Biological Forum
an International Journal 18(1): 30-34(2026)
ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Association Studies in Fenugreek (*Trigonella foenum-graecum* L.) for Yield and its Attributing Trait

Shubham Khichi[1*], Rupal Dhoot[2], Divya Chouhan[2] and Namrata[3]
[1]Ph.D. Scholar, Department of Genetics and Plant Breeding, Agriculture University, Jodhpur (Rajasthan), India.
[2]Assistant Professor (GPB), Agriculture University, Jodhpur (Rajasthan) India.
[3]Assistant Professor (GPB), Dr. BRCARS, Mandor, Agriculture University, Jodhpur (Rajasthan), India.

(Corresponding author: Shubham Khichi)*
(Received: 08 October 2025; Revised: 27 November 2025; Accepted: 31 December 2025; Published online: 13 January 2026)
(Published by Research Trend)

DOI: https://doi.org/10.65041/BiologicalForum.2026.18.1.5

ABSTRACT: Fenugreek (*Trigonella foenum-graecum* L.) such an important seed spice crop having medicinal, industrial and economical importance in India. To overcome the demand of fenugreek, breeding for yield improvement is a crucial step. For increment in seed yield which is a quantitative trait having influence of multiple genes as well as contributing of many traits, taking this reason it is necessary to find the association of seed yield with its contributing traits. So, an experiment was conducted with 38 genotypes in Randomized Block Design with three replications at instructional farm, college of agriculture, Jodhpur (Rajasthan) during *Rabi* 2024-25. Correlation coefficient shows that trait seed yield per plant having positive and significant correlation with number of pods per plant, pod length, number of seeds per pod, 1000-seed weight, biological yield per plant and harvest index. The results of path analysis revealed that highest positive direct effect on seed yield per plant was exerted by harvest index, while days to 50% flowering exerted negative direct effect maximum indirect effect was exerted by biological yield per plant on seed yield per plant through number of pods per plant. The experimental results conclude that selection of these traits may bring simultaneous improvement in seed yield in fenugreek.

Keywords: Fenugreek, Correlation, Path analysis, Direct effect, Indirect effect.

INTRODUCTION

India is the country famous for its spice's richness and in the list of such Indian spices, fenugreek is one of the seed spices, botanically called as *Trigonella foenum-graecum* L. (2n = 2x = 16) and commonly known as "methi" in India, belongs to family Leguminosae and the crop is being consumed as a leafy vegetable and as a whole seed. Climatic conditions favor growth of fenugreek is having temperature range between of 20°C to 25°C. The crop has two centers of origin, the Indian sub-continent and the eastern Mediterranean region (Vavilov, 1926). The mode of pollination in fenugreek is self-pollination and germination of seed take place in hypogeal manner. Fenugreek's importance is not only as a spice, it has many medicinal properties also, that helps in lowering the blood sugar level, decreasing cholesterol level because of presence of an alkaloid called "Diosgenin" and neuroprotective because of an alkaloid called "Trigonelline" and has anti-carcinogenic properties, anti-fungal properties, the consumption of fenugreek on daily basis helps in curing gastrointestinal disorder. Because of the presence of "Saponin" in fenugreek it considered as steroidal significant crop. Fenugreek constitute both macro as well as micro nutrients like in 100 grams of fenugreek it contains 26.2 g of protein etc. (Gupta *et al.*, 1989). Compounds like "Epicatechin" which help in rejuvenating skin cell and preventing premature aging by free radicals, which make skin sharper and healthier, so because of this anti-aging active compound in fenugreek, it has significant cosmetologically importance also. Oil derived from fenugreek seeds used to promote hair health and growth, researchers suggest it can strengthen hair from roots, improve scalp health because the oil contain compound like "Lecithin" which moisturizes and conditions the scalp. Fenugreek consist a polysaccharide called "Galactomannan" which make fenugreek industrially important plant, because this polysaccharide acts as a stabilizer, emulsifier, thickener, and gelling agent. Hence, it is widely used in food industries as well. Fenugreek covered 1.58 lac ha area in India and 0.77 lac ha area in Rajasthan with overall all production of 2.49 lac tons in India, in which Rajasthan is the second largest producer having production of 1.02 lac tons after Madhya Pradesh (Anonymous, 2023-24). The importance of fenugreek making its demand kept on increasing and for fulfilling this need, improvement in fenugreek is to be done which increases yield that can be done by studying the association and relationship between different traits and

grain yield which is better understood by using correlation studies in conjunction with path analysis. Several researchers has reported yield enhancement through the selection of yield contributing traits (Shivraj *et al.*, 2023; Yadav *et al.*, 2024; Mohanalakshmi *et al.*, 2025). The degree and direction of the association between the various yield contributing features and yield can be shown by correlation. The path coefficient calculates the direct effect of a predictive variable on its response variable, with the indirect effect of a predictive variable being the second component.

MATERIALS AND METHODS

The experiment was carried out during *Rabi*-2024-25 at Instructional farm, College of Agriculture, Jodhpur (Rajasthan). The experimental material consist of 38 fenugreek genotypes which was laid out in randomized block design with three replication planted at spacing 30 × 10 cm^2. All the recommended package of practices was followed to raise a healthy crop and necessary prophylactic measures were adopted against pests and diseases. The characters under study are days to 50% flowering, days to maturity, plant height(cm), number of primary branches per plant, number of pods per plant, pod length(cm), number of seeds per pod, 1000-seed weight(g), biological yield per plant(g), harvest index(%), seed yield per plant(g), protein content(%) and oil content(%) in which the data was recorded on five randomly selected plants from each genotype in each replication for all the characters except days to 50 percent flowering and days to maturity, where data were recorded on plot basis. protein is estimated using calculation nitrogen through Kjeldahl unit method (J. Kjeldahl, 1883) and oil content through Soxhlet apparatus (F. Soxhlet, 1879). The data collected from field trial on fenugreek for thirteen characters were statistically analyzed with the help of WINDOSTAT Version 9.3 software.

Correlation coefficients were calculated at genotypic and phenotypic level using the formulae suggested by Dewey *et al.* (1959) and the direct and indirect effects both at genotypic and phenotypic levels were estimated by taking seed yield per plant as dependent variable, using path coefficient analysis as suggested by Wright (1921); Dewey and Lu (1959).

RESULT AND DISCUSSION

The correlation coefficient is a statistical tool used to determine the level of relationship between two or more variables which signifies the contribution of other characters in improving seed yield. The characters number of pods per plant, pod length, number of seeds per pod, 1000-seed weight, biological yield per plant and harvest index depicted positive and significant correlation with seed yield per plant at both genotypic and phenotypic level and plant height at genotypic level only (Table 1) Similar results were reported by Prajapati *et al.* (2010); Meena *et al.* (2021); Kole *et al.* (2023). Days to 50 percent flowering and days to maturity showed negative significant correlation with seed yield per plant at genotypic level only and the similar findings were demonstrated by Jain *et al.* (2013); Choudhary *et al.* (2022).

Path coefficient analysis can investigate the direct and indirect contributions of characters to a dependent variable which is seed yield per plant. Indirect effect has a key importance in cause and effect relationship analysis as it reveals how one trait influences another through a mediating trait which provide breeders to make selection of those traits that indirectly improve desired characteristics even if the direct effect is weak (Fig. 1). Form the result it is recorded that the positive direct effect on seed yield per plant were due to days to maturity, number of pods per plant, pod length, number of seeds per pod, biological yield per plant and harvest index at both genotypic and phenotypic levels (Table 2). Similar findings were earlier recorded by Mori *et al.* (2017); Abtew and Abate (2020). Characters such as days to 50 percent flowering, plant height and 1000-seed weight exerted negative direct effect on seed yield per plant at both genotypic and phenotypic levels and these results were in accordance with Prakash *et al.* (2021). The maximum indirect effect was exerted by biological yield per plant on seed yield per plant through number of pods per plant this result was in accordance with Gurjar *et al.* (2016).

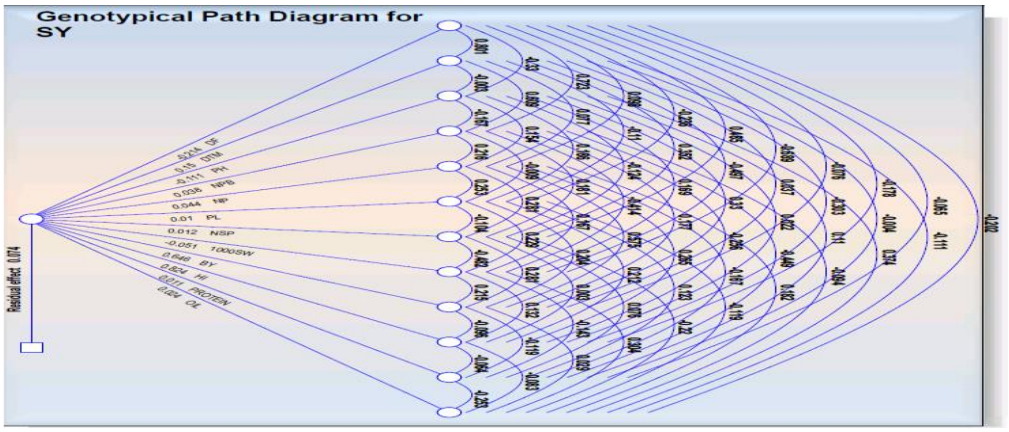

Fig. 1. Genotypic path diagram of fenugreek genotypes for seed yield and yield contributing characters.

Table 1: Phenotypic and genotypic correlation coefficients for grain yield and its contributing characters.

Characters		Days to 50 percent flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of pods per plant	Pod length (cm)	Number of seeds per pod	1000-seed weight	Biological yield per plant (g)	Harvest index (%)	Protein content (%)	Oil content (%)	Seed yield per plant (g)
DF	P	**1.000**	0.5705**	-0.2745**	0.6020**	0.0785	-0.1894*	0.4141**	-0.6087**	-0.0532	-0.1395	-0.0455	-0.1862*	-0.1419
	G	**1.000**	0.8005**	-0.3305**	0.7234**	0.0981	-0.2361*	0.4845**	-0.6893**	-0.0758	-0.1782	-0.0647	-0.2019*	-0.1894*
DTM	P		**1.000**	-0.0095	0.4132**	0.0859	-0.0526	0.2784**	-0.3701**	0.0457	-0.1620	-0.0129	-0.0840	-0.0859
	G		**1.000**	-0.0031	0.6091**	0.0772	-0.1101	0.3517**	-0.4973**	0.0370	-0.3028**	-0.0043	-0.1109	-0.1953*
PH	P			**1.000**	-0.1429	0.1392	0.1654	-0.0921	0.1369	0.2743**	0.0271	0.0907	0.3506**	0.1644
	G			**1.000**	-0.1675	0.1535	0.1856*	-0.1237	0.1690	0.3300**	0.0215	0.1098	0.1098	0.1929*
NPB	P				**1.000**	0.1979*	0.0917	0.1301	-0.3576**	0.1564	-0.2338*	-0.4108**	-0.0843	-0.0851
	G				**1.000**	0.2158*	-0.0091	0.1814	-0.4140**	0.1771	-0.2557**	-0.4492**	-0.0943	-0.0788
NP	P					**1.000**	0.2127*	0.2468**	0.1710	0.5212**	0.2230*	-0.1560	0.1768	0.5495**
	G					**1.000**	0.2530**	0.2812**	0.1665	0.5752**	0.2652**	-0.1669	0.1819	0.6159**
PL	P						**1.000**	-0.0848	0.2022*	0.1628	0.1672	0.0911	-0.1052	0.2690**
	G						**1.000**	-0.1043	0.2287*	0.2042*	0.2122*	0.1225	-0.1187	0.3270**
NSP	P							**1.000**	-0.4040**	0.2529**	0.0534	0.0729	-0.1970*	0.2271*
	G							**1.000**	-0.4819**	0.2812**	0.0034	0.0763	-0.2200*	0.1974*
1000-SW	P								**1.000**	0.2082*	0.1199	-0.1364	0.2930**	0.2360*
	G								**1.000**	0.2155*	0.1322	-0.1429	0.3040**	0.2460**
BY	P									**1.000**	-0.1255	-0.1093	0.0291	0.5481**
	G									**1.000**	-0.0956	-0.1192	0.0292	0.5784**
HI	P										**1.000**	-0.0460	-0.0710	0.7485**
	G										**1.000**	-0.0644	-0.0829	0.7478**
PC	P											**1.000**	-0.2467**	-0.1172
	G											**1.000**	-0.2526**	-0.1387
OC	P												**1.000**	-0.0501
	G												**1.000**	-0.0578
SY	P													**1.000**
	G													**1.000**

*, ** Represent significant at 5% and 1% probability levels respectively. P - At phenotypic level, G - At genotypic level

Table 2: Direct and indirect effect of different characters on seed yield at genotypic and phenotypic levels.

Characters		DF	DM	PH	NPB	NP	PL	NSP	1000SW	BY	HI	PC	OC
Days to 50 percent flowering	P	**-0.0169**	-0.0097	0.0046	-0.0102	-0.0013	0.0032	-0.007	0.0103	0.0009	0.0024	0.0008	0.0032
	G	**-0.2144**	-0.1716	0.0708	-0.1551	-0.0210	0.0506	-0.1039	0.1478	0.0163	0.0382	0.0139	0.0433
Days to maturity	P	0.0156	**0.0273**	-0.0003	0.0113	0.0023	-0.0014	0.0076	-0.0101	0.0013	-0.0044	-0.0004	-0.0023
	G	0.1199	**0.1498**	-0.0005	0.0912	0.0116	-0.0165	0.0527	-0.0745	0.0055	-0.0454	-0.0007	-0.0166
Plant height (cm)	P	0.0124	0.0004	**-0.0452**	0.0065	-0.0063	-0.0075	0.0042	-0.0062	-0.0124	-0.0012	-0.0041	-0.0159
	G	0.0367	0.0003	**-0.1110**	0.0186	-0.0170	-0.0206	0.0137	-0.0188	-0.0366	-0.0024	-0.0122	-0.0416
Number of primary branches per plant	P	-0.0109	-0.0075	0.0026	**-0.0180**	-0.0036	-0.0017	-0.0023	0.0065	-0.0028	0.0042	0.0074	0.0015
	G	0.0272	0.0229	-0.0063	**0.0376**	0.0081	-0.0003	0.0068	-0.0156	0.0067	-0.0096	-0.0169	-0.0035
Number of pods per plant	P	0.0027	0.0030	0.0049	0.0069	**0.0350**	0.0074	0.0086	0.0060	0.0182	0.0078	-0.0055	0.0062
	G	0.0043	0.0034	0.0067	0.0094	**0.0437**	0.0111	0.0123	0.0073	0.0251	0.0116	-0.0073	0.0079
Pod length (cm)	P	-0.0044	-0.0012	0.0038	0.0021	0.0050	**0.0233**	-0.0020	0.0047	0.0038	0.0039	0.0021	-0.0024
	G	-0.0024	-0.0011	0.0019	-0.0001	0.0026	**0.0103**	-0.0011	0.0023	0.0021	0.0022	0.0013	-0.0012
Number of seeds per pod	P	0.0057	0.0038	-0.0013	0.0018	0.0034	-0.0012	**0.0137**	-0.0055	0.0035	0.0007	0.0010	-0.0027
	G	0.0060	0.0044	-0.0015	0.0022	0.0035	-0.0013	**0.0124**	-0.0060	0.0035	0.0000	0.0009	-0.0027
1000-seed weight (g)	P	0.0008	0.0005	-0.0002	0.0005	-0.0002	-0.0003	0.0005	**-0.0013**	-0.0003	-0.0002	0.0002	-0.0004
	G	0.0349	0.0251	-0.0085	0.0209	-0.0084	-0.0116	0.0244	**-0.0506**	-0.0109	-0.0067	0.0072	-0.0154
Biological yield per plant (g)	P	-0.0339	0.0291	0.1747	0.0996	0.3320	0.1037	0.1611	0.1326	**0.6370**	-0.0800	-0.0696	0.0185
	G	-0.0490	0.0239	0.2132	0.1145	0.3717	0.1320	0.1817	0.1392	**0.6463**	-0.0618	-0.0770	0.0188
Harvest index (%)	P	-0.1137	-0.1320	0.0221	-0.1905	0.1816	0.1362	0.0435	0.0977	-0.1023	**0.8147**	-0.0375	-0.0579
	G	-0.1469	-0.2496	0.0177	-0.2108	0.2187	0.1749	0.0028	0.1090	-0.0788	**0.8244**	-0.0531	-0.0683
Protein content (%)	P	0.0005	0.0002	-0.0011	0.0049	0.0019	-0.0011	-0.0009	0.0016	0.0013	0.0005	**-0.0119**	0.0029
	G	-0.0007	0.0000	0.0012	-0.0051	-0.0019	0.0014	0.0009	-0.0016	-0.0013	-0.0007	**0.0113**	-0.0029
Oil content (%)	P	0.0002	0.0001	-0.0003	0.0001	-0.0002	0.0001	0.0002	-0.0003	0.0000	0.0001	0.0002	**-0.0009**
	G	-0.0049	-0.0027	0.0091	-0.0023	0.0044	-0.0029	-0.0054	0.0074	0.0007	-0.0020	-0.0061	**0.0243**
Correlation with seed yield	P	-0.1419	-0.0859	0.1644	-0.0851	0.5495	0.2609	0.2271	0.2360	0.5481	0.7485	-0.1172	-0.0501
	G	-0.1894	-0.1953	0.1929	-0.0788	0.6159	0.3270	0.1974	0.2460	0.5784	0.7478	-0.1387	-0.0578

Note: Residual effect Genotypic (G) =0.0739, Phenotypic (P) = 0.1317

CONCLUSIONS

Through this study on association between seed yield per plant and traits in fenugreek it is concluded that selection of these traits which are number of pods per plant, pod length, number of seeds per pod, 1000-seed weight, biological yield per plant can be used for further crop improvement programme of fenugreek which may bring simultaneous improvement in seed yield.

FUTURE SCOPE

As a result, the data gathered from this study suggests that the following phenotypic traits providing yield enhancement to fenugreek should be used as the basis for the selection of traits to improve the yield of fenugreek. To make accurate conclusions, the relationship between each trait must be confirmed in more than one growing season and in many different environments before declaring that they are stable. Genotypes which appear to have higher potential for increased yield could serve as a basis for future hybridization programme development for fenugreek with higher yields. Additionally, the use of molecular approaches may increase the ability to accurately select genotypes for improved yield potential in combination with traditional selection approaches. Future investigations into increasing both the quality and yield of fenugreek may include growing and evaluating fenugreek under a variety of agro-climatic conditions.

Acknowledgement. The authors like to acknowledge the Dr. BRCARS, Mandor, Agriculture university, Jodhpur. Department of Genetics and Plant Breeding, College of Agriculture, Jodhpur and Agriculture University, Jodhpur, Rajasthan for the assistance, support and cooperation.

REFERENCES

Abtew, Y. A. and Abate, A. (2020). Association of traits in Ethiopian fenugreek (*Trigonella foenum-graecum* L.) genotypes regarding to seed yield by using phenotypic data. *Acta agriculturae Slovenica*, *115*(1), 161-169.

Anonymous (2023). Estimate by Spices Board India, Calicut.

Choudhary, M., Gothwal, D. K., Jakhar, M. L., Singh, D., Kumawat, K. R. and Kumawat, R. (2022). Genetic variability, character association and path analysis in fenugreek (*Trigonella foenum-graecum* L.) under normal and staggered irrigation regimes. *Electronic Journal of Plant Breeding*, *13*(2), 465-475.

Dewey, D. I. and Lu, K. H. (1959). A Correlation and Path Coefficient Analysis of Components of Crested Wheat grass Seed Production. *Agronomy Journal*, *51*, 515-518.

Gupta, K. K., Thakral, A. and Wagle, D. S. (1989). Abstract of papers. *First National Seminar on seed spices*, 24-25 October 1989, RAU Jaipur p. 551.

Gurjar, M., Naruka, I. S. and Shaktawat, R. P. S. (2016). Variability and correlation analysis in fenugreek (*Trigonella foenum-graecum* L.). *Legume Research-An International Journal*, *39*(3), 459-465.

Jain, A., Singh, B., Solanki, R., Saxena, S. N. and Kakani, R. K. (2013). Genetic variability and character association in fenugreek. *International Journal of Seed Spices*, *3*(2), 22-28.

Kjeldahl, J. (1883). A new method for the estimation of nitrogen in organic compounds. *Z. Anal. Chem*, *22*, 366.

Kole, P. C., Goswami, T. and Kole, A. (2023). Genetic Variability, Correlation and Path Analysis in Fenugreek Grown under Sub-humid Sub-tropical Red Lateritic Belt of Eastern India. *Journal of Stress Physiology and Biochemistry*, *19*(4), 108-113.

Meena, R. S., Choudhary, S., Verma, A. K., Meena, N. K. and Mali, S. C. (2021). Estimates of genetic variability, divergence, correlation and path coefficient for morphological traits in fenugreek (*Trigonella foenum-graecum* L.) genotypes. *Legume Research*, *44*(3), 281-286.

Mohanalakshmi, M., Prabhu, M., Jegadeeswari, V., Vijayalatha, K. R., Devi, A. N., Venkatesan, K. and Umamaheswari, T. (2025). Variability, Correlation and Path Coefficient Analysis in Fenugreek (*Trigonella foenum-graecum*) Genotypes. *Legume Research-An International Journal*, *1*, 6.

Mori, K., Sharma, L. K., Mori, V., Kulkarni, G. U. and Jadeja, S. R. (2017). Genetic variability, correlation and path analysis in fenugreek (*Trigonella foenum-graecum* L.). *Frontiers in Crop Improvement*, *5*(1), 28-32.

Prajapati, D. B., Ravindrababu, Y. and Prajapati, B. H. (2010). Genetic variability and character association in fenugreek (*Trigonella foenum-graecum* L.). *Journal of Spices and Aromatic Crops*, *19* (1 and 2), 61–64.

Prakash, S., Pandey, V. P. and Bhargava, A. K. (2021). Assessment of correlation and path analysis in fenugreek (*Trigonella foenum-graecum* L.) Germplasms. *International Journal of Chemical Studies*, *9*(1), 3432-3434.

Shivraj, P. K., Kumar, R., Chouhan, S. and Tutlani, A. (2023). Exploring Genetic Variability, Correlation and Path Analysis in Fenugreek (*Trigonella foenum-graecum* L.) for Crop Improvement. *International Journal of Bio-resource and Stress Management*, *14*(11), 1523-1529.

Soxhlet, F. (1879). Die gewichtsanalytische bestimmung des milchfettes. *Dingler's Polytech J, 232*, 461–465.

Vavilov, N. I. (1926). Studies on the origin of cultivated plants. *Bulletin of Applied Botanic*, *16*, 2.

Wright, S. (1921). Correlation and causation. *Journal of Agricultural Research*, *20*(7), 557-585.

Yadav, K., Nema, S., Nair, R., Singh, Y., Tantwai, K. and Soni, A. (2024). Genetic variability and multivariate analysis in fenugreek (*Trigonella foenum-graecum* L) germplasm lines. *Plant Archives*, *24*(2).

How to cite this article: Shubham Khichi, Rupal Dhoot, Divya Chouhan and Namrata (2026). Association Studies in Fenugreek (*Trigonella foenum-graecum* L.) for Yield and its Attributing Trait. *Biological Forum*, *18*(1): 30-34.