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Studies on Genetic Variability, Correlation and Path Coefficient in Fennel Germplasm (*Foeniculum vulgare* Mill.)

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A B S T R A C T

Fifteen genotypes were used to studies the genetic variability, heritability, genetic advance, correlation and path coefficient for growth and yield attributing characters in fennel. The highest PCV and GCV were recorded in seed yield per plant, number of secondary branches per plant and number of primary branches per plant. The highest heritability was noticed for seed yield per plant, number of umbelles per plant and number of secondary branches per plant. Plant height, days to 50% flowering and days to first flowering exhibited highest genetic advance as percentage of mean. The seed yield per plant had significant and positive correlation with number of number of secondary branches per plant, plant height, number of umbellates per umbel and test weight. Number of secondary branches per plant, days to 50% flowering, test weight and number of umbellates per umbel had direct effect on seed yield per plant. Therefore, greater emphasis should be given on these characters for genetic improvement of fennel.

Introduction

Fennel (*Foeniculum vulgare* Mill) belonging to family Apiaceae, is a cross pollinated crop and a diploid species with chromosome number, 2n =22. It is native of Europe and Meditarean region (Agarwal *et al.*, 2001). Fennel is an annual, aromatic herb of 100-180 cm height. Mature fennel fruits and essential oil are used as flavouring agents in food products such a liqueurs, bread, pickles, pastries, and cheese (Zoubiri *et al.*, 2014). Fennel is cultivated throughout the temperate and subtropical region in the world mainly in the countries like, Romania, Russia, Hungary, Germany, France, Italy, India, Sri Lanka, Malaysia, Japan, Argentina and USA. In India, it is mainly grown in the states of Gujarat and Rajasthan and to some extent in U.P., Karnataka, A.P., Punjab, M.P., Bihar, Haryana and J & K. Total area under the crop in India is about 94070 hectares with production of 135930 tonnes. Fennel is a cross pollinated crop with high heterozygosity prevailing in the natural population. Genetic variability is prerequisite for any crop improvement in a crop. The survey of genetic

variability with the help of suitable genetic parameters like genotypic and phenotypic coefficients of variations, heritability estimates and genetic advance as percentage of mean are indispensable in breeding programmes aimed at improvement of seed yield. The heritability measures the contribution of genetic variability to the total variability i.e. phenotypic variability observed for any quantative trait. The estimated heritability can be utilized for the estimation of genetic gain expected for the selection of top 5 per cent individuals. Such studied enable the breeders to have a maximum selection response of the variance exhibited by population which is largely due to additive gene effects.

Materials and Methods

The experimental materials are consisting of fifteen genotypes of fennel and evaluated at Vegetable Research Farm, Maharajpur, Department of Horticulture, JNKVV, Jabalpur during 2017- 2018. The collected genotypes were sown in Randomized Complete Block design with three replications, whereas, the row to row and plant to plant distance was 30 and 10 cm respectively. Standard techniques were adopted in data collection from five selected plants from each genotypes for nine characters viz. plant height, number of primary branches per plant, number of secondary branches per plant, days to first flower initiation, days to 50% flowering, number of umbels per plant, number of umbellets per plant, test weight and seed yield per plant.

Coefficient of variation, heritability and genetic advance were estimated as formula given by Panse and Sukhatme (1976). The genotypic and phenotypic correlation coefficients were calculated as the formula by Miller *et al.,* (1958) and path analysis on basis of method by Fisher and Yates (1963).

Results and Discussion

The analysis of variance revealed significant differences among the germplasms for most of the characters. The phenotypic coefficient of variance (PCV) was higher than genotypic coefficient of variance (GCV) for all the characters.

The phenotypic coefficient of variation ranged between 4.75% (days to 50% flowering) to 45.62 % (seed yield per plant) (Table:1). The highest phenotypic coefficient of variations was recorded in seed yield per plant (45.60%), number of secondary branches per plant (17.26%) and number of primary branches per plant (15.12%) while it was lowest for days to 50% flowering (4.47%). Genotypic coefficient of variation of fennel genotypes varied from 4.18% (days to 50% flowering) to 43.70 % (seed yield per plant). The highest GCV was found in seed yield per plant (43.70%), number of secondary branches per plant (16.37%) and number of primary branches per plant (13.62%), however it was noticed low for days to 50% flowering (4.18%). The highest heritability was observed for seed yield per plant (91.77%), number of umbelles per plant (91.50%) and number of secondary branches per plant (90.01%), however it was lowest for test weight (70.85%). Plant height (24.02), days to 50% flowering (8.61) and days to first flowering (8.48) exhibited highest genetic advance as percentage of mean. The correlation coefficients were calculated at phenotypic and genotypic basis to assess the specific role of each character in determining yield. The seed yield per plant had significant and positive correlation with number of number of secondary branches per plant (0.877), plant height (0.837), number of umbellates per umbel (0.534) (Abhay and Sastry (2011) and test weight (0.465), while it was also found significant but negative correlated with days to 50% flowering (-0.410) and number of umbels per plant (-0.305). The results are in conformity with the findings of Lal (2007); Meena *et al.,* (2010); Dashora and Sastry (2011) and Meena *et al.,* (2013). Plant height was found significant correlated with seed yield per plant (0.837), number of secondary branches per plant (0.851), number of umbellates per umbel (0.559) and test weight (0.413), while it was also found significant but negative correlated with days to 50% flowering (-0.425).

Table.1 Estimates of genetic parameters of variations for various characters in Fennel

Characters	Grand Mean	Range		Coefficient of variations		Heritability % (BS)	Genetic Advance	GA as % of mean
		Min.	Max.	Phenotypic	Genotypic			
Plant height (cm)	166.03	141.45	182.68	8.38	7.67	83.80	24.02	14.47
No. of primary branches plant^{-1}	6.74	5.31	8.54	15.12	13.62	81.09	1.70	25.24
No. of secondary branches plant^{-1}	17.12	10.68	21.32	17.26	16.37	90.01	5.48	32.01
Days to 1st flowering	90.16	82.67	97.67	5.60	5.06	81.53	8.48	9.41
Days to 50% flowering	113.31	105.67	121.67	4.74	4.18	77.88	8.61	7.60
No. of umbels plant^{-1}	14.72	12.45	17.45	12.45	11.91	91.50	3.45	23.47
Number of umbellate umbel^{-1}	20.10	15.46	25.43	14.82	12.72	73.62	4.52	22.48
Test weight (g)	5.22	4.40	6.01	9.86	8.30	70.85	0.75	14.39
Seed yield plant^{-1}	6.08	2.54	10.73	45.62	43.70	91.77	5.24	86.19

Table.2 Estimates of genotypic and phenotypic correlation coefficients among seed yield and its attributing traits in Fennel

Characters		No. of primary branches plant^{-1}	No. of secondary branches plant^{-1}	Days to 1st flowering	Days to 50% flowering	No. of umbels plant^{-1}	Number of umbellate umbel^{-1}	Test weight (g)	Seed yield plant^{-1}
Plant height (cm)	G	-0.045	0.898	-0.107	-0.513	-0.234	0.627	0.771	0.997
	P	0.044	0.851**	-0.105	-0.425**	-0.213	0.559**	0.413**	0.837**
No. of primary branches plant^{-1}	G		0.115	0.320	0.078	-0.060	0.051	0.063	0.073
	P		0.067	0.222	-0.069	-0.046	0.095	0.067	0.041
No. of secondary branches plant^{-1}	G			-0.089	-0.518	-0.254	0.572	0.476	0.964
	P			-0.043	-0.430**	-0.206	0.489**	0.319*	0.877**
Days to 1st flowering	G				0.651	0.351	-0.042	-0.085	-0.049
	P				0.517**	0.323*	-0.101	-0.064	-0.021
Days to 50% flowering	G					0.698	-0.583	-0.565	-0.532
	P					0.543**	-0.446**	-0.458**	-0.410**
No. of umbels plant^{-1}	G						-0.289	-0.282	-0.319
	P						-0.233	-0.261	-0.305*
Number of umbellate umbel^{-1}	G							0.597	0.634
	P							0.403**	0.534**
Test weight (g)	G								0.573
	P								0.465**

Significant at 5% level = * Significant at 1% level = **

Table.3 Genotypic and phenotypic path coefficients showing direct and indirect effects of different characters on seed yield plant^{-1} (g) in Fennel

Characters		Plant height (cm)	No. of primary branches plant^{-1}	No. of secondary branches plant^{-1}	Days to 1st flowering	Days to 50% flowering	No. of umbels plant^{-1}	Number of umbellate umbel^{-1}	Test weight (g)	Seed yield plant^{-1}
Plant height (cm)	G	**-2.050**	0.017	2.335	0.064	-0.798	0.127	0.207	1.095	0.997
	P	**0.224**	-0.002	0.534	-0.004	-0.048	0.031	0.033	0.069	0.837**
No. of primary branches plant^{-1}	G	0.093	**-0.385**	0.298	-0.193	0.121	0.033	0.017	0.090	0.073
	P	0.010	**-0.036**	0.042	0.010	-0.008	0.007	0.006	0.011	0.041
No. of secondary branches plant^{-1}	G	-1.841	-0.044	**2.600**	0.053	-0.806	0.137	0.189	0.676	0.964
	P	0.190	-0.002	**0.628**	-0.002	-0.049	0.030	0.029	0.054	0.877**
Days to 1st flowering	G	0.219	-0.124	-0.231	**-0.601**	1.014	-0.190	-0.014	-0.121	-0.049
	P	-0.023	-0.008	-0.027	**0.043**	0.059	-0.048	-0.006	-0.011	-0.021
Days to 50% flowering	G	1.051	-0.030	-1.345	-0.391	**1.558**	-0.378	-0.193	-0.803	-0.532
	P	-0.095	0.002	-0.270	0.022	**0.114**	-0.080	-0.026	-0.077	-0.410**
No. of umbels plant^{-1}	G	0.480	0.023	-0.660	-0.211	1.087	**-0.542**	-0.095	-0.401	-0.319
	P	-0.048	0.002	-0.129	0.014	0.062	**-0.148**	-0.014	-0.044	-0.305*
No. of umbellate umbel^{-1}	G	-1.285	-0.020	1.487	0.025	-0.908	0.156	0.331	0.848	0.634
	P	0.125	-0.003	0.307	-0.004	-0.051	0.034	0.058	0.068	0.534**
Test weight (g)	G	-1.581	-0.024	1.237	0.051	-0.881	0.153	0.197	1.420	0.573
	P	0.092	-0.002	0.200	-0.003	-0.052	0.039	0.024	0.168	0.465**

Residual effect Genotypic = 0.4092 Residual effect Phenotypic = 0.3963

Number of number of primary branches per plant had non-significant positive correlation with days to first flowering (0.222). Number of number of secondary branches per plant was found significant and positive correlation with seed yield per plant (0.877), number of umbellates per umbel (0.489) and test weight (0.319). Similar result correlated with Rohit *et al.,* (2017), while it was also found significant but negative correlation with days to 50% flowering (-0.430). Days to first flowering had significant and positive correlation with days to 50% flowering (0.517) and number of umbels per plant (0.323). Days to 50% flowering was found positive correlation with number of umbels per plant (0.543), while it was significant but negative correlation with number of umbellates per umbel (-0.446) and test weight (-0.458). Number of umbels per plant had also recorded significant but negative correlated with seed yield per plant (-0.305). Number of umbellates per umbel was found significant and positively correlated with seed yield per plant (0.534) and test weight (0.403).Test weight was recorded significant and positively correlated with seed yield per plant (0.465).

Path coefficient analysis based on genotypic correlation coefficient was also carried out and following Fisher and Yates (1963). The results indicated that number of secondary branches per plant (2.600), days to 50% flowering (1.558), test weight (1.420) (Abhay Dashora, 2011) and number of umbellates per umbel (0.331) had direct effect on seed yield per plant. This finding is correlated with Agnihotri *et al.,* (1995). The direct effect of plant height (-0.2.050), number of primary branches per plant (-0.385), days to first flowering (-0.601) and number of umbels per plant (-0.542) was negative.

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