Correlation coefficient along with direct & indirect analysis for important economic traits and yield in fennel (*Foeniculum vulgare* Mill.)

ABSTRACT

The experiment was carried out during *Rabi* season of the year 2020-2021 at Main Experiment Station Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) India. The study was undertaken on 75 genotypes & three checks in Augmented Block Design. The study revealed that seed yield per plant showed highly and positively significant correlation with days to maturity (0.289**) although there was no highly and negative correlation found for other traits. Whereas Test weight with nodes per plant (0.389**), Plant height with Number of branches per plant (0.341**), Umbel diameter with days to 50% flowering (0.311**) & Number of umbel per plant with days to 50% flowering (0.318**) showed highly and positively significant correlation with each other. While significant positive correlation was also shown for Number of umbellate per umbel (0.207**) with seed yield per plant and test weight with umbel diameter (0.233*) followed by inter nodal length (0.216*). Whereas Umbel diameter with number of umbels per plant (0.272*), Number of fruit per umbel with number of branches per plant (0.233*) also shown significant positive correlation. Plant height showed significant correlation with fruit per umbellate (0.276*) followed by number of umbellate per (0.257*). Path coefficient analysis indicated that the highest positive direct effect at phenotypic level was found on days to maturity (0.2956) followed by number of umbellate per umbel (0.1637), plant height (0.15972), nodes per plant (0.1062), number of umbels per plant (0.0232), 1000-seed weight (0.0549), number of branches per plant (0.0011) and days to 50% flowering (0.2960). While negative direct effect at phenotypic level was found on inter nodal length (-0.1400) followed by umbel diameter (-0.1731) and number of fruit per umbellate (-0.2171). This show the contributing characters among the genotypes that have been assessed; these genotypes will be enhanced through breeding & selection programs for both yield and its contributing features.

Key Word: Correlation, Path coefficient, Augmented Block Design, Fennel

Introduction

Fennel (*Foeniculum vulgare* Mill.) is an important seed spice crop belonging to the family Umbelliferae (Apiaceae). It is a cross-pollinated, diploid species with a chromosome number of 2n = 2x = 22. The crop originates from Europe and the Mediterranean region. Fennel is an annual, aromatic herb that grows to a height of 100–180 cm, characterized by slender, branched, and smooth stems that become hollow at maturity with distinct veins. The inflorescence is terminally borne and consists of numerous compound umbels. The flowers are small, bright yellow, and grow in flat-topped clusters. Fully grown fruits are schizocarps, measuring 4–8 mm in length, and split into multiple segments. The size and color of the fruits vary depending on market demand and the timing of harvest. In India, fennel seeds are commonly used for mastication and are often chewed alone or with betel leaves.

The correlation coefficient is considered significant only when the observed values exceed the estimated values. Understanding the correlation between yield-contributing traits is crucial for improving crop yield. Studying correlation provides insights into the magnitude and direction of the association between yield and its components, as well as the interrelationships among these components. Path analysis, based on partial regression coefficients, quantifies both direct and indirect effects of one variable on another. It helps identify the underlying causes of associations between two variables, offering a deeper understanding of their relationships. The study of various traits and their interrelationships is a vital approach to overcoming genetic barriers to yield improvement. Correlation analysis helps identify the components of complex traits, such as yield. Path coefficient analysis further enhances this understanding by partitioning the correlation coefficients into direct and indirect effects of independent variables on dependent variables. This information is invaluable for breeders in selecting high-yielding genotypes across crops. This research investigates the significance of both direct and indirect influences of component traits on seed yield and identifies key quality traits to be prioritized in fennel improvement programs.

Method & Material

This experiment was conducted at the Main Experiment Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.), India, during the Rabi season of 2020–2021, using an Augmented Block Design.The experiment included 78 genotypes along with checks and was conducted at a location situated between 26.560° N latitude and 81.84° E longitude, at an altitude of 98 meters above mean sea level. The site is located in the Gangetic Alluvial Plains of Eastern Uttar Pradesh, within the Ayodhya district. The weather during the crop season is typically normal and favorable, promoting optimal growth and development of the crops. The seedlings were transplanted at a spacing of 60 × 40 cm. Five plants were randomly selected from each plot for observation. Observations were recorded for twelve traits, including plant height (cm), number of primary branches per plant, number of nodes per plant, days to maturity, inter nodal length (cm), days to 50% flowering, number of umbels per plant, number of umbellate per umbel, number of seeds per umbellate, umbel diameter (cm), 1000-seed weight (g), and seed yield per plant (g). The analysis of variance among genotypes was conducted following the method suggested by Federer (1956). The genotypic and phenotypic correlation coefficients were calculated using the method described by Searle (1961). Path analysis based on genotypic correlations was performed according to the approach outlined by Dewey and Lu (1959).

Result

Polygenic traits, such as yield, are controlled by multiple genes and closely associated with various contributing characters. These traits offer valuable insights into the interrelationships among different characters and their impact on yield. Furthermore, they provide a comprehensive overview of high-yielding genotypes, which can guide hybridization programs. Assessment of only phenotypic correlation coefficient is not provide complete information between traits, because this is outcome of genotypes & environment interaction. The true association can only assess through genotypic correlation, which eliminates the environmental effect. The seed yield per plant showed highly and positive significant correlation with days to maturity (0.289**) although there was no highly and negative correlation found. Number of umbellate per umbel (0.207**) showed significant positive correlation with seed yield per plant. 1000 seed weight had showed high and positive significant correlation with nodes per plant (0.389**) and there was no significant negative association with any characters. While test weight showed significant and positive relation with umbel diameter (0.233*) followed by inter nodal length (0.216*) and no significant negative correlation with any genotype. Days to maturity have no high significant positive and negative correlation with any traits and also have no significant positive and negative correlation to other characters. Nodes per plant showed significant positive association intermodal length (0.288*). There are no significant negative correlation with other traits. Plant height was highly significant and positive correlated with number of branches per plant (0.341**) but not show highly significant and negative correlation to any characters. Plant height show significant correlation with number of fruit per umbellate (0.276*) and followed by number of umbellate per (0.257*). Umbel diameter had high significant positive association with days to 50% flowering (0.311**) and significant positive correlation with number of umbels per plant (0.272*) but negatively correlated with number of umbellate per umbel (- 0.079) followed by number of branches per plant (-0.159). Number of fruit per umbel was showed significant and positive correlation with number of branches per plant (0.233*) and negatively correlated with inter nodal length (-0.021). Number of umbellate per umbel had not correlated with any traits and negatively correlated with (-0.034) of umbels per plant. Number of umbel per plant showed highly significant and positive correlation with days to 50% flowering (0.318**) and negatively correlated with inter nodal length (- .024). Inter nodal length was not correlated with other traits and showed negative correlated to number of branches per plant (-.098). Number of branches per plant had not correlated to any traits but negatively correlated to days to 50% flowering (- 0.006).Similar finding were also reported by Kumar *et al.* (2017) and Sharma *et al*. (2015)

Path coefficient analysis

Path coefficient analysis was performed using simple correlations among 12 traits to determine the direct and indirect effects of these traits on seed yield per plant. Correlation studies provided information on the mutual associations among traits, while path coefficient analysis revealed the magnitude of both direct and indirect contributions of each trait to dependent variables such as seed yield. The highest positive direct effect at phenotypic level on days to maturity (0.2956) followed by number of umbellate per umbel (0.1637), plant height (0.1597), nodes per plant (0.1062), number of umbels per plant (0.0232), 1000-seed weight (0.0549), number of branches per plant (0.0011), days to 50% flowering. While negative direct effect at phenotypic level on inter nodal length (-0.1400) followed by umbel diameter (-0.1731), number of fruit per umbellate (-0.2171). Days to 50% flowering (0.2960) followed by number of umbellate per umbel (0.0268) exerted high order of positive indirect effect on seed yield per plant via days to maturity. In case of indirect positive effect towards seed yield per plant indicated that days to 50% flowering (0.1640) followed by plant height via Number of umbellate per umbel. Days to 50% flowering (0.1600) followed by number of branches per plant (0.0544) exerted high order of positive indirect effect on seed yield per plant via plant height. Days to 50% flowering (0.1060) followed

by test weight (0.0413) exerted high order of positive indirect effect on seed yield per plant via nodes per plant. Days to 50% flowering (0.0550) followed by nodes per plant (0.0213) exerted high order of positive indirect effect on seed yield per plant via test weight.

Table 1: Estimates of phenotypic correlation coefficient between eleven characters in fennel genotypes

Characters	Days to 50% flowering	No. of branches per plant	Inter nodal length	umbels per plant	No. of umbellate per umbel	No. of seed per umbellate	Umbel diameter	Plant height	Nodes per plant	Days to maturity	1000- seed weight	Seed yield per plant
Days to 50% flowering	1.000	-0.006	0.052	0.318**	0.194	0.025	0.311**	0.118	0.003	0.108	0.082	0.029
No. of branches per plant		1.000	-0.098	0.096	0.003	0.233*	-0.159	0.341**	0.196	-0.031	-0.007	0.060
Inter nodal length			1.000	-0.024	0.125	-0.021	0.042	0.174	0.228*	-0.017	0.216*	-0.064
No. of umbels per plant				1.000	-0.034	0.048	0.272*	0.150	-0.005	0.081	0.159	0.020
No. of umbellate per umbel					1.000	0.152	-0.079	0.257*	0.080	0.091	0.078	0.207*
No. of seed per umbellate						1.000	0.052	0.276*	0.043	0.052	0.032	-0.131
Umbel diameter							1.000	0.147	0.019	-0.022	0.223*	-0.166
Plant height								1.000	-0.079	-0.109	-0.007	0.055
Nodes per plant									1.000	0.022	0.389**	0.090
Days to maturity										1.000	0.098	0.298**
1000- seed weight											1.000	0.065

Table 2: Direct and indirect effects of different characters on seed yield per plant at phenotypic level in fennel genotypes

Characters	Days to 50% flowering	No. of branches per plant	Inter nodal length	No. of umbels per plant	No. of umbellate per umbel	No. of seed per umbellate	Umbel diameter	Plant height	Nodes per plant	Days to maturity	1000- seed weight	Correlation with seed yield per plant
Days to 50% flowering	**0.0010**	0.0010	-0.1400	0.0230	0.1640	-0.2170	-0.1730	0.1600	0.1060	0.2960	0.0550	0.029
Number of branches per plant	0.0000	**0.0011**	0.01368	0.00224	0.00049	-0.0505	0.02759	0.05445	0.02087	-0.0093	-0.0004	0.060
Inter nodal length	0.00003	-0.0001	**-0.1400**	-0.0006	0.0204	0.00458	-0.0073	0.02785	0.02427	-0.0050	0.01183	-0.064
No. of umbels per plant	0.00017	0.0001	0.00335	**0.02321**	-0.0055	-0.0104	-0.047	0.02396	-0.0006	0.02384	0.00874	0.020
Number of umbellate per umbel	0.0001	0.0001	-0.0174	-0.0008	**0.16371**	-0.033	0.01368	0.04105	0.00847	0.02688	0.00429	0.207*
No. of seed per umbellate	0.00001	0.0002	0.00295	0.00111	0.02485	**-0.2171**	-0.0090	0.04409	0.00456	0.01549	0.00176	-0.131
Umbel diameter	0.00017	-0.0002	-0.0059	0.00631	-0.0129	-0.0112	**-0.1731**	0.02353	0.00197	-0.0065	0.01227	-0.166
Plant height	0.00006	0.00038	-0.0244	0.00348	0.04207	-0.0599	-0.0255	**0.15972**	-0.0084	-0.0323	-0.0004	0.055
Nodes per plant	0.0000	0.0002	-0.0320	-0.0001	0.01304	-0.0093	-0.0032	-0.0126	**0.10629**	0.00664	0.02135	0.090
Days to maturity	0.00006	-0.0003	0.00235	0.00187	0.01488	-0.0114	0.00383	-0.0174	0.00239	**0.29569**	0.0054	0.298**
1000- seed weight	0.00004	-0.0001	-0.0302	0.0037	0.01278	-0.007	-0.0387	-0.0011	0.04133	0.0291	**0.0549**	0.065

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