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Studies on Genetic Variability, Heritability and Genetic Advance in Fennel (*Foeniculum vulgare* Mill.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was carried out with a view to study the extent of variability, heritability in broad sense, genetic advance in per cent of mean in fennel during *Rabi* season 2018-19 in Augmented Block Design. Plant spacing of 60cm x 40cm and each genotypes were grown in the plot size of 2.0 m x 1.2 m. The observations were recorded on ten characters. In Analysis of variance, the variances due to checks and genotypes were highly significant for all the characters, while, the variance due to blocks were significant for days to 50%flowering, number of umbels per plant and number of umbellets per umbel. Based on mean performance NDF-1, NDF-2, NDF-58, NDF-59, NDF-55, NDF-60 and NDF-76 were observed as significant and most promising genotypes for seed yield per plant and its component traits. The estimates of phenotypic coefficients of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all traits. High magnitudes of variability PCV and GCV were observed in case of seed yield per plant (37.12, 36.95) followed by number of umbels per plant (30.89, 29.78), number of branches per plant (28.25, 22.92), weight of grains per umbel (26.02, 24.01) and number of umbellets per umbel (21.29,19.80). High heritability was observed for all the characters except number of branches per plant (65.83%) having moderate heritability. While, high genetic advance in per cent of mean was estimated for seed yield per plant (75.76) followed by number of umbels per plant (59.13). The high heritability coupled with high genetic advance in per cent of mean was estimated for maximum characters which indicated opportunity for selection response.

Keywords: Genetic variability; GCV; PCV; heritability (h2); genetic advance.

1. INTRODUCTION

"Historically", India has always been recognized as a Home of Spices. Fennel (*Foeniculum vulgare* Mill., 2n=2x=22) is most emerging and medicinal seed spices crops which belong to family Apiaceae (Umbelliferae). It is native of Southern Europe and Mediterranean region where it has been grown since ancient times. Seed spices "High value low volume crops" are the most remunerative commodities of arid and semi- arid regions of India. Spices have a characteristics aroma and taste and they are widely used to season and flavour various food preparations, and as well as in the medicine, pharmaceuticals, perfumery, cosmetics and several other industries. Fennel is a cool season crops, with dry and cool weather favouring high seed production. In India, present area under fennel cultivation is greatly increases from previous years with offering 90 thousand hectares with 157 thousand MT and productivity 1.575 MT/ha" (Anonymous, 2018).

"Genetic variability forms the basis for crop improvement. Selection and hybridization approaches are easily followed in bringing about the quantitative improvement in order to bring about the desired improvement. Knowledge of heritability is essential for selection based improvement as it indicates the extent of transmissibility of character into future generation.

2. MATERIALS AND METHODS

The experiment was conducted at Main Experiment Station, Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) India in well leveled field having proper drainage facilities. Geographically, Narendra Nagar is located in between 24.47^0 and 26.56^0 N latitude and 82.12^0 and 83.98^0 E longitude at an altitude of 113 m above the mean sea level in the Gangetic Alluvial Plains of Eastern Uttar Pradesh of Ayodhya district. The mechanical composition of soil was 60.9 per cent sand, 27.8 per cent silt and 11.3 per cent clay with soil pH 8.5. The annual rainfall was received about 1200 mm.

To evaluate the performance of 94 fennel genotypes, including four checks, the experiment was carried out in Augmented Block Design with three replications. The crop was spaced 40 cm apart from 60 cm. In the winter of 2019, the experiment was planted. To improve the crop stand, all suggested agronomic techniques and plant protection measures were implemented. 80:40:40 (NPK kg/ha) and 10 tons FYM of fertilizer were applied. Plant protection measures were followed and the subsequent irrigation was

given as required. The observations were recorded for 10 different characters viz., days to 50% flowering, plant height (cm), days to maturity, primary branches per plant, number of umbels per plant, number of umbellets per umbel, number of grains per umbellate, weight of grains per umbels (g), 1000-seed weight (g) and seed yield per plant (g).

The observed data were subjected to analysis of variance, genetic variability for different parameters, heritability and expected genetic advance as per the procedure suggested by Federer, (1956), Burton and De Vane (1953) and Hanson (1963), respectively.

3. RESULTS AND DISCUSSION

The analysis of variance are presented in Table 1 and revealed that the variances due to checks were highly significant for all the characters, while, the variance due to blocks were significant for days to 50% flowering, number of umbels per plant and number of umbellets per umbel. The variability among the genotypes considered in this study due to

Table 1. Analysis of variance for ten characters in fennel genotypes

Characters	Source of variation					
	Block	Treatment	Check	Genotypes	Check vs. Genotypes	Error
	(b-1)	(c+g)-1	(c-1)	(g-1)		(b-1)(c-1)
d. f	5	93	3	89	1	15
Days to 50% flowering	481.81 **	1.94 **	1.94 **	26.28 **	13.54 **	0.18
Days to maturity	451.22 **	0.91 *	0.21	21.52 **	0.4	0.34
Plant height (cm)	342.05 **	145.47 **	22.2	168.02 **	74.72 *	10.37
Number of branches per plant	4.68 **	0.94 *	0.34	1.11 **	1.93 *	0.33
Number of umbels per plant	674.77 **	83.8 **	25.19 *	117.26 **	0.11	6.94
Number of umbellets per umbel	53.22 **	19.42 **	35.37 **	21.63 **	0.25	2.46
Number of grains per umbel	27 **	21.04 **	1.2	22.63 **	59.77 **	1.61
Weight of grains per umbel (g)	0.97 **	0.3 **	0.01	0.34 **	0.71 **	0.04
1000-seed weight (g)	2.12 **	1.03 **	0.1	0.96 **	16.52 **	0.07
Seed yield per plant (g)	3019.54 **	583.61 **	7.48	686.42 **	7625.02 **	5.27

**- Significant at 5%, **- Significant at 1%*

Table 2. Estimates of range, grand mean, phenotypic (PCV) and genotypic (GCV) coefficient of variation, heritability in broad sense [$h^2_{(bs)}$%], genetic advance in per cent of mean ($\overline{Ga}$ %) for ten characters in fennel genotypes

Sl. No.	Character	Grand Mean ($\overline{x}$)	Range		PCV (%)	GCV (%)	Heritability broad sense [h^2%]	Genetic advance in per cent of mean ($\overline{Ga}$ %)
			Min.	Max.				
1	Days to 50% flowering	99.78	94.59	103.72	4.666	4.647	99.19	9.53
2	Days to maturity	160.91	158.27	165.15	2.622	2.597	98.12	5.29
3	Plant height (cm)	101.65	84.16	142.73	11.643	11.204	92.61	22.21
4	Number of branches per plant	3.47	0.79	5.82	28.255	22.924	65.83	38.31
5	Number of umbels per plant	32.01	13.67	64.97	30.895	29.780	92.91	59.13
6	Number of umbellets per umbel	20.07	11.16	40.18	21.288	19.804	86.54	37.95
7	Number of grains per umbel	21.71	13.08	39.26	20.115	19.243	91.52	37.92
8	Weight of grains per umbel (g)	2.07	1.10	4.13	26.021	24.018	85.20	45.66
9	1000-seed weight (g)	5.90	3.68	9.08	15.060	14.409	91.54	28.39
10	Seed yield per plant (g)	63.27	17.74	149.00	37.122	36.949	99.07	75.76

diverse genetic makeup of the genotypes. Yogi et al. (2013), Meena and Dhakar (2017) and Kumar et al.(2017) suggested better scope for selection in the available germplasm of fennel.

In the Table 2, highest value of PCV and GCV were obtained for seed yield per plant, number of umbels per plant, number of branches per plant and weight of grains per umbel. While, the lowest value of PCV and GCV were observed for days to 50% flowering followed by days to maturity. Therefore, the characters with high PCV may improve through selection based on its phenotypic performance of the genotypes. Similar reports were also proposed by Meena and Dhakar (2017), Yadav et al. (2013) and Rawat et al. (2013) which observed "high PCV for number of umbels per plant, seed yield per plant and weight of grains per umbel. High GCV and PCV values facilitate many opportunities for improvement through selection and its differences reflects the effect of environment on the phenotypic expression".

The highest heritability was recorded for all the characters except number of branches per plant (65.83%) having moderate heritability. Patel et al. (2008), Rawat et al. (2013), Yadav et al. (2013) and Meena and Dhakar (2017) also found "high heritability estimates for most of the characters. Expected genetic advance in per cent of mean was high for all the traits except days to 50% flowering and days to maturity which have lower values of genetic advance". Yadav et al. (2013) also proposed same result as found in our experiment. The magnitude of high heritability coupled with high genetic advance were obtained for seed yield per plant (99.07, 75.76), number of umbels per plant (92.91, 59.13), plant height (92.61, 22.21), 1000-seed weight (91.54, 28.39), number of grains per umbel (91.52, 37.92), number of umbel per umbellets (86.54, 37.95) and weight of grains per umbel (85.20, 45.66) as same proposed by Kumar et al. (2017). It indicated that selection for these characters should be very effective to improvement of economic seed yield of fennel.

4. CONCLUSION

The analysis of variance due to checks were highly significant for all ten characters representing the variability among the genotypes considered in this study due to diverse genetic makeup of the genotypes. The selection of these characters may improve through selection based on their phenotypic performance. High heritability along with high expected genetic advance in per cent of mean will provide good scope for further improvement in advance generations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

There is no uses of generative AI technologies such as large models (Chat GPT, COPILOT etc.) and text-to image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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