



Reviewed By

Dr. Narendra Kumar
ICAR-Directorate of Groundnut
Research, Regional Research
Station, Bikaner, Rajasthan, India.
Email: narendrapb09@gmail.com

*Correspondence

I.S. Naruka
drisnaruka@yahoo.com

Received: 20 April 2022

Revision: 31 January 2024

Accepted: 14 February 2024

Citation

Chaya, Y.A., Meena, K.C., Soni, N., Naruka, I.S., Kachouli, B.K. and Singh, O.P. 2022. Effect of Organic Manure and Biofertilizers on Growth and Yield of Dill (*Anethum graveolens* L.). *Int J Seed Spices*.12 (1), 39-47

DOI

<https://doi.org/10.56093/IJSS.v12i1.4>

Affiliation

¹Department of Plantation, Spices, Medicinal and Aromatic Crops; College of Horticulture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Mandsaur - 458001 (M.P.)

²Department of Fruit Science; College of Horticulture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Mandsaur - 458001 (M.P.)

³Department of Plant Breeding and Genetics; College of Horticulture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Mandsaur - 458001 (M.P.), India

⁴Department of Plant Physiology; College of Horticulture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Mandsaur – 458001 (M.P.)

Studies on genetic variability, heritability and genetic advance in fenugreek (*Trigonella foenum-graecum* L.) germplasms grown under the Malwa region of Madhya Pradesh, India

Y.A.Chaya¹, K.C. Meena¹, Nitin Soni², I.S. Naruka^{*2}, B.K. Kachouli³ and O.P. Singh⁴

Abstract

An evaluation of eighteen germplasms was conducted in *Rabi* season 2020-21 using Randomized Block Design with three replications at Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (M.P.). The phenological characteristics of 18 germplasm showed that G₃ - MDF-2 took the least amount of time for 50 % flowering (45.33 days), 50 % pod setting (53.67) and days to maturity (116.00) as compared to other germplasm. However, G₁₃-Suraj had maximum plant height (10.34, 24.61, 49.99 and 92.18 cm) but G₁₀-Sehore-12 had highest fresh weight (2.27, 9.67, 29.09 and 52.45 g), dry weight (0.32, 3.32, 18.55 and 23.16 g), number of branches (4.33, 7.10, 10.80 and 14.57), leaf area (131.59, 572.17, 1629.65 and 711.84) and leaf area index (1.09, 3.54 and 3.9) at 30, 45, 60 DAS and at harvest respectively. Whereas, G₁₀-Sehore-12 had highest number of pods (34.57), number of seeds (22.20), pod length (12.07 cm), shelling % (72.63), seed yield (27.17) and harvest index (43.37). While, G₈-Sarayu had maximum test weight (17.47 g). The highest GCV(21.01) and PCV (30.29) were observed for leaf area. Although, the highest heritability was recorded in plant height (70.66) and test weight (64.55). The highest genetic advance was recorded in leaf area (139.15) and plant height (14.66). While the highest genetic advance as a percent of mean was observed in leaf area (30.03) and leaf area index (27.80). Out of eighteen studied germplasms, the highest yield was recorded in G₁₀-Sehore-12 followed by G₁₇-Shree and G₇-Lajwab.

Keywords : Genetic variability, heritability, fenugreek.

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) popularly known as “*Methi*” in India belongs to the family Fabaceae. The generic name *Trigonella* comes from Latin meaning 'little triangle' about the triangular shape of the small yellowish-white flowers (Shakthi *et al.*, 2020). It is an annual herb, and plants are semi-erect, tall, and moderately branched with bold, typically yellow grains (Kumar *et al.*, 2018). Among the seed spices crop

grown in India, fenugreek is one of the oldest and is the third most important seed spice after cumin and coriander. Fenugreek is majorly produced in Rajasthan, Gujarat, and Madhya Pradesh, with over 85% of our national production coming from these three states. (Shekhawat *et al.*, 2023). It is a self-pollinated dicotyledonous plant with branched stems, and trifoliate leaves. Fenugreek is a multipurpose crop being used as a spice, leafy vegetables, fodder and as a medicinal plant. Fenugreek contains alkaloid trigonelline (0.13-0.35%), diosgenin (0.78-1.9%) and a trace trigogenin. Fenugreek seeds contain a substantial amount of the steroidal substance “diosgenin” which is used as a starting material in the synthesis of sex hormones and oral contraceptives (Shakthi *et al.*, 2020). Being a legume, it also serves as a soil renovating crop, its root nodules containing bacteria *rhizobium* improves the soil fertility by fixing atmospheric nitrogen. It may be regarded as a cash crop occupying a prime place amongst the seed spices grown in Rajasthan. Its high market price attracts the farmers to include this crop in their cropping system. Genetic and heritable variation is a prerequisite for an effective breeding programme. The performance of locally available germplasm of fenugreek is poor in the Malwa region of Madhya Pradesh. Hence, there is an urgent need for genetic improvement to develop high yielding cultivars suitable for such situations. Keeping this in view present investigation was planned to find out genetic variability, heritability and genetic advance in fenugreek germplasms grown Malwa region of Madhya Pradesh.

Material and Methods

The field experiment was carried out at Department of Plantation Spices Medicinal and Aromatic Crops, College of Horticulture, Mandsaur, under Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (M.P.) during *rabi* season of 2020-21 in randomized block design with replicated three times. The investigation was carried out with eighteen germplasm which are obtained from College of Agriculture, Sehore (M. P). The five plants were randomly collected from each plot at 30, 45 60 and harvest to record all the parameters and later on, their mean was calculated. The experimental data were subjected to statistical analysis using the analysis of variance technique suggested by Panse and Sukhatme (1985). Where the “F” test was found significant at 5% level of significance, the critical differences for the treatment's comparison were worked out. The phenotypic and genotypic coefficients of variation were worked out as per Burton, 1952. Heritability in broad

sense was estimated according to the formula given by Johnson *et al.*, (1955). PCV and GCV were classified as suggested by Sivasubramanian and Menon (1973) such as less than 10 % is low, 10-20 % is moderate and more than 20 % is high. The heritability h^2 (b) was classified as suggested by Johnson *et al.*, (1955), 0-30 % is low, 31-60 % is moderate, 61 % and above is high. The genetic advance as per cent of mean was classified as suggested by Johnson *et al.*, (1955) less than 10 % is low, 10-20 % is moderate and more than 20 % is high.

Results and Discussion

The study emphasized the growth and yield parameters for illustrating the performance of different germplasms of fenugreek concerning various productivity parameters.

Phenological parameters

A significant difference was noted in all the phenological parameters among the germplasms except for days to 50 per cent pod set. Results revealed that the minimum days to 50 % flowering was recorded in the germplasm G₁₅-MDF-3 (45.33) and the maximum in G₈ Sehore-11 (51.33). The possible reason of early flowering in certain genotypes indicated adaptability of these genotypes in a particular environment, better and efficient utilization of nutrients in a relatively hostile environment which might have resulted in early termination of vegetative phase and initiation of reproductive stage as compared to genotypes which took longer time to flowering. Similar results have also been reported by confirmed with Jhajhra *et al.*, (2017) in fenugreek, Patil *et al.*, (2016), and Jyothi and Hegde (2018) in fenugreek. The results confirm that, G₃-MDF-2 (53.67) shown early pod set. While, late in G₈-Sehore-11 (60.67). Similar findings were reported by Anitha *et al.*, (2016). G₃-MDF-2 (116.00) took the less number of days to maturity, while it was more in G₈-Sehore-11 (124.00). Early maturing varieties and late maturing varieties are having great importance in crop breeding since these extremely ranged genotypes for days to maturity could be used as complementary parents for crossing programme. The variation in days to maturity is also evidenced by Pathak *et al.*, (2014), Singh and Naula (2017), Sharanya *et al.*, (2018) in fenugreek.

Growth parameters

The significant variations observed among the germplasms about growth characteristics at all the intervals. The yield of the crop depends on the vigor nature of the plant. The plant vigor is shown by growth

parameters. G₁₃-Suraj had the highest plant height (10.34, 24.61, 49.99, and 92.18 cm plant⁻¹) while, lowest (6.97, 17.70, 35.33 and 64.62 cm) in G₃-MDF-2 at 30, 45, 60 DAS and at harvest respectively. Different responses to plant height might be due to genetic characteristics of genotypes and adaptability to a particular environment. Similar results were reported by Jhajhra *et al.*, (2017) and Shakthi *et al.*, (2020) in fenugreek. Moreover, the maximum values of fresh weight (2.27, 9.67, 29.09 and 52.45 g plant⁻¹) and dry weight (0.32, 3.32, 18.55 and 23.16 g plant⁻¹) had in G₁₀-Sehore-12. While minimum fresh weight (0.92, 5.87, 19.17 and 42.57) and dry weight (0.01, 1.47, 7.86 and 15.63 g plant⁻¹) were found in G₃-MDF-2 at 30, 45, 60 DAS and at harvest respectively. Higher vegetative growth especially more number of branches helped in synthesis of greater amount of food material which might have increased biomass. These findings were agreement with Anitha *et al.*, (2016), Latye *et al.*, (2016) and Sharanya *et al.*, (2018) in fenugreek. The result pertaining that, the highest number of primary branches were observed in G₁₀-Sehore-12 (4.33, 7.10, 10.80 and 14.57) and they were lowest in G₃-MDF-2 (2.87, 5.80, 8.23 and 12.67) at 30, 45, 60 DAS and at harvest respectively. It may be differed due to their genetic makeup which is indirectly governed by morphology of the plant and also endogenous hormonal level and apical dominance. The similar results also reported by Gurjar *et al.*, (2016) and Latye *et al.*, (2016), Sharanya *et al.*, (2018) in fenugreek. The present study revealed that, G₁₀-Sehore-12 had maximum leaf area (131.59, 572.17, 1629.65 and 711.84 cm² plant⁻¹) and leaf area index (1.09, 3.54 and 3.90), while, the lowest leaf area and leaf area index was found in G₃-MDF-2 (50.35, 330.80, 886.96 and 298.5), (0.65, 2.03 and 1.98) at 30, 45, 60 DAS and at harvest respectively. The enhancement in the growth stages due to maximum size of the leaves and number of leaves leads to highest photosynthetic surface area as resulting in maximum leaf area that intern increases the leaf area index. Similar results were reported by Anitha *et al.*, (2016), Latye *et al.*, (2016) in fenugreek.

Yield and yield components

The significant variations were observed in yield and yield attributing parameters. However, the maximum number of pods (34.57), number of seeds pod⁻¹ (22.20), pod length (12.07) and shelling percent (72.63) seed yield (27.17) and harvest index (42.18) were found with G₁₀-Sehore-12 while, minimum number of pods (23.07), number of seeds pod⁻¹ (12.33), pod length (9.83)

and shelling percent (57.27) seed yield (17.06) and harvest index (31.60) with G₃-MDF-2.

This might be due to congenial climatic condition like cool relative humidity, low temperature and optimum photoperiod for luxuriant vegetative growth and flowering which favors better pod production in fenugreek (Shakthi *et al.*, 2020). The higher number of seeds pod⁻¹ may be due to the higher pod length which will result in higher seed yield. These results were agreement with the findings of Jyothi and Hedge (2018) in fenugreek. The increase in seed yield and harvest index might be due to favorable climatic conditions like temperature, high relative humidity and optimum sunshine hours and also may be due to high seed yield compare to dry weight of the plant. The similar results were founded by Shakthi *et al.*, (2020) in fenugreek. But the highest test weight (17.47) by G₁₈-Sarayu and it was lowest in G₈-Sehore-11 (12.00). The variation due to bold and fertile seeds, similar results were reported by Prakash *et al.*, (2020) in fenugreek.

Study of genetic parameters

Nature and extent of variability is very important from the selection point of view for many crop improvement programmes. It is a tool of plant breeder for selection of desirable traits in crop plants, greater the genetic variability, effective will be the selection in crop breeding programme. Hence, the attempt has been made to ascertain the variability presenting different genotypes of fenugreek.

Genotypic and phenotypic coefficient of variation

The phenotypic coefficient of variation is higher than the genotypic due to influence of environment on the expression of the characters. Though, out of 19 characters, the GCV was high for one, moderate for five and low for the remaining characters. However, the highest GCV was observed for leaf area (21.01) followed by leaf area index (17.24). These findings are accordance with the findings of Kumar *et al.*, (2020) in fenugreek. Similarly, out of nineteen characters, the PCV was high for two, low for seven and moderate for the remaining characters. The highest PCV observed for leaf area (30.29) followed by leaf area index (22.02). These results were in agreement with the findings of Kumar *et al.*, (2020) for leaf area and leaf area index.

Heritability

Among the nineteen parameters, the heritability was high for four, low for one and moderate for rest of the

parameters. High heritability in a broad sense helps to identify suitable characters for selection and enables the breeder to select superior genotypes based on phenotypic expression of quantitative characters (Dhakad *et al.*, 2017). In the present study the heritability was ranged between 15.69 to 71.70 %. However, it was highest in number of leaves plant⁻¹ (71.70) followed by plant height (70.66), 1000 seed weight (64.55) and leaf area index (61.28). The results are consistent with those reported by Meena *et al.*, (2011), Pathak *et al.*, (2014) and also with those reported by Dhakad *et al.*, (2017) in coriander.

Genetic advance

Heritability indicates only the effectiveness with which selection of a genotype based on phenotypic performance, but fails to indicate the genetic progress. Heritability estimates along with genetic gains are more effective and reliable in predicting the improvement through selection (Dhakad *et al.*, 2017). In the present study, the genetic advance was ranged between 0.27 to 139.15 %. The highest genetic advance was recorded in leaf area plant⁻¹ (139.15) followed by plant height (14.66), shelling % (4.79), harvesting index (3.71), number of seeds pod⁻¹ (2.93), number of pods plant⁻¹ (2.75), fresh weight of the plant (2.56), days to maturity

(2.17), 1000 seed weight (2.04), dry weight of the plant (1.86), days to 50% flowering (1.59), seed yield plant⁻¹ (g) (1.05), days to 50% pod set (0.85), leaf area index (0.74), pod length (0.51), number of branches plant⁻¹ (0.48). Similar findings were reported by Patahk *et al.*, (2014), Gurjar *et al.*, (2016) and Singh *et al.*, (2019) in fenugreek.

Genetic advance as percent of mean

The genetic advance as percentage of mean was high for two, low for ten and moderate for remaining. It was highest with leaf area (30.03) followed by leaf area index (27.80), the results were close proximate that of Hosamoth *et al.*, (2017) for leaf area in fenugreek. Similar findings were also reported by Gurjar *et al.*, (2016) and Singh *et al.*, (2019) in fenugreek.

Conclusion:

A study of genetic variability, heritability, and genetic advance in fenugreek is useful for selecting high-yielding genotypes. Out of eighteen studied germplasms, the highest yield was recorded in G₁₀-Sehore-12 followed by G₁₇-Shree and G₇-Lajwab. Considering the results of one year of research, the germplasm G 10 - Sehore-12 and G 17 - Shree can be used for further breeding of fenugreek.

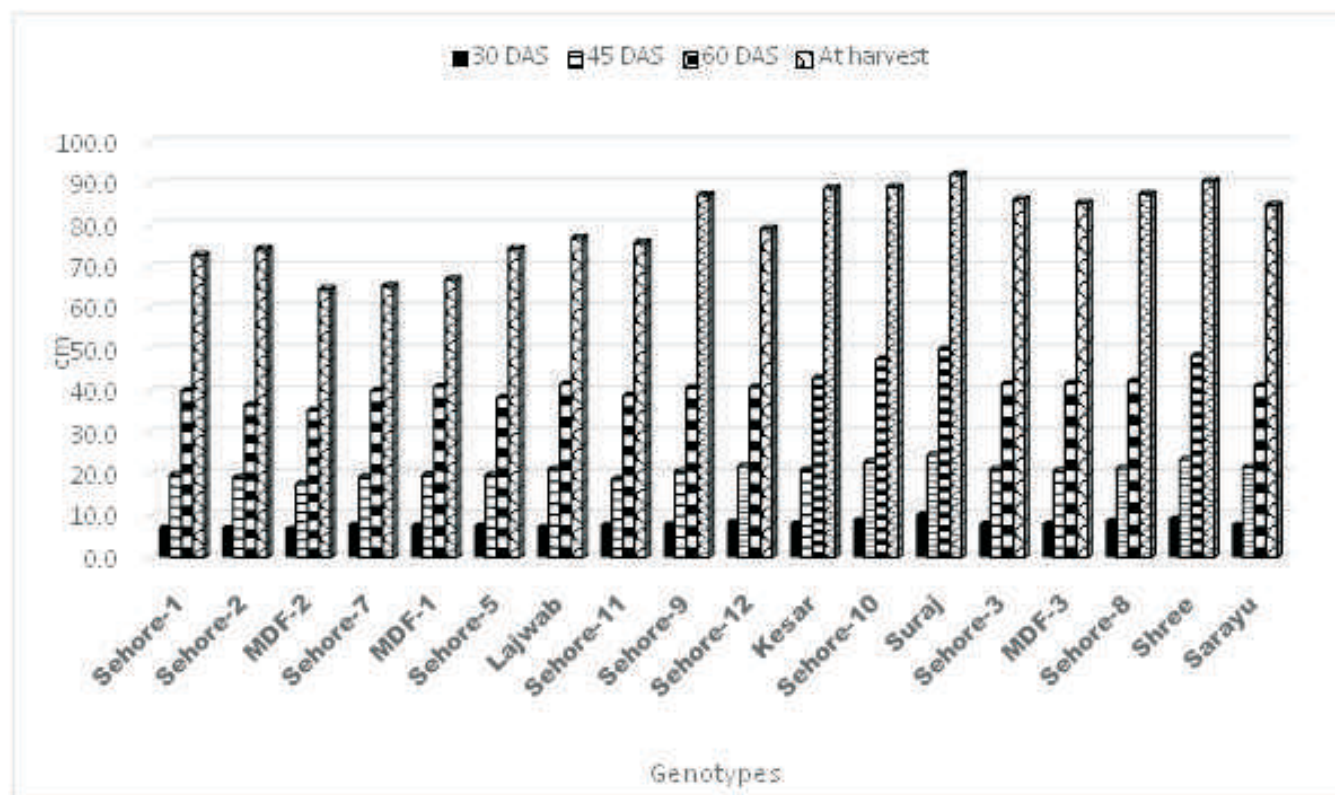


Figure 1: Mean performance of fenugreek germplasm for plant height at different stages of plant growth

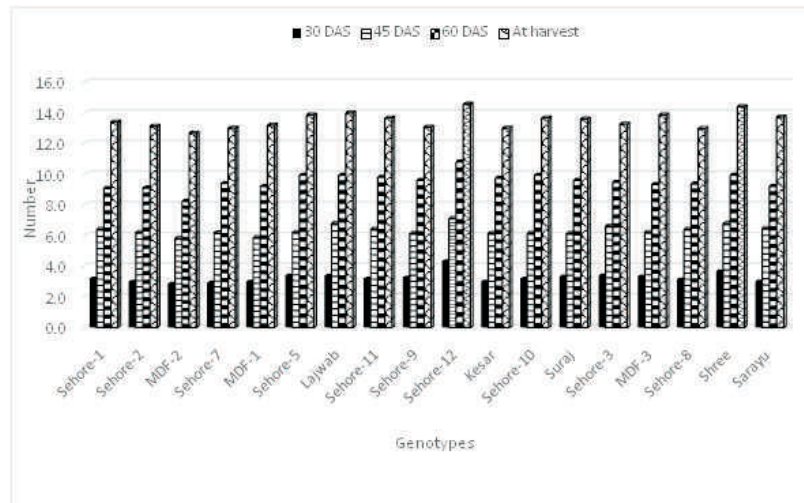


Figure 2: Mean performance of fenugreek germplasm for primary branches at different stages of plant growth

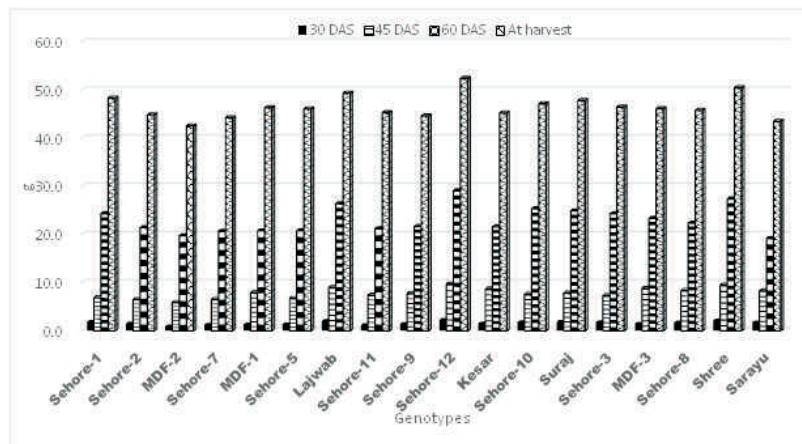


Figure 3: Mean performance of fenugreek germplasm for fresh weight of plant at different stages of plant growth

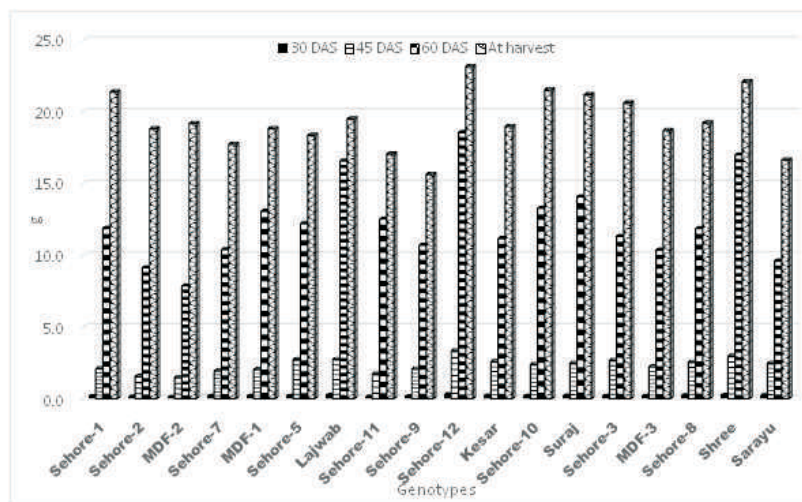


Figure 4: Mean performance of fenugreek germplasm for dry weight of plant at different stages of plant growth

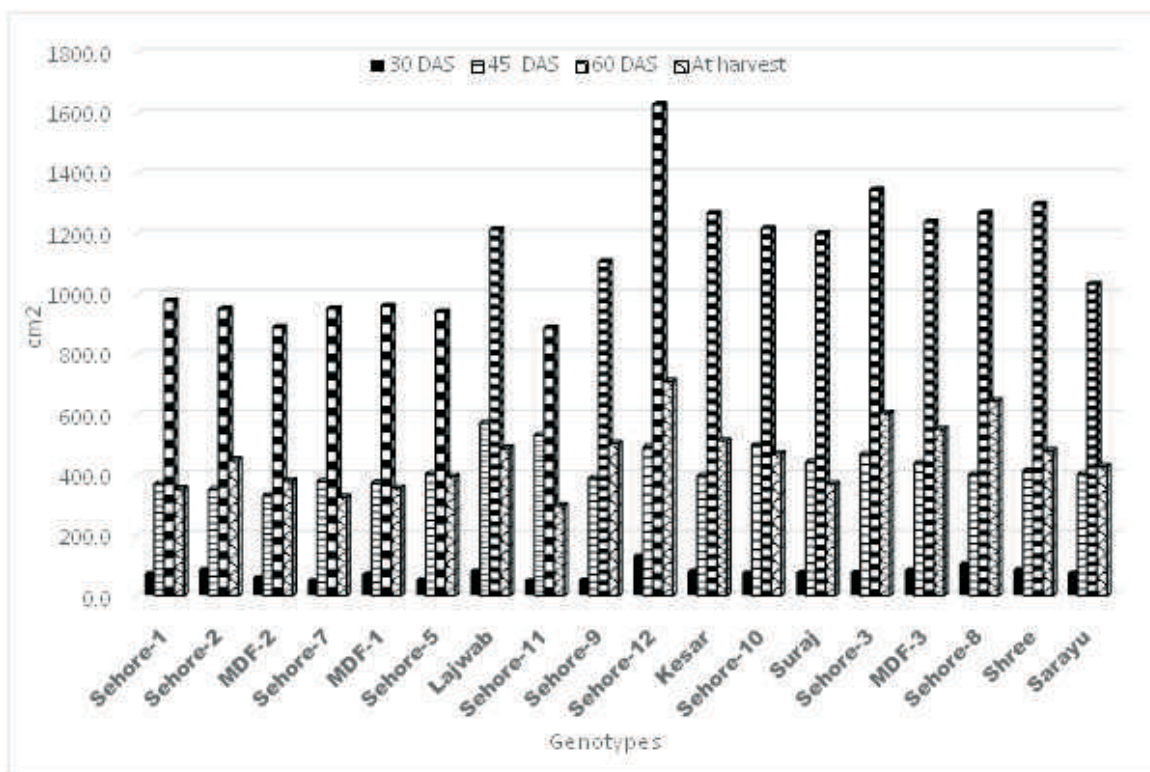


Figure5:Mean performance of fenugreek germplasm for leaf area at different stages of plant growth

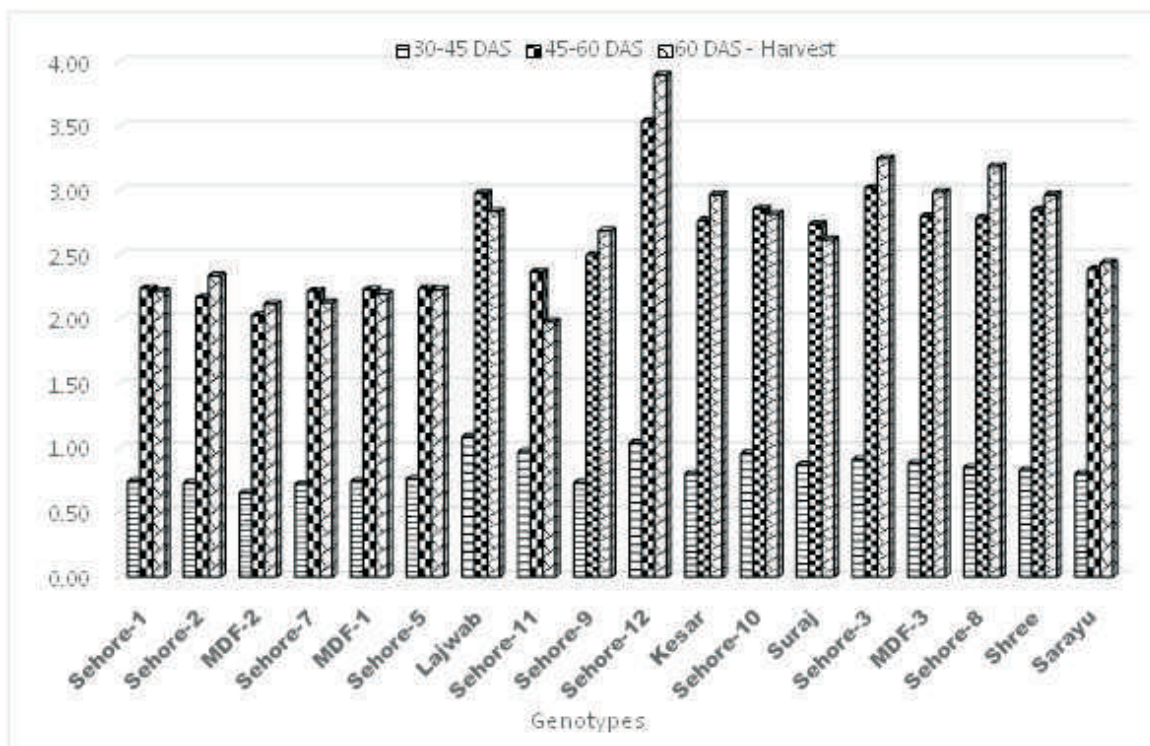


Figure 6:Mean performance of fenugreek germplasm for leaf area index at different stages of plant growth

Table 1: Mean performances of fenugreek germplasms for phenology and yield parameters

Genotypes	days to 50 % of flowering	Days to 50 % pod set	Days to seed maturity	Number of pods plant ⁻¹	Number of seeds Pod ⁻¹	pod length (cm)	Shelling percentage	Test weight (g)	Seed yield plant ⁻¹ (g)	Seed yield (qha ⁻¹)	Harvesting index (%)
Sehore-1	50.67	59.67	121.33	25.27	16.67	10.47	61.47	15.50	6.38	25.05	42.07
Sehore-2	48.00	59.00	123.00	24.53	17.13	11.07	59.23	14.03	6.40	20.81	42.23
MDF-2	46.00	53.67	116.00	23.07	12.33	9.83	57.27	16.00	4.97	17.06	31.60
Sehore-7	47.67	57.67	117.67	26.60	16.53	11.60	59.07	16.00	6.03	22.00	41.37
MDF-1	45.67	55.67	118.67	25.43	16.07	11.47	57.37	16.17	6.90	20.06	39.59
Sehore-5	46.33	56.33	120.67	25.13	17.73	11.13	59.93	15.00	6.03	21.09	38.28
Lajwab	46.00	56.00	121.00	29.33	18.20	11.53	69.07	15.53	7.00	26.73	41.60
Sehore-11	51.33	60.67	124.00	29.10	16.13	11.00	58.53	12.00	6.50	23.50	36.73
Sehore-9	48.33	58.33	122.67	23.87	17.80	10.80	56.07	15.07	5.07	24.97	40.97
Sehore-12	47.00	57.00	117.33	34.57	22.20	12.07	72.63	14.27	8.07	27.17	42.18
Kesar	46.67	56.33	119.00	27.67	16.20	10.87	62.77	13.43	6.47	25.30	37.37
Sehore-10	46.67	56.67	119.67	29.27	16.47	10.73	63.23	14.17	6.97	25.90	38.12
Suraj	46.67	56.67	118.00	24.20	16.00	11.27	64.57	14.53	5.55	26.47	37.67
Sehore-3	46.00	56.00	118.00	23.40	17.73	10.27	63.47	15.40	6.63	24.39	36.41
MDF-3	45.67	55.33	116.33	26.87	16.67	10.73	62.37	16.00	5.03	26.70	43.37
Sehore-8	46.00	56.33	119.00	24.20	16.47	10.53	67.83	16.00	5.27	24.01	35.87
Shree	46.00	56.00	117.67	29.50	20.73	11.60	70.73	17.33	7.79	27.10	40.07
Sarayu	49.00	59.00	121.00	25.27	16.87	10.73	59.47	17.47	6.27	22.67	32.23
SEm(±)	1.07	1.39	1.45	1.84	0.86	0.34	2.93	0.53	0.47	1.74	1.90
CD at 5%	3.07	3.99	4.17	5.30	2.48	0.99	8.43	1.52	1.36	4.99	5.47

Table 2: Estimation of GCV, PCV, Heritability, Genetic Advance and GA as percent of mean for different characters of fenugreek germplasms

Characters	Mean	Range		Coefficient of Variation		Heritability (%)	Genetic Advance	GA as % over mean
		Min.	Max.	GCV %	PCV %			
Plant height (cm)	80.11	64.62	92.18	10.57	12.57	70.66	14.66	18.30
Fresh weight (g plant)	46.50	42.57	52.45	4.30	6.94	38.49	2.56	5.50
Dry weight of plant (g)	19.37	15.63	26.16	8.01	13.71	34.07	1.86	9.63
No of branches plant ⁻¹	13.50	12.67	14.57	2.98	5.12	33.84	0.48	3.57
No of Leaves plant ⁻¹	44.59	51.45	72.11	10.36	12.23	71.70	11.01	18.06
Leaf areaplant ⁻¹	463.41	298.50	1629.65	21.01	30.29	48.13	139.15	30.03
Leaf area index	2.66	1.98	3.90	17.24	22.02	61.28	0.74	27.80
Days to 50 % flowering	47.19	45.33	51.33	2.80	4.82	33.84	1.59	3.36
Days to 50% pod set	57.02	53.67	60.67	1.82	4.59	15.69	0.85	1.48
Days to maturity	119.50	116.00	124.00	1.51	2.59	33.99	2.17	1.81
No of pods plant ⁻¹	26.50	23.07	34.57	8.63	14.82	33.91	2.75	10.35
No of seeds pod ⁻¹	17.11	12.33	22.20	10.73	13.85	60.05	2.93	17.13
Pod length (cm)	10.98	9.83	12.07	3.89	6.68	33.84	0.51	4.66
Shelling (%)	62.50	56.07	72.63	6.16	10.20	36.47	4.79	7.66
Test weight (g)	15.22	12.00	17.47	8.10	10.09	64.55	2.04	13.41
Seed Yield ha ⁻¹ (qha ⁻¹)	23.94	17.06	27.17	9.34	15.65	35.65	2.75	11.49
Harvest index (%)	38.76	31.60	43.37	7.19	11.13	41.74	3.71	9.57

Conflicts of Interest : The authors declare no conflicts of interest.

References

- Anitha, B., Reddy, M.L.N., Rao, A.D., Patro, T.K. and Suneetha, D.S. 2016. Growth indices and yield as influenced by sowing dates and variety in Fenugreek. *Plant Arch.*, 16(1):485-492.
- Burton, G.W. 1952. Quantitative inheritance in grasses, *Proc, 6th Int. Grassland Cong.*, 1: 227-287.
- Dhakad, R.S., Sengupta, S.K., Lal, N. and Shiurkar, G. 2017. Genetic diversity and heritability analysis in coriander. *The Pharma Innovation J.*, 6(8):40-46.
- Gurjar, M., Naruka, I.S. and Shaktawat, R.P.S. 2016. Variability and correlation analysis in Fenugreek (*Trigonella foenum graecum* L.). *Legume Res.*, 39:459-465.
- Hosamath, J.V., Hegde, R.V., Venugopal, C.K., Vijayakumar, A.G. and Hegde, M.G. 2017. Studies on genetic variability, heritability and genetic advance in Fenugreek (*Trigonella foenum graecum* L.). *Int J Curr Microbiol App Sci.*, 6(11):4020-4036.
- Jhajhra, M.R., Rana, D.K. and Ola, A.L. 2017. Evaluation of Fenugreek (*Trigonella foenum-graecum* L.) varieties under sub-tropical condition of Garhwal Himalayas. *Chem Sci Rev Lett.*, 6(22):684-689.
- Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soybean. *J Agronomy*, 47:314-318.
- Jyothi, V.H. and Hegde, R.V. 2018. Performance of Fenugreek (*Trigonella foenum-graecum* L.) genotypes for seed yield. *Int J Curr Microbiol App Sci.*, 7(8): 661-666.
- Kumar, A., Pandey, V.P., Maurya, V.K., Tiwari, D. and Sriom, A.D. 2018. Genetic variability, heritability and genetic advance in Fenugreek (*Trigonella foenum graecum* L.). *Int J Chem Stud.*, 6(4):153-156.
- Kumar, S., Ram, C.N., Nath, S., Kumar, S., Kumari, M. and Singh, V. 2020. Studies on genetic variability, heritability and genetic advances in fenugreek (*Trigonella foenum-graecum* L.). *J Pharmaco Phytoche*, 9(5):1358-1361.
- Latye, P.T., Bharad, S.G., Kale, V.S., Nandeshwar, V.N. and Kholia, A. 2016. Varietal performance of Fenugreek under Akola conditions. *Int J Minor Fruits, Med Arom Plants*, 2(1):32-34.
- Meena, R.S., Kakani, R.K., Anwer, M.M. Panwar, A., Choudhary, S. and Meena, S.R. 2011. Variability studies in Fenugreek (*Trigonella foenum-graecum* L.). *Int J Seed Spices*, 1(1):44-46.
- Panse, V.G. and Sukhatme, P.V. 1985. Statistical method for agriculture workers, Indian Council of Agriculture Research, New Delhi, 155.
- Patahk, A.R., Patel, A.I., Joshi, H.K. and Patel, D.A. 2014. Genetic variability, correlation and path coefficient analysis in Fenugreek, (*Trigonella foenum-graecum* L.). *Trends Bios.*, 7(4):234-237.
- Patil, J., Vijayapadma, S.S. and Koppad, S. 2016. Genetic variability studies in Fenugreek (*Trigonella foenum-graecum* L.). *Res Environ Life Sci.*, 9(12):1482-1483.
- Prakash, S., Pandey, V.P., Goutam, D.K., Bhargava, A.K. and Nath, T. 2020. Evaluation of Germplasm Genetic Variability, Heritability and Genetic Advance in Fenugreek (*Trigonella foenum-graecum* L.). *Int J Curr Microbiol App Sci.*, 9(4):303-308.
- Shakthi, P.N., Meena, K.C., Naruka, I.S., Haldar, A. and Soni, N. 2020. Performance of fenugreek (*Trigonella foenum-graecum* L.) genotypes for yield and yield contributing traits. *Int J Seed Spices*, 10(1):11-15.
- Sharanya, B.R., Naruka, I.S., Shaktawat, R.P.S., Kushwah, S.S., Singh, O.P. and Singh, D. 2018. Effect of plant geometry on growth, yield and quality of different varieties of Fenugreek (*Trigonella foenum-graecum* L.). *Indian J Agric Res.*, 12(2):28-32.
- Shekhawat, N., Meena, V.S., Singh, K., Rani, K. and Gupta, V. 2023. Studies on Genetic Variability, Heritability and Genetic Advance for Morphological Traits in Fenugreek (*Trigonella foenum-graecum* L.) for Arid Climate of Rajasthan. *Legume Res.*, 46(3):312-315.
- Singh, A. and Naula, R. 2017. Variability parameters for growth and yield characters in Fenugreek (*Trigonella spp.*) genotypes. *Int J Agri Sci.*, 9(14):4077-4080.
- Singh, A., Pandey, V.P., Kumar, P., Kumar, M., Kumar, S. and Vaishya, D.V. 2019. To study of correlation coefficient and path coefficient analysis for different characters in germplasm of Fenugreek (*Trigonella foenum-graecum* L.). *J Pharma. Phytochem.*, 8(1):857-861.
- Sivasubramanian, S. and Menon, M. 1973. Heterosis and inbreeding depression in rice. *Madras Agric J.*, 60:1139-1149.