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Variability and correlation studies for yield and yield contributing traits in fennel (*Foeniculum vulgare* Mill.) germplasm

R.S. Meena*, A.K. Verma, N.K. Meena, Anita Ahari, S.R. Balai and S.C. Mali

ICAR-National Research Centre on Seed Spices, Tabiji, Ajmer-305 206, India

Abstract

Fifty germplasm of fennel (*Foeniculum vulgare* Mill.) were evaluated in Augmented Block Design during *Rabi* 2012-2013 at ICAR-NRCSS, Tabiji, Ajmer (Rajasthan). Analysis of variance revealed significant variability for most of the traits namely secondary branches plant^{-1}, plant height up to main umbel (cm), length of first inter node, number of umbels plant^{-1}, number of seeds umbellate^{-1}, test weight (cm) and seed yield plant^{-1}. High estimates of PCV along with GCV as well as broad sense heritability, genetic advance and genetic advance as percentage of mean were observed for number of secondary branches plant^{-1}, number of umbels plant^{-1} and seed yield plant^{-1}. High heritability (broad sense) coupled with high genetic advance as percent of mean was observed for the characters viz., number of secondary branches plant^{-1}, number of umbels plant^{-1} and seed yield plant^{-1}. Association analysis was significant and positive for plant height up to main umbel (cm), plant height up to top (cm), length of first inter node (cm), diameter of primary umbel (cm) and number of seeds umbellate^{-1}.

Key words : Correlation, fennel, genetic advance, heritability, yield and yield components.

Introduction

Fennel (*Foeniculum vulgare* Mill, 2n = 22) belongs to family Apiaceae (Umbelliferae). It is an allogamous crop with cross-pollination up to 82.2 to 95.40 (Ramanujam *et al.,* 1964). It is native to Southern Europe and Mediterranean region. Fennel is a tall erect glabrous glaucous biennial or perennial herb, with yellow flowers and aromatic seeds. Flowers are bisexual, actinomorphic and open centripetally. The fruit is light green to dark brown, lens-shaped schizocarp, oblong-oval to elliptical 2-3 mm with long pedicel and short stylopodium. A fully grown fruit is 4 to 8 mm long.

The favorable environment of fennel is cool and dry climate. It is cultivated easily in all types of soil. Its sowing time is September to October. It's mainly cultivated for its seeds in the state of Rajasthan and Gujarat. The leaves and seeds of fennel are used in many culinary traditions (Ehsanipour *et al.,* 2012). It is long duration crop. In fennel all umbel do not mature at the same time. Its life cycle completed in 170-175 days.

Mature fennel fruits and essential oil are used as flavouring agents in food products such as liqueurs, bread, pickles, pastries and cheese (Zoubiri *et al.,* 2014). Fennel's seeds, leaves and roots have medicinal properties. It cures appetite loss, gassy colic in children, dysentery, eye strain, throat pain, stomach pain and headache, and improves eye sight. Fennel is rich in vitamin A and contains a fair amount of calcium, phosphorous and potassium.

Analysis of variability among the traits and the association of a particular character in relation to other traits contributing to yield of a crop would be of great importance in planning a successful breeding program (Mary and Gopalan, 2006). Knowledge of heritability is essential for selection based improvement as it indicates the extent of transmissibility of a character into future generations (Sabesan *et al.,* 2009). The knowledge of the association of yield and its components enables breeder to know how the selection pressure exerted on one trait will cause changes in other traits (Aliyu, 2006).

Materials and methods

The present study was carried out to assess the variability and correlation in 50 germplasm lines of fennel. The germplasm lines under study were grown in Augmented Block Design with four checks namely AF-1, GF-2, RF-101 and RF-143 during *Rabi* 2012-2013 at the research farm of ICAR-NRCSS, Ajmer (Rajasthan). The study location was lying between 74° 35'39" to 74° 36' 01"E longitude and 26° 22'12" to 26° 22' 31" N latitude with an altitude of 486 MSL. The soil of the site was sandy loam in texture, poor in fertility and water holding capacity, having pH 8.0 to 8.3, EC 0.07 to 0.12 and 0.15 to 0.23% organic carbon, available N 178.5 kg ha^{-1} (low) and P_2O_5

*Corresponding author email: rsm.nrcss@gmail.com

12 kg ha^{-1} (medium), K_2O 5 kg ha^{-1} (low). Climate of the Ajmer area characterized as semi-arid. All the recommended package of practices were followed to raise a good crop. Observations were recorded on five randomly selected plants from each line for number of primary branches plant^{-1}, number of secondary branches plant^{-1}, plant height up to main umbel, plant height up to top, diameter of main umbel, length of first inter node, number of umbels plant^{-1}, number of umbellates umbel^{-1} and number of seeds umbellate^{-1} while for test weight, the data recorded on whole line basis. To estimate the variation among the germplasm and checks, analysis of variance was carried out as per the procedure suggested by Federer (1956). Heritability in broad sense and genetic advance (GA) were calculated by the following formula as suggested by Hanson *et al.,* (1956) and Johnson *et al.,* (1955) respectively.

The present investigation was made to explore the genetic diversity, to determining the genetic coefficient of variation, heritability and genetic advance of different traits and their correlation among fifty fennel germplasm lines.

Results and discussion

The analysis of variance revealed that significant amount of variability was present in germplasm lines for almost all morphological traits studied *viz.* number of primary branches plant^{-1}, number of secondary branches plant^{-1}, plant height up to main umbel, plant height up to top, diameter of main umbel, length of first inter node, number of umbels plant^{-1}, number of umbellates umbel^{-1}, number of seeds umbellate^{-1}, test-weight and seed yield plant^{-1} (Table 1). The present findings confirm the earlier reports on variability in various characters by Shah *et al.,* (1969); Shukla *et al*., (2003); Singh *et al*., (2004); Lal, (2007); Chandra *et al.*, (2008); Meena *et al*., (2010) and Abou *et al.*, (2013).

A wide range of mean for yield and some of its contributing traits indicates good chance for improvement of yield through direct selection or by transferring desired traits. On the basis of mean performance of yield and other yield contributing morphological traits, the germplasm UF-168, UF-131, UF-205, UF-200, UF-173, UF-109 and UF-197 were found to be superior. These genotypes may be further tested and released as high yielding variety (Table 2). The present findings confirm the earlier reports on variability given by Alam *et al.,* (2003), Singh *et al.,* (2004) and Malik *et al.,* (2009).

The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were worked out (Table 2). Higher GCV was recorded for seed yield plant^{-1}, number of umbels plant^{-1}, number of secondary branches plant^{-1} and, it expresses the true genetic potential which indicated the presence of high amount of genetic variability for these characters thus, selection may be more effective for these characters because the response to selection is directly proportional to the component of variability, while, test-weight, length of first inter node, number of seeds umbel^{-1} and number of primary branches plant^{-1} showed moderate to high GCV. Whereas plant height up to top, number of umbellates umbel^{-1}, plant height up to main umbel showed low magnitude of GCV. The phenotypic coefficients of variation, in general, were higher than the genotypic coefficient of variation for all the characters which indicated considerable influence of environment on these characters.

Higher PCV was recorded for seed yield plant^{-1}, number of umbels plant^{-1}, number of secondary branches plant^{-1} while, number of seeds umbel^{-1}, length of first inter node, test weight, number of umbellates umbel^{-1} and number of primary branches plant^{-1} showed moderate to high PCV. Whereas diameter of primary umbel, plant height up to main umbel, plant height up to top showed low magnitude of PCV (Table 2). The present findings confirm the earlier reports of Mehta and Patel, (1983), Shukla *et al*., (2003), Lal, (2007), Meena *et al*., (2010), Dashora and Sastry, (2011), Yogi, (2013) and Abou *et al*., (2013).

The phenotypic coefficient of variation and genotypic coefficient of variation alone would not be sufficient to indicate the proportion of total heritable part of variation. The estimates of heritability were used to estimate genetic advance. If heritability of a character is high (> 70%), selection for such a character should be fairly easy. In the present investigation, the estimates of heritability (in broad sense) expressed in percentage was high for the characters *viz*., number of secondary branches plant^{-1}, test weight, number of umbels plant^{-1} and seed yield plant^{-1} (Table 2). Similar result was found in the findings of Mehta and Patel, (1983), Shukla *et al*., (2003), Lal, (2007), Dashora and Sastry, (2011) and Abou *et al.*, (2013). The characters namely number of primary branches plant^{-1}, plant height up to primary umbel, length of first inter node, number of umbellates umbel^{-1} and seeds umbellate^{-1} showed moderate to high heritability.

Genetic advance as percentage of mean for the characters ranged from 7.22 (plant height up to top) to 107.64 (seed yield plant^{-1}). Genetic advance expressed as percentage of mean were high for the characters *viz.* seed yield plant^{-1}, number of umbels plant^{-1} and number of secondary branches plant^{-1} (Table 2). Similar findings were also noted by Agnihotri *et al.,* (1997), Meena *et al*., (2010),

Table 1. Analysis of variation for different characters in fennel germplasm

Source of variation	DF	Number of primary branches plant^{-1}	Number of secondary branches plant^{-1}	Plant height up to main umbel (cm)	Plant height up to top (cm)	Diameter of primary umbel (cm)	Length of first internodes (cm)	Number of umbels plant^{-1}	Number of umbellate umbel^{-1}	Number of seeds umbellate^{-1}	Test weight (1000) (g)	Seed yield plant^{-1} (g)
Block (eliminating Check+Var.)	4	0.45	3.42	93.80	82.61	0.52	0.41	9.35	3.29	2.61	0.05	341.45
Entries (ignoring Blocks)	53	0.85*	31.85**	251.18*	26221*	3.79*	1.40**	165.98**	17.00*	20.48*	1.28**	21883.49**
Checks	3	0.73	21.67*	120.95	46273*	1.16	1.16*	378.02**	12.32	28.79*	3.29**	17511.49**
Varieties	49	0.87	33.06**	208.40*	176.78	3.42	1.12*	152.74**	11.90	17.71*	1.13**	10961.23**
Checks vs. Varieties	1	0.19	3.22	2738.62**	3846.8**	29.63**	15.75**	178.89*	291.89*	131.22**	2.63**	570176.70**
Error	12	0.29	2.03	47.49	91.57	1.44	0.23	18.94	7.07	5.68	0.04	1252.69

Table 2. Overall mean values of accessions, their range, genotypic and phenotypic coefficient of variation, heritability in broad sense and genetic advance as percentage of mean for characters in fennel

Character	Mean	Range	Genotypic coefficient of variation (GCV) %	Phenotypic coefficient of variation (PCV)	Heritability in broad sense (%)	Genetic Advance as % of mean
Number of primary branches plant^{-1}	6.44	5.13-9.28	10.31	13.27	0.60	16.51
Number of secondary branches plant^{-1}	18.33	9.32-33.21	26.38	27.51	0.92	52.13
Plant height up to primary umbel (cm)	123.31	88.15-164.37	8.93	10.53	0.71	15.59
Plant height up to top of the plant (cm)	146.66	109.44-174.96	5.46	8.511	0.41	7.22
Diameter of primary umbel(cm)	14.65	8.49-17.88	8.35	11.70	0.50	12.27
Length of first inter nodes(cm)	6.39	4.33-8.35	12.78	14.89	0.73	22.61
Number of umbels plant^{-1}	27.88	15.08-102.10	36.02	39.25	0.84	68.08
Number of umbellets umbel^{-1}	24.67	16.07-33.08	7.73	13.26	6.33	9.28
Number of seeds umbellets^{-1}	25.61	16.28-35.20	11.75	14.99	0.61	18.98
1000-seed weight (g)	6.71	4.70-10.57	13.53	13.88	0.95	27.19

Table 3. Phenotypic and genotypic correlation coefficient between different characters in fennel

Characters	Level	Number of primary branches plant^{-1}	Number of secondary branches plant^{-1}	Plant height up to main umbel (cm)	Plant height up to top (cm)	Diameter of primary umbel (cm)	Length of first internodes (cm)	Number of umbels plant^{-1}	Number of umbellets umbel^{-1}	Number of seeds umbellet^{-1}	Test weight (1000) (g)	Seed yield plant^{-1} (g)
Number of primary branches plant^{-1}	P	1	0.42**	0.12	0.10	0.17	0.10	0.40**	-0.17	0.01	-0.21	0.12
	G	1	0.43**	0.17	0.16	0.09	-0.09	0.36**	-0.09	0.05	-0.22	0.04
Number of secondary branches plant^{-1}	P		1	-0.03	-0.03	-0.14	0.05	0.55**	-0.13	0.14	-0.04	0.04
	G		1	0.08	0.08	-0.15	0.14	0.58**	-0.14	0.13	-0.04	0.04
Plant height up to main umbel (cm)	P			1	0.88**	0.49**	0.27*	0.02	0.24*	0.13	-0.24*	0.21
	G			1	0.86**	0.41**	0.23*	0.07	0.26*	0.17	-0.15	0.24*
Plant height up to top (cm)	P				1	0.48**	0.26*	0.03	0.40**	0.29*	-0.11	0.36**
	G				1	0.40**	0.23*	0.05	0.41**	0.31*	-0.02	0.38**
Diameter of primary umbel (cm)	P					1	0.46**	0.05	0.31*	0.28*	-0.22	0.23*
	G					1.	0.35**	0.04	0.31*	0.27*	-0.18	0.19
Length of first internodes(cm)	P						1	0.27*	0.05	0.13	0.04	0.34**
	G						1	0.29*	0.10	0.19	0.04	0.32*
Number of umbels plant^{-1}	P							1	-0.08	0.10	0.00	0.03
	G							1	-0.12	0.08	-0.03	0.02
Number of umbellets umbel^{-1}	P								1	0.61**	-0.13	0.20
	G								1	0.58**	-0.08	0.20
Number of seeds umbellet^{-1}	P									1	-0.36**	0.37**
	G									1	-0.34**	0.38**
Test weight (1000) (g)	P										1	0.03
	G										1	0.03
Seed yield plant^{-1} (g)	P											1
	G											1

** *Significant at p =0.01* * Significant at p = 0.05

Dashora and Sastry, (2011) and Yogi (2013). Genetic advance was moderate for the characters *viz.* number of primary branches plant^{-1}, length of first inter node, test weight and seeds umbellate^{-1}.

High Heritability (broad sense) coupled with high genetic advance as percent of mean was observed for the characters *viz.*, number of secondary branches plant^{-1}, test weight, number of umbels plant^{-1} and seed yield plant^{-1}. Whereas moderate to high heritability with moderate genetic advance was observed for the characters *viz*., number of primary branches plant^{-1}, plant height up to main umbel, length of first inter node, number of umbellates umbel^{-1} and seeds umbellate^{-1}.

The association analysis at both genotypic and phenotypic level revealed that the seed yield plant^{-1} was significantly and positively correlated with plant height up to main umbel, plant height up to top, length of first inter node, diameter of main umbel and number of seeds umbellate^{-1}. Similar results were found in the findings of Kathiria, (1980), Mehta and Patel, (1983), Agnihotri *et al*., (1997), Singh and Sastry (2005), Meena *et al*., (2010), Dashora and Sastry, (2011), Yogi, (2013) and Abou *et al.*, (2013). While the correlation of number of primary branches plant^{-1}, number of secondary branches plant^{-1}, umbels plant^{-1}, number of umbellates umbel^{-1} and test weight showed positive but non-significant correlation with seed yield per plant. Similar result was found in the findings of Dashora and Sastry, (2011), Yogi (2013) and Abou *et al.*, (2013).

References

Abou, El-Nasr T. H. S., Sherin, A., Mahfouze and Al Kordy, M.A.A. 2013. Assessing phenotypic and molecular variability in fennel (*Foeniculum vulgare* Mill.) Varieties. *Australian Journal of Basic and Applied Sciences*, 7(2): 715-722.

Agnihotri, P., Dashora, S. L. and Sharma, R. K. 1997. Variability, correlation and path analysis in fennel (*Foeniculum vulgare* Mill). *Journal of Spices and Aromatic Crops*, 6(1): 51-54

Alam, K., Chaterjee, R., Pariari, A. and Sharangi, A. B. 2003. Evaluation of fennel (*Foeniculum vulgare* Mill.) germplasm for growth and yield. *Environment and Ecology*, 21(2): 477-4

Aliyu, O. M. 2006. Phenotypic correlation and path coefficient analysis of nut yield and yield components in cashew (*Anacardium occidentale* L.). *Silvae Genetica*, 55(1): 19-24.

Chandra, R., Lal, R. K., Shankar, H., Kumar, D. and Bansal, K. 2008. Genetic and morphological variability in fennel (*Foeniculum vulgare* Mill.).Published in 4th National Interactive Meet Sonvenir held at CIMAP (CSIR) Lucknow, NIM 2008-17.

Dashora, Abhay and Sastry, E. V. D. 2011. Variability, character association and path coefficient analysis in fennel. *Indian Journal of Horticulture*, 68(3): 351-356.

Ehsanipour, A., Razmjoo, J., Zeinali, H. 2012. Effect of Nitrogen Rates on Yield and Quality of Fennel (*Foeniculum vulgare* Mill.) Accessions. *Industrial Crops Products*, 35(1): 121-125.

Federer, W. T. 1956. Augmented designs. Hawaiian Planters' Record (2): 191-208.

Hanson, C. H., Robinson, H. F. and Comstock, R. E. 1956. Biometrical studies of yield in segregating population of Korean Laspedaza. *Agronomy Journal*, 48: 268-272.

Johnson, H. W., Robinson, H. F. and Comstoc, R. E. 1955. Estimation of genetic and environmental variability in soybean. *Agronomy Journal*, 47: 314-318.

Kathiria, K. B. 1980. Variability and correlation in a selected and unselected bulk of fennel. M.Sc. (Ag.) Thesis, University of Udaipur, Campus-Jobner (Rajasthan).

Lal, R. K. 2007. Association among agronomic traits and path analysis in fennel (*Foeniculum vulgare* Mill.) *Journal of Sustainable Agriculture*, 30 (1): 21-29.

Malik, T. P., Tehlan, S. K. and Thakral, K. K. 2009. Performance of fennel (*Foeniculum vulgare* Mill.) genotypes for seed yield. Published in National Workshop on "Spices and Aromatic Plant in 21st century India" held at S.K.N College of Agriculture, Jobner (Rajasthan), pp. 62.

Mary, S. S. and Gopalan, A. 2006. Dissection of genetic attributes yield traits of fodder cowpea in F3 and F4. *J Applied Sci Res*. 2: 805-808.

Meena, R. S., Kakani, R. K., Anwer, M. M. and Panwar, A. 2010. Variability of some morphological characters in fennel (*Foeniculum vulgare Mill.*). *Indian Journal of Agricultural Sciences*, 80(8): 710-712.

Mehta, K. G. and Patel, R. H. 1983. Variability in fennel (*Foeniculum vulgare* P. Miller) under North Gujarat conditions. *Journal of Plantation crops,* 11(1): 21-23.

Ramanujanm, S., Joshi, B. S. and Saxena, M. B. L. 1964. Extent and randomness of cross pollination in some umbelliferous spices of India. *Indian Journal of Genetics and Plant Breeding,* 24: 62-67.

Sabesan, T., Suresh, R. and Saravanan, K. 2009. Genetic variability and correlation for yield and grain quality characters of rice grown in coastal saline lowland of Tamil Nadu. Electr. *J. Plant Breed.* 1: 56-59.

Shah, C. S. Quadri, J. S. and Chauhan, M. G. 1969. Chemical races in *Foeniculum vulgare* Mill. *Current Science*, 38: 365-366.

Shukla, S., Singh, P. K. and Garg, V. K. 2003. Study on genetic variability and heritability in fennel grown on sodic soils. *Journal of Medicinal and Aromatic Plant Sciences*, 25(4): 956-958.

Singh, V. V. and Sastry, E. D. V. 2005. Association studies for seed yield and its attributes in bi-parental progenies of fennel. *Agricultural Science Digest*, 25 (4): 303-304.

Singh, V. V. Singhania, D. L., Sastry, E. D. V., Sharma, K. C. and Rajput, S. S. 2004. Character association in half sib and S1progenies of fennel (*Foeniculum vulgare* Mill.). Published in National Seminar on New Perspective in Commercial Cultivation, Processing and Marketing of Seed Spices and Medicinal Plants held at S.K.N. collage of Agriculture Jobner (Rajasthan) pp. 12

Yogi, R., Meena, R. S., Kakani, R. K. Panwar, A. and Solanki, R. K. 2013.Variability of some morphological characters in fennel (*Foeniculam vulgare* Mill.) *International Journal of Seed Spices*, 3 (1): 41- 43.

Zoubiri, S., Baaliouamer, A., Seba, N. and Chamouni, N. 2014, Chemical composition and larvicidal activity of Algerian *Foeniculum vulgare* seed essential oil. *Arab J Chem*. 7(4): 480-485.

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