheic, against colic and as a lactation promoter (Neamatollahi *et al.*, 2009) [2].

It gains its importance from high medicinal uses as it contains: "Anethol" which is an *anti*- cancer compound fight the liver and breast cancer, "Quercetin" which is *anti*-inflammation compound, dietary nitrates which lower the blood pressure and it also contain melatonin which help in lowering the excess body weight. Also fennel contains vitamin- A and C vitamins and rich in fibers (Wesam *et al.*, 2015) [3]. In Indian folk, dry seeds may be eaten to improve vision and treat glaucoma, in Egyptian folk; boiling fennel in water may be the first baby diet as it relief its digestive system; later on fennel water becomes one of the constitutes the domestic „gripe water“, used to correct flatulence of infants (Rather *et al.*, 2012). Fennel essential oil is as value as gold for it has antibacterial, antifungal, antioxidant and anticancer activity (Lucinewton *et al.*, 2005) [4].

In India, the major fennel producing states like Gujarat, Rajasthan and Uttar Pradesh, while many other states grown it on a small scale such as Bihar, Madhya Pradesh, Punjab, and Haryana (Meena *et al.*, 2010) [5]. Gujarat is the leading state in fennel production, which contributes about 80–85% of total production in India (Anonymous, 2019) [6]. India is a major seed spices producer in the world. Among seed spices, only fennel contributes about 17.47% of total production. In India, present area under fennel cultivation is greatly increases from previous years with offering 90.0 thha with 157 thmt and productivity 1.575 mtha⁻¹.

Genetic divergence analysis estimates the extent of diversity present among the studied genotypes and these studies could help the plant breeder in selecting the diverse parents for purposeful hybridization. Hence, the study was conducted to assess the genetic divergence and inter-relationship among the sixty genotypes of

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fennel for different yield attributes. The use of D^2 statistics of multi-variate analysis gives an understanding of genetic diversity in the fennel. D^2 measures the degree of diversity and determines the relative proportion of each component traits to the total divergence. Information on these aspects in fennel is limited and hence there is a need for identifying the genotypes having better performance for yield and quality traits which belong to diverse parents. In D^2 analysis the genetic diversity is depicted by the cluster representing number of groups in which a population can be classified on the basis of D^2 statistics (Beale, 1969 and Spark D^2 1973) [1]. Thus, the study was done to study the extent of genetic divergence using ninety four genotypes of fennel including four checks (AF-1, NDF-5, NDF-12 and RF-101) in Augmented Block Design (Federer, 1956) [1]. The genetic divergence was estimated using the Mahalanobis D^2 , Mahalanobis (1963).

2. Materials and method

The experiment was conducted during *Rabi* season (October- 2018–February-2019) at Main Experiment Station, Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.) in Augmented Block Design with three replication to assess the performance of 94 genotypes of fennel including four checks. The experiment was sown in winter seasons during 2018–2019. All the cultural and agronomic

practiced was done during the whole period of crop. Geographically, Narendra Nagar is located in latitude between 24.47° and 26.56° N and longitude 82.12° and 83.98° E at an altitude of 113 m above the mean sea level. The annual rainfalls were received about 1200 mm. The observations were recorded for 10 different characters viz., days to 50% flowering, plant height (cm), days to maturity, primary branches plant⁻¹, number of umbels plant⁻¹, number of umbellets umbel⁻¹, number of grains umbellate⁻¹, weight of grains umbels⁻¹ (g), 1000-seed weight (g) and seed yield plant⁻¹ (g). The genetic divergence D^2 was estimated by using non - hierarchical Euclidean clusters analysis (Beale, 1969 and Spark, 1973.) [1]

3. Results and discussions

The data depicted in this table indicated that of genetic divergence among the ninety four genotypes of fennel was carried out by using D^2 analysis (Beale, 1969 and Spark, 1973) [1]. All 94 genotypes were grouped into ten different non-overlapping clusters (Table: 1). The cluster VI (20) had highest number of genotypes followed by cluster IV and cluster IX (16), cluster III (12), cluster V (10), cluster VII (9), cluster I (5), cluster X (3), cluster VIII (2) and cluster II had one genotype.

Table 1. Clustering pattern of ninety four genotypes of fennel

I	5	NDF-2, NDF-3, NDF-9, NDF-47, NDF-74
II	1	NDF-1
III	12	NDF-4, NDF-5, NDF-10, NDF-15, NDF-14, NDF-6, NDF-8, NDF-11, NDF-26, NDF-7, NDF-12, NDF-13
IV	16	NDF-25, NDF-27, NDF-28, NDF-30, NDF-92, NDF-93, NDF-91, NDF-94, NDF-41, NDF-59, NDF-32, NDF-33, NDF-31, NDF-48, NDF-50, NDF-51
V	10	NDF-34, NDF-35, NDF-49, NDF-52, NDF-53, NDF-56, NDF-55, NDF-75, NDF-78, NDF-73
VI	20	NDF-36, NDF-40, NDF-60, NDF-39, NDF-77, NDF-79, NDF-80, NDF-71, NDF-76, NDF-37, NDF-38, NDF-42, NDF-44, NDF-54, NDF-43, NDF-57, NDF-45, NDF-58, NDF-72, NDF-81
VII	9	NDF-17, NDF-46, NDF-21, NDF-24, NDF-23, NDF-19, NDF-22, NDF-29, NDF-16
VIII	2	NDF-18, NDF-20
IX	16	NDF-62, NDF-66, NDF-64, NDF-65, NDF-61, NDF-82, NDF-88, NDF-89, NDF-90, NDF-83, NDF-84, NDF-85, NDF-70, NDF-68, NDF-86, NDF-87
X	3	NDF-67, NDF-69, NDF-63

Table 2. The estimates of intra and inter – cluster distant represented by D^2 values given.

Cluster Number	I	II	III	IV	V	VI	VII	VIII	IX	X
I	10.915	36.760	21.198	27.891	17.798	28.349	55.427	60.708	43.270	27.975
II		0.000	75.195	88.321	61.106	98.415	148.264	147.518	129.573	95.530
III			10.211	13.673	17.837	15.624	25.678	33.844	20.135	20.486
IV				7.889	17.216	11.731	16.333	31.467	17.008	18.889
V					10.292	14.665	39.039	45.610	29.598	25.219
VI						7.490	18.959	27.413	12.950	16.319
VII							3.327	23.040	15.987	26.424
VIII								4.918	30.026	35.811
IX									6.795	13.891
X										5.665

*Bold diagonal values indicate intra-cluster distance; the remainder of values indicates the inter-cluster distances.

Table: 2. The data depicted in table: 2 indicated the *per se* performance of intra cluster D^2 values ranged from 0.000 (cluster II) to 10.915 (cluster I). The maximum inter-cluster distance was observed between clusters II (36.76) and VII (148.264) which revealed that members of these two clusters (II and VII) are genetically much diverse to each other. The inter-cluster values between clusters II

(36.76), cluster VIII (147.518) and cluster II (36.76) and IX (129.573) was very high. The minimum inter-cluster D^2 value was recorded in cluster IV (13.67) and cluster VI (11.731). The higher inter-cluster distance indicated greater genetic divergence between the genotypes of those clusters, whereas, lower inter-cluster values between the clusters suggested that genotypes of the clusters were not much genetically diverse from each other. The *per se* performance of the intra

cluster D^2 values ranged from 0.000 (cluster II) to 10.915 (cluster I). The maximum inter-cluster distance was observed between clusters II and VII (148.264) which revealed that members of these two clusters (II and VII) were, genetically much diverse to each other. The inter-cluster values between cluster II and cluster VIII (147.518) and cluster II and IX (129.573) were very high. The minimum inter-cluster D^2 value was recorded in cluster IV and cluster VI (11.731). The higher inter-cluster distance indicated greater genetic divergence between the genotypes of those clusters. Whereas, lower inter-cluster values between the clusters suggested that genotypes of the clusters were not much genetically diverse from each other. The results align with previous study was done and reported by Meena *et al.*, (2010) [5]

Table: 3 Intra and inter clusters D^2 values for ten clusters in 94 fennel genotypes

The inter clusters means for ten characters in 94 fennel genotypes had given. It showed that cluster means for different characters indicated considerable differences between the clusters. Days to 50% flowering showed minimum mean value in cluster II (94.59) followed by cluster III (96.87) and cluster VIII (97.24). Days to maturity exhibited minimum mean value in cluster VIII (158.77) cluster VII (159.17). Plant

height showed maximum mean value in cluster II (142.73) followed by cluster III (112.80) and cluster I (111.78). Number of branches plant⁻¹ showed maximum mean value in cluster II (5.81) followed by cluster V (4.83) and cluster I (4.75). Number of umbels plant⁻¹ showed maximum mean value in cluster II (62.04) followed by cluster V (44.75) and cluster I (40.75). Number of umbellets/umbel⁻¹ showed maximum mean value in cluster II (40.18) followed by cluster I (25.65) and cluster V (23.02). Number of grains umbel⁻¹ showed maximum mean values in cluster II (39.25) followed by cluster I (29.11) and cluster X (26.78). Weight of grains umbel⁻¹ exhibited maximum mean values in cluster II (4.13) and cluster I (3.64). Test weight (1000-seed weight) showed maximum mean values in cluster VIII (8.77) and cluster II (8.03) and seed yield plant⁻¹ exhibited maximum mean values in cluster II (148.99) followed by cluster V (100.53) and cluster I (98.89). Similar finding were also reported by (Meena *et al.*, 2010) [5]. The results indicated that genetic divergence is not related to geographical diversity and may possibly be due to varietal diversity among the varieties due to diversity of their pedigree along with natural and directional selection pressure for certain agronomic traits. A similar result was also reported by Kole *et al.* (2002) [7].

Table 3. Cluster mean for ten characters in different genotypes of fennel

Characters Cluster No.	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of branches plant ⁻¹	Number of umbels plant ⁻¹	Number of umbellets/umbel ⁻¹	Number of grains umbel ⁻¹	Weight of grains umbel ⁻¹ (g)	1000-seed weight (g)	Seed yield per plant (g)
	1	2	3	4	5	6	7	8	9	10
I	97.707	161.206	111.782	4.752	40.752	25.658	29.118	3.639	6.989	98.898
II	94.592	160.746	142.730	5.817	62.042	40.183	39.258	4.129	8.029	148.998
III	96.874	161.973	112.807	3.577	36.721	20.165	22.127	2.260	6.175	69.059
IV	99.304	160.090	108.596	3.773	32.723	21.940	23.858	1.729	5.348	51.029
V	100.972	160.358	109.933	4.832	44.759	23.021	23.718	2.344	6.627	100.528
VI	101.487	160.759	94.668	3.889	33.512	19.211	20.317	1.964	6.185	68.218
VII	97.811	159.176	88.345	2.783	19.967	14.808	17.878	1.401	4.426	29.947
VIII	97.242	158.771	89.710	2.242	19.592	14.858	15.383	1.204	8.779	23.435
IX	101.629	162.532	93.868	2.131	23.928	17.858	18.305	1.929	5.378	46.642
X	101.392	161.304	97.596	1.258	19.933	20.600	26.783	2.796	6.121	75.394

4. Conclusion

Considerable and significant variability was exists among the 94 genotypes of fennel. The genotype NDF-1, NDF-2, NDF-58, NDF-59 and NDF-55, NDF-60 and NDF-76 was recognized promising genotypes for seed yield plant⁻¹ and other traits. Therefore, they might be utilizing for varietal improvement programme in fennel.

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