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Original Research Article

Correlation and Path Analysis in Fennel (*Foeniculum vulgare* Mill.) in Normal and Drought Condition

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A B S T R A C T

To know the correlation coefficient and path analysis at phenotypic level in fennel (*Foeniculum vulgare* Mill.), a study were undertaken at SKN College of Agriculture, Jobner (Rajasthan) in RBD design with three replication in two environment condition (Normal and drought condition) created by withholding irrigation and irrigation when required, respectively. Analysis of variance was worked out and it was recorded that yield and it's all contributing characters understudy were found significant. Results, Seed yield per plant was significantly and positively correlated with umbels per plant (557*), seeds per umbles (471*) and plant height (431*) in normal environment. In drought environment Seed yield per plant was significantly and positively correlated with umbels per plant (638*), seeds per umbel (595**), test weight (556**) and branches per plant (449*). Path coefficient analysis exhibit umbels per plant (0.532) followed by seed per umbel (0.424) had highest positive direct effect on fennel seed yield in normal environment. In drought environment umbels per plant (0.532) and test weight (0.444) had highest positive direct effect on seed yield per plant. Along with seed yield, characters seed per umbel, umbels per plant and test weight are important contribution in selection parameters in fennel improvement.

Keywords

Environment, characters, Yield, Correlation and path

Introduction

The Spices and Condiments are natural plant or vegetable products or mixtures generally used as whole or grounded products, mainly used for flavor, aroma and pungency of food. Fennel (*Foeniculum vulgare* Mill. 2n = 22) is an allogamous used and belongs to family Apiaceae with (82.2 to 95.4%) cross-pollination (Ramanujan *et al.,* 1964) & native of Europe and Mediterranean region (Agrawal *et al.,* 2001). Fennel crop require cool and dry climate and is cultivated easily in all types of soil. Fennel fruits/seeds are generally used in diseases like bile disturbances, cholera, constipation, nervous disorders, dysentery and diarrhea and also used for control of diseases attacking chest, spleen, lungs, kidney and in colic pain. The seeds contain about 9.5% protein, 10.0% fat, 42.3% carbohydrates, 18.5% crude fiber and 13.4% minerals In India the seeds are also used for mastication and chewing either alone or with betel leaves (Girija Lakshman, 1952). Total area under the crop in India is about

0.89 lakh hectare with production of 1.48 lakh tones (Spice Board India, 2017-18). Rajasthan and Gujarat contributes about 80% of the total production of India in arid to semi-arid region and called "Seed Spices Bowl". In Rajasthan, it occupies an area of 0.45 lakh hectare with an annual production of 0.56 lakh tones. (Anonymous, 2017-2018). It is mainly cultivated in the districts of Sirohi, Jodhpur, Nagour, Tonk, Dausa and Pali and to a limited extent in Bharatpur, Kota and Ajmer. As yield is influenced by many factors selection based on simple correlation without taking into consideration the interaction between the different component characters can be misleading. Determination of correlation and path coefficient between yield and yield criteria is important for the selection of favourable plant types for effective plant breeding programmes. Hence, path analysis was done to determine the amount of direct and indirect effect of the causal components on the effective component, to study correlation and path analysis for yield and yield related traits which will help in isolating promising lines for hybridization programme and to explore high yield potential (Denton and Nwangburuka, 2011) [4]. Correlation studies provide knowledge on contribution of various traits on yield (Allard, 1960) whereas; it does not provide the relation among cause and effect.

Materials and Methods

A field experiment was carried out at Agronomy Research farm of S.K.N. College of Agriculture, Jobner during *rabi* season 2019-20, to investigate "correlation and path analysis in Fennel (*Foeniculum vulgare* Mill.) in Normal (E1) and drought environment (E2) condition . The experiment was conducted on eight genotypes (Two drought tolerant and six drought susceptible) namely RF-101, RF-125, RF-143, RF-178, RF-205, RF- 145, RF-281 and RF-157 in randomized block design with three replications for days to 50 per cent flowering, plant height (cm), branches per plant, umbels per plant, Umbellettes per umbel, Seeds per umbel, , days to maturity, test weight (g) and Seed yield per plant (g). Drought condition were created by withholding irrigation and for normal conditions the experimental plots were irrigated as and when required. Analysis of variance will be carried out by using standard statistical methods (Panse and Sukhatme, 1985). The phenotypic correlation coefficients were computed using phenotypic variances and covariance (Hanson *et al.*, 1956). The path coefficient analysis was done according to the method suggested by Dewey and Lu (1959).

Results and Discussion

Analysis of variance (Table 1) indicated significant differences between the genotypes and non-significant difference between the replications. Mean squares due to genotypes were found to be significant for all the traits except test weight (g) in normal environment and days to 50 % per cent flowering in drought environment. This indicated inherent differences among the genotypes for each of the trait. Replications mean SS was found to be non-significant in each of the environment. This indicated field selected for experiments was homogenous. Thus, analysis of variance indicated that considerable amount of genetic variability was present in the experimental material which can be exploited for improvement of seed yield in fennel.

Phenotypic correlation

The values of all possible correlation coefficients among various characters at phenotypic were calculated under normal and drought conditions and are presented in Table 2.

Table.1 Anova for yield and its contributing characters of fennel in normal environment

	D.f	Environment	Days to 50 per cent flowering	Plant height (cm)	Branches per plant	Umbels per plant	Umbellettes per umbel	Seeds per umbel	Days to maturity	Test weight (g)	Seed yield per plant (g)
Replication	2	E1	7.041	54.77	0.22	1.39	8.07	1103.39	22.16	0.37	1.79
		E2	67.79	233.33	0.039	0.92	9.29	885.59	32.29	0.14	3.67
Treatment	7	E1	63.61**	575.56*	1.24*	3.60*	54.69**	34999.49*	83.69*	1.17	11.36**
		E2	94.04	279.38**	1.68**	10.37**	33.73**	28332.89**	170.64**	1.42**	35.38**
Error	14	E1	10.13	152.33	0.37	1.20	7.22	962.23	23.98	0.33	2.49
		E2	28.77	54.38	0.27	1.93	4.66	2823.21	26.62	0.30	4.36

*Significant at 5% probability level **Significant at 1% probability level

Table.2 Phenotypic Correlation coefficient among yield and its contributing characters of fennel in both environments

Characters	**Environment**	Days to 50 per cent flowering	Plant height (cm)	Branches per plant	Umbels per plant	Umbellettes per umbel	Seeds per umbel	Days to maturity	Test weight (g)	Seed yield per plant (g)
Days to 50 per cent flowering	E1	1	0.583**	0.324NS	-0.344NS	0.124NS	-0.249NS	-0.304NS	0.251NS	-0.474*
	E2	1	0.161NS	0.001NS	0.034NS	0.119NS	-0.181NS	-0.295NS	0.042NS	0.090NS
Plant height (cm)	E1		1	0.016NS	-0.489*	-0.115NS	-0.338NS	-0.036NS	-0.069NS	0.431*
	E2		1	-0.147NS	-0.070NS	0.371NS	0.008NS	-0.285NS	0.019NS	0.118NS
Branches per plant	E1			1	0.234NS	0.065NS	0.334NS	0.109NS	0.413*	0.028NS
	E2			1	0.414*	0.201NS	0.465*	0.028NS	0.454*	0.499*
Umbels per plant	E1				1	0.314NS	0.528**	0.312NS	0.208NS	0.577**
	E2				1	0.277NS	0.556**	0.104NS	0.119NS	0.638**
Umbellettes per umbel	E1					1	0.478*	-0.141NS	0.376NS	0.138NS
	E2					1	0.295NS	0.296NS	0.305NS	0.381NS
Seeds per umbel	E1						1	0.350NS	-0.011NS	0.471*
	E2						1	0.042NS	0.519**	0.595**
Days to maturity	E1							1	-0.167NS	0.009NS
	E2							1	0.020NS	0.126NS
Test weight (g)	E1								1	-0.056NS
	E2								1	0.566**

Table.3 Path coefficient of the phenotypic traits on seed yield per plant of fennel in both environments

Characters	Environment	Days to 50 per cent flowering	Plant height (cm)	Branches per plant	Umbels per plant	Umbellettes per umbel	Seeds per umbel	Days to maturity	Test weight (g)	Seed yield per plant (g)
Days to 50 percent flowering	E1	-0.341	0.070	-0.016	-0.177	-0.027	-0.106	0.131	-0.009	-0.474*
	E2	0.087	0.036	0.000	0.018	-0.010	-0.010	-0.051	0.019	0.090NS
Plant height (cm)	E1	-0.198	0.121	-0.001	-0.252	0.025	-0.143	0.016	0.002	0.431*
	E2	0.014	0.226	-0.014	-0.037	-0.031	0.000	-0.049	0.009	0.118NS
Branches per plant	E1	-0.110	0.002	-0.050	0.121	-0.014	0.142	-0.047	-0.014	0.028NS
	E2	0.000	-0.033	0.097	0.220	-0.017	0.026	0.005	0.201	0.499*
Umbels per plant	E1	0.117	-0.059	-0.012	0.515	-0.067	0.224	-0.134	-0.007	0.577**
	E2	0.003	-0.016	0.040	0.532	-0.023	0.031	0.018	0.053	0.638**
Umbellettes per umbel	E1	-0.042	-0.014	-0.003	0.162	-0.215	0.203	0.061	-0.013	0.138NS
	E2	0.010	0.084	0.020	0.147	-0.082	0.016	0.051	0.135	0.381NS
Seeds per umbel	E1	0.085	-0.041	-0.017	0.272	-0.103	0.424	-0.151	0.000	0.471*
	E2	-0.016	0.002	0.045	0.296	-0.024	0.055	0.007	0.230	0.595**
Days to maturity	E1	0.103	-0.004	-0.005	0.161	0.030	0.149	-0.430	0.006	0.009NS
	E2	-0.026	-0.065	0.003	0.055	-0.024	0.002	0.172	0.009	0.126NS
Test weight (g)	E1	-0.086	-0.008	-0.021	0.107	-0.081	-0.005	0.072	-0.035	-0.056NS
	E2	0.004	0.004	0.044	0.063	-0.025	0.029	0.003	0.444	0.566**

Success of any breeding programme depends upon the efficiency of the selection. Selection cannot be applied on the basis of single character because most of the characters are polygenic in nature and are influenced by each other.

Normal environment

To know the extent of relationship between yield and its various components, it is important for the plant breeder to select plants which consists of desirable characteristics. Seed yield per plant show positive and significant phenotypic correlated with plant height (431*), umbels per plant (557**) and seeds per umbel (471*), negative and positive significant correlated with days to 50 % flowering (-474*) and remaining characters show non-significant correlation in normal environment. In drought environment seed yield per plant show positive and significant phenotypic correlation with umbles per plant (638**), seeds per umbel (595**), test weight (556**) and branches per plant (499*). Yield attributing characters show positive and significant phenotypic correlation like days to 50% floweing with plant height (583*), branches per plant with test weight (413*), umbels per plant with seed per umbel (528*) and Umbellettes per umbel with seeds per umbel (478*) in normal environment. In drought environment, yield attributing characters show positive and significant phenotypic correlation like branches per plant with umbels per plant (414*), seeds per umbels (465*) and test weight 454*), seeds per umbels with test weight (519**). Out of both environment only a yield attributing characters plant height with umbles per plant (-489*) show Negative and significant phenotypic correlation in normal environment. Similar results were found in the findings of Agnihotri *et al.,* (1997), Lal (2007), Meena *et al.,* (2010), Dashora and Sastry (2011), Ali *et al.,* (1993) and Yogi *et al.,* (2013).

Path analysis

Path coefficient analysis helps in separating the direct effect of a component character on yield from indirect effect via other characters. The phenotypic correlation coefficients of seed yield with its contributing characters were partitioned into direct and indirect effect through path coefficient analysis. The maximum positive direct effect was observed for umbels per plant(0.515) followed by seeds per umbels (0.424) and plant height(0. 121), negative direct effect was observed days to maturity (-0.430) followed by days to 50% flowering (-0.341) in normal environment. In drought environment maximum positive direct effect was observed for umbels per plant (0.532) followed by test weight (0.444) and plant height (0.226). In normal environment days to 50 % flowering had high positive and negative indirect effect with days to maturity (0.177) and umbels per plant (-0.133), respectively. Plant height had negatively indirect effect with umbels per plant and seeds per umbel. Seeds per umbel had negatively indirect effect with days to maturity. Similar result found by Bhandari and Gupta (1997), Vijayalatha and Chezhiyan (2004), and Patel and Patel (2015).

In conclusion, eight verities selected for this experiment was found significantly variable in all characters which were consider. Characters like seeds per umbel, umbel per plant, test weight and branches per plant can be simultaneously improvement with seed yield per plant because they have significantly and positively correlated with seed yield per plant.

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