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Unlocking Genetic Variability and Character Relationships in Green Fenugreek (*Trigonella foenum-graecum* L.) Genotypes

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ABSTRACT

The present experiment was carried out with 21 diverse fenugreek genotypes to study the genetic variability and relationships among green leaf yield and yield attributing traits. Analysis of variance indicated significant differences among genotypes for all the variables, demonstrating the presence of variability within the studied materials. It also revealed that the phenotypic coefficient of variation exceeded the genotypic coefficient of variation for all traits under consideration. High genotypic and phenotypic coefficients of variation were observed for plant height, number of primary branches per plant, number of green leaf harvests, leaf area and total green leaf yield per hectare. Moderate values were noted for the days to first flowering, days to first green leaf harvest, days to last green leaf harvest and total green leaf yield per plant. High heritability coupled with high genetic advance as percentage of mean was observed for plant height, number of primary branches per plant and leaf area. Whereas, traits like days to first flowering, days to 50% flowering, total chlorophyll content in leaves, soluble protein content in leaves and total green leaf yield per plant exhibited high heritability with medium genetic gain. These characters can be regarded as most reliable for selection because these are controlled by additive gene action. Number of primary branches per plant, days to last green leaf harvest, total green leaf yield per plant, leaf area, total chlorophyll content in leaves and plant height can be considered as the most important selection indices for enhancing green leaf yield in fenugreek as per the association ship studies.

Key words: fenugreek, genetic variability, heritability, character association

INTRODUCTION

Fenugreek, a popular winter leafy vegetable in India, belongs to the order *Fabales*, family *Fabaceae*, subfamily *Papilionaceae* and has a chromosome number of 2n = 2x = 16. It is thought to have originated in Asia (De Candolle, 1964) or the Mediterranean region of the Old World (Vavilov, 1926). Of the approximately 50 species in the genus *Trigonella*, only two are economically significant: *Trigonella foenum-graecum*, known as 'Common Methi' and *Trigonella corniculata*, known as 'Kasuri Methi' (Kumari et al., 2016). Fenugreek serves as a versatile crop with applications spanning culinary spice, leafy green vegetable, animal fodder and therapeutic medicinal plant uses (Hosamath et al., 2017). Leaves boast a high concentration of iron, calcium, protein, vitamins and minerals. The seed is composed of 45–60% carbohydrate, primarily mucilaginous fiber, alongside protein, fat, saponins and key nutrients such as phosphorus and potassium. It also contains mineral nutrients like calcium, iron, and sodium, as well as amino acids including leucine, valine, lysine, and phenylalanine (Krishnaveni et al., 2021). Seeds are also considered as a rich source of "diosgenin", a steroidal chemical which is utilized as a precursor in the production of oral contraceptives and sex hormones (Meena et al., 2017). Fenugreek is primarily produced in India, with cultivation extending to various nations including Iran, Nepal, Bangladesh, Pakistan, North and East Africa, Ukraine, Russia, Greece, Argentina, Egypt, France, Spain, Turkey, Morocco and China. Within India, key fenugreek-producing states are Rajasthan, Gujarat, Madhya Pradesh, Punjab, Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Himachal Pradesh and Haryana. Notably, Rajasthan and Gujarat collectively account for a substantial portion of India's fenugreek production, representing 72% of the total cultivation area and 86% of the overall production (Yadav et al., 2024).

Being a leguminous plant this crop also engages in a symbiotic relationship with nitrogen-fixing bacteria, predominantly of the genus *Rhizobium* which colonize its root nodules. These bacteria facilitate the transformation of atmospheric nitrogen into biologically accessible forms, consequently improving soil fertility and reducing the demand for synthetic fertilizers. This nitrogen fixation process in fenugreek enhances soil health, encourages sustainable agricultural methods and provides advantages to subsequent crops in rotational systems (Krishnaveni et al., 2021).

Despite India's status as the foremost producer of this crop, its productivity remains suboptimal, primarily due to a lack of superior genotypes or improved cultivars suitable for breeding programs aimed at developing potential hybrids. Consequently, the development of novel, high-yielding varieties and hybrids is imperative. A fundamental prerequisite for devising effective breeding strategies lies in a thorough assessment of the nature and scope of variability within the germplasm resource (Krishna et al., 2007). The extent of genetic variability present in a crop's germplasm dictates its potential for improvement. A population exhibiting greater variability offers enhanced prospects for successful selection of desirable traits (Vavilov, 1951). The most of the research conducted in India on this crop previously was exclusively for seed purpose. Therefore, the current research aimed to assess the growth and yield characteristics of various fenugreek genotypes collected from diverse parts of India especially for vegetable purpose.

MATERIALS AND METHODS

A field experiment was carried out during the *Rabi* season of 2024–2025 at the Vegetable Research and Demonstration Farm under the Horticulture Department of M S Swaminathan School of Agriculture, Centurion University of Technology and Management, Odisha, India. Plant materials for the study consisted of fenugreek genotypes, obtained from various regions of India, selected specifically for green herbage production (Table 1). The experiment utilized a randomized complete block design, incorporating 21 treatments with 3 replications. The crop was cultivated in individual plots measuring 2.5 meters (m) × 1.2 meters (m), with row-to-row and plant-to-plant spacing of 25 centimeters (cm) and 15 centimeters (cm), respectively. Standard cultural practices and protective measures as outlined in the 'Advance Production Technology of Fenugreek' bulletin published by NRC, Seed Spices, Ajmer (Kakani et al., 2009) were implemented to promote a robust crop stand. Data were recorded on a plot basis for the days to 1st (DFF) and 50% flowering (50%DF), days to 1st (DFGLH) and last green leaf harvest (DLGLF) and the total number of green leaf harvests (NGLH). Ten plants were randomly selected from each genotype within each replication to record observations such as plant height (PH), number of primary branches per plant (NPBPP), leaf area (LA), total chlorophyll content in leaves (TCC), total soluble protein content in leaves (TSPC) and total green leaf yield per plant (TGLYPP) and hectare (TGLYPH). Total chlorophyll content of leaves was measured as per the method suggested by Sadasivam and Manickam (2008) and expressed in the unit mg/g whereas, total soluble protein content was estimated using the formula provided by Lowry et al. (1951) and expressed with mg/g.

ANOVA assumptions of normality and homogeneity of variance were examined before analysis. The genotypic and phenotypic coefficients of variation were determined according to Burton and DeVane (1953) while heritability and genetic advance were calculated following Johnson et al. (1955). Phenotypic correlation coefficients for green leaf yield were calculated using the formula provided by Al-Jibouri et al. (1958) and path analysis was determined using the Dewey and Lu (1959) formula. All calculations were performed using the statistical software R (version 4.5.0).

Table 1. List of fenugreek genotypes along with their sources.

Sl. No.	Name of the genotypes	Source
1.	Bckv—M—13	Hooghly, West Bengal, India
2.	Maxima—11	Mayurbhanj, Odisha, India
3.	Bckv—M—45	Nadia, West Bengal, India
4.	Maxima	Gajapati, Odisha, India
5.	Afg—3	ICAR-NRC for Seed Spices, Ajmer, Rajasthan, India
6.	Bckv—M—54	Nadia, West Bengal, India
7.	Afg—4	ICAR-NRC for Seed Spices, Ajmer, Rajasthan, India
8.	Bckv—M—33	Murshidabad, West Bengal, India
9.	Afg—5	ICAR-NRC for Seed Spices, Ajmer
10.	Bckv—M—42	Nadia, West Bengal, India
11.	Bckv—M—56	Birbhum, West Bengal, India
12.	Bckv—M—37	Purulia, West Bengal, India
13.	Pusa Early Bunching	ICAR-IARI, New Delhi, India
14.	Bckv—SM	Purulia, West Bengal, India
15.	Methi Green Queen	Anugul, Odisha, India

16.	Bckv—M—48	Murshidabad, West Bengal, India
17.	Methi Hybrid	Srikakulam, Andhra Pradesh, India
18.	Kissan	Vizianagaram, Andhra Pradesh, India
19.	Bckv—M—39	Nadia, West Bengal, India
20.	Bckv—M—50	Nadia, West Bengal, India
21.	Methi Multicut	Dhenkanal, Odisha, India

RESULTS AND DISCUSSION

In the 2024–2025 growing season, twenty-one fenugreek genotypes were assessed for growth and yield characteristics. Analysis of variance was performed for twelve quantitative traits, as detailed in Table 2. Results indicated that the mean squares for genotypes were highly significant across all traits, supporting the study of genetic variability within the genotypes. Table 3 shows that the coefficient of variation was below 10% for most characters, except for PH, DFGLH, NGLH and LA, suggesting the experiment was reliable with minimal Genotype × Environment interactions.

Table 2. ANOVA for twelve quantitative characters of fenugreek.

Source of variation	Mean sum of square		
	Replication	Treatments	Error
Degrees of Freedom (DF)	2	20	40
PH (cm)	0.83	839.59 **	203.34
DFF	1.83	595.73 **	93.11
50% DF	19.61	639.51 **	200.76
NPBPP	0.04	89.13 **	1.53
DFGLH	30.09	191.52 **	165.23
DLGLF	82.95	1986.32 **	814.41
NGLH	5.36	89.93 **	93.30
LA (cm^2)	3.07	222.44 **	205.50
TCC (mg/g)	26.53	324.97 **	73.92
TSPC ((%)	0.09	2.74 **	0.17
TGLYPP (g)	30.41	1250.34 **	236.72
TGLYPH	4.34	198.19 **	9.09

**: Significant at 1% level of probability.

Table 3. Mean performance of 21 fenugreek genotypes.

Sl. No.	Genotypes	PH (cm)	DFF	50%DF	NPBPP	DFGLH	DLGLF	NGLH	LA (cm^2)	TCC (mg/g)	TSPC (%)	TGLYPP (g)	TGLYPH (t)
1	Bckv-M-13	22.48	38.47	**46.80**	6.22	**17.33**	66.23	**6.67**	**11.96**	31.50	3.34	**54.99**	**8.44**
2	Maxima-11	20.94	39.56	44.91	**6.46**	17.67	65.19	**6.67**	11.03	30.89	3.28	53.03	8.01
3	Bckv-M-45	16.44	33.80	40.32	4.73	19.67	54.77	5.00	8.59	27.43	3.29	47.13	6.13
4	Maxima	11.49	30.20	36.18	2.99	22.00	49.26	3.00	5.28	24.34	3.07	40.14	3.33
5	Afg-3	18.09	35.89	42.69	5.15	18.67	58.91	5.67	9.86	28.37	3.14	48.73	6.80
6	Bckv-M-54	21.55	37.75	44.41	6.03	19.00	60.05	6.00	10.17	29.68	2.94	51.33	7.85
7	Afg-4	15.47	32.25	39.47	4.20	20.67	53.37	4.67	8.15	27.00	3.18	45.81	5.42
8	Bckv-M-33	11.54	30.56	36.75	2.88	22.33	50.55	3.33	6.17	24.84	2.90	40.77	3.31
9	Afg-5	16.69	33.06	40.96	4.47	20.33	53.33	4.67	8.24	27.10	2.75	46.83	5.84
10	Bckv-M-42	18.55	36.10	43.12	5.47	18.67	59.79	5.67	9.47	28.67	2.90	49.59	7.05
11	Bckv-M-56	18.53	35.40	42.99	5.00	19.33	58.09	5.33	9.47	28.11	3.10	47.65	6.69
12	Bckv-M-37	15.56	31.55	39.18	4.05	21.33	52.75	4.33	7.76	26.52	2.77	45.29	4.81
13	Pusa Early Bunching	21.44	**40.07**	45.73	6.42	17.67	**66.34**	**6.67**	11.61	**31.61**	**3.31**	53.10	8.38
14	Bckv-SM	14.62	31.72	38.46	3.97	21.67	52.73	4.00	7.82	26.36	3.30	43.44	4.61
15	Methi Green Queen	11.84	30.88	37.77	3.16	22.33	50.64	3.67	6.76	25.06	3.19	42.14	3.66
16	Bckv-M-48	**22.55**	37.23	44.55	6.25	18.00	63.25	6.33	10.81	30.03	3.25	51.95	7.91
17	Methi Hybrid	11.10	30.44	36.18	3.20	22.67	49.21	3.00	5.58	23.77	2.69	39.88	3.08
18	Kissan	13.84	32.40	38.43	3.55	22.00	50.41	4.00	7.46	26.03	3.09	43.24	4.45
19	Bckv-M-39	13.66	32.24	38.55	3.41	21.67	49.74	3.67	6.80	25.18	2.80	42.29	3.91
20	Bckv-M-50	19.21	37.00	43.46	5.80	18.33	59.68	6.00	9.84	29.31	3.31	50.51	7.47
21	Methi Multicut	17.12	34.58	40.80	4.70	19.67	56.62	5.00	9.21	27.63	2.88	47.55	6.59
	Mean	16.80	34.34	41.03	4.67	20.05	56.23	4.92	8.67	27.59	3.07	46.92	5.89
	SE. (m±)	1.30	0.88	1.29	0.11	1.17	2.60	0.88	1.30	0.78	0.03	1.40	0.27
	C.D. at 5%	3.74	2.51	3.69	0.32	3.35	7.44	2.52	3.74	2.24	0.10	4.01	0.78
	C.V. (%)	13.42	4.44	5.46	4.19	10.13	8.02	11.03	13.14	4.92	2.14	5.18	8.09

PH =Plant height (cm), DFF= Days to first flowering, 50%DF= Days to 50% flowering, NPBPP= Number of primary branches per plant, DFGLH= Days to first green leaf harvest, DLGLH= Days to last green leaf harvest, NGLH= Number of green leaf harvest, LA= Leaf area (cm^2), TCC= Total chlorophyll content (mg/g), TSPC= Total soluble protein content (%), TGLYPP= Total green leaf yield per plant(g), TGLYPH= Total green leaf yield per hectare (t). Bold values indicate the highest value of the respective trait.

Phenotypic and Genotypic Coefficient of Variability (PCV and GCV)

Genotypic and phenotypic coefficients of variation are simple measures which are commonly used for the assessment of variability. The relative value of these types of coefficients gives an idea about the magnitude of variability present in a genetic population. In the present investigation, a higher phenotypic coefficient of variation was obtained compared to its corresponding genotypic coefficient of variation for all the traits evaluated. But, only slight differences were noticed between these two coefficient variations for almost all the traits (Table 4). It indicated that most of the traits under study were less influenced by environment. Similar results in fenugreek were previously reported by Hosamath et al. (2017), Krishnaveni et al.

(2021) and Yadav et al. (2024). High PCV values (more than 20%) were recorded PH, NPBPP, NGLH, LA and TGLYPH. Moderate PCV values (10–20%) were observed for DFF, DFGLH, DLGLF and TGLYPP. Low PCV values (less than 10%) were observed for days to 50% DF, TCC and TSPC. Likewise, high GCV values were recorded for PH, NPBPP and TGLYPH. Moderate GCV values were observed for DFF, NGLH and LA. Low GCV values were observed for 50%DF, DFGLH, DLGLF, TCC, TSPC and TGLYPP (Table 4). Similar findings were previously reported by Krishnaveni et al. (2021), Maurya et al. (2021), Singh and Rajpoot (2021), Kole et al. (2023) and Yadav et al. (2024). The proportion of GCV to PCV noticed in this investigation ranged from 48.60% in number of green leaf harvest to 98.74% in number of primary branches per plant. A significant difference between phenotypic and genotypic coefficients of variation suggests sensitivity to environmental factors, while a narrow difference indicates less environmental impact on trait expression. Traits exhibiting high to moderate phenotypic and genotypic coefficients of variation hold economic significance, offering potential for enhancement through selective breeding (Barik et al., 2023; Supriya et al., 2023).

Table 4. Mean, range and estimates of genetic parameters of 21 fenugreek genotypes.

Character	Mean	Range	GCV (%)	PCV (%)	GCV: PCV	h^2 in broad sense (%)	Genetic advance as % of mean
PH (cm)	16.80	11.10–22.55	20.80	24.80	83.87	70.36	35.95
DFF	34.34	30.20–40.07	10.80	11.86	89.24	79.73	16.20
50% DF	41.03	36.18–46.80	7.30	9.11	80.13	64.16	12.05
NPBPP	4.67	2.88–6.46	25.97	26.30	98.74	97.45	52.81
DFGLH	20.05	17.33–22.67	6.72	12.16	55.26	30.53	7.64
DLGLF	56.23	49.21–66.34	9.12	12.14	75.12	56.38	14.11
NGLH	4.92	3.00–6.67	17.26	35.51	48.60	23.62	17.28
LA (cm^2)	8.67	5.28–11.96	16.29	30.80	52.88	62.97	20.75
TCC (mg/g)	27.59	23.77–31.61	7.94	9.34	85.01	72.20	13.89
TSPC ((%)	3.07	2.69–3.34	6.85	7.17	95.53	91.15	13.48
TGLYPP (g)	46.92	40.14–54.99	9.25	10.60	87.26	76.12	16.63
TGLYPH	5.89	3.08–8.44	30.48	31.54	96.63	93.42	60.70

GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of Variation, h^2 = heritability, PH =Plant height (cm), DFF= Days to first flowering, 50%DF= Days to 50% flowering, NPBPP= Number of primary branches per plant, DFGLH= Days to first green leaf harvest, DLGLH= Days to last green leaf harvest, NGLH= Number of green leaf harvest, LA= Leaf area (cm^2), TCC= Total chlorophyll content (mg/g), TSPC= Total soluble protein content (%), TGLYPP= Total green leaf yield per plant(g), TGLYPH= Total green leaf yield per hectare (t).

Heritability and Genetic Advance (GA) as Percentage of Mean

Heritability provides a useful measure of the degree to which traits are inherited from parents to their offspring. Lush (1943) conceptualized heritability as the ratio of variance attributable to hereditary differences to the overall observed variance. For plant breeders estimates of heritability are beneficial in the selection of genotypes from diverse genetic populations. Following the heritability classifications (low, medium, and high) outlined by Johnson et al. (1955), this study found high heritability estimates for PH, DFF, 50%DF, NPBPP, LA, TCC, TSPC, TGLYPP and TGLYPH among the characters investigated. Medium heritability estimate was recorded for DLGLF and DFGLH and low heritability was recorded for NGLH (Table 4). High heritability suggested a diminished impact of environmental factors on observed variation. This implies that selection based on phenotypic expression could be dependable, given the substantial role of genetic constitution in the manifestation of these traits. Low heritability indicates that the character is highly influenced by environmental effects thereby genetic improvement through selection is difficult (Songsri et al., 2008).

Genetic gain refers to the enhanced performance observed in selected lines compared to the original population (Nayak, 2024). Johnson et al. (1955) proposed that utilizing heritability estimates in combination with genetic gain provides a more effective approach than relying solely on heritability when predicting the outcomes of selecting top-performing individuals. High heritability coupled with high genetic advance as percent of mean was observed for PH, NPBPP, LA and TGLYPH. Contrarily, DFF, 50%DF, TCC, TSPC and TGLYPP exhibited high heritability and medium genetic advance. Whereas, medium heritability along with moderate genetic advance was observed in the trait DLGLF. Given their control by additive gene action, these traits are deemed the most reliable for selection, as selection based on those is predicted to effectively improve yield (Panse, 1957). Traits like DFGLH was found to have medium heritability coupled with low genetic advance as per cent of mean and NGLH was found to exhibit low heritability accompanied with medium genetic advance. This suggests that the presence of dominance and epistatic effects, potentially rendering selection for this trait ineffective (Panse, 1957). Previously, Prakash et al. (2017), Meena et al. (2021), Mishra et al. (2021), Maurya et al. (2021), Singh and Rajpoot (2021), Kumari et al. (2022) conducted experiment on fenugreek by collecting several genotypes and observed high heritability and high GA value for the traits like PH, NPBPP, LA and TGLYPH which very nicely supported the present findings.

Correlation among the Traits

Effective crop improvement programs rely on the presence of substantial variability and inter-relationships among various traits, which are essential for successful selection strategies (Chatterjee, 2017; Chatterjee, 2022). These investigations also allow the breeders to ascertain the suitability of multiple traits for indirect selection, as selecting for certain traits can lead to correlated responses in others (Searle, 1965). Correlation coefficients, as statistical measures, quantify the interrelationships between multiple variables, helping to identify key traits that can be targeted to improve yield.

In the present study, phenotypic correlation co-efficient was analyzed for all the 12 characters under study. The characters namely NPBPP, DFF, TGLYPP, TCC, PH, 50%DF, DLGLF, LA, NGLH and TSPC showed positive significant phenotypic correlations with TGLYPH. It indicated that increment in these component traits can ultimately enhance the green leaf yield of fenugreek. Contrastingly, DFGLH was found to have negative significant correlation with green leaf yield per hectare. Therefore, selection for the early harvesting traits would automatically improve the yield (Figure 1).

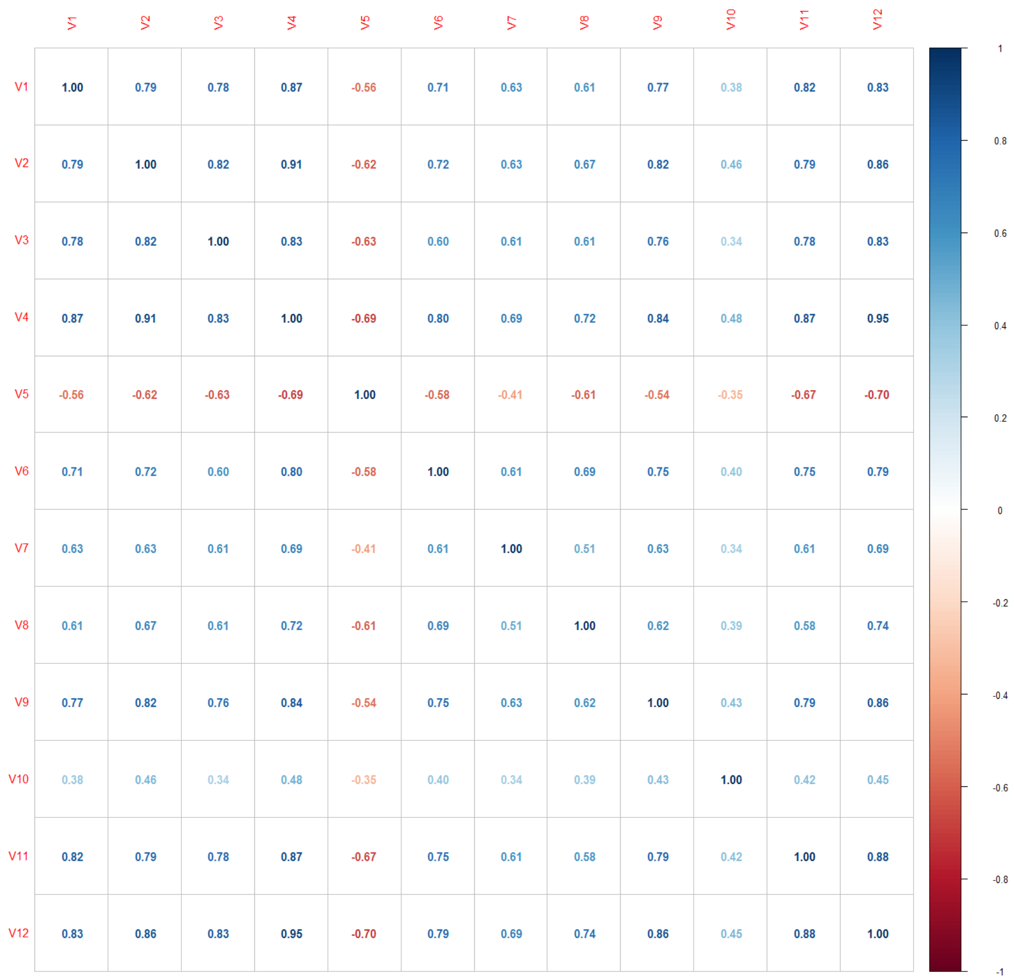

Fig. 1. Phenotypic correlations among twelve characters of fenugreek genotypes. V1—Plant height, V2—Days to first flowering, V3—Days to 50% flowering, V4—Number of primary branches per plant, V5—Days to first green leaf harvest, V6—Days to last green leaf harvest, V7—Number of green leaf harvest, V8—Leaf area, V9—Total chlorophyll content in leaves, V10—Total soluble protein content in leaves, V11—Total green leaf yield per plant and V12—Total green leaf yield per hectare.

Path Analysis

Correlation studies are valuable for identifying yield-contributing traits; however, associations become intricate with an increasing number of variables. This complexity arises because two traits might appear correlated due to their individual correlations with a third trait (Chatterjee et al., 2018). Path coefficient analysis addresses this issue by dissecting correlation coefficients into direct and indirect effects, enabling a detailed assessment of each trait's relative importance. In this study, direct and indirect effects were estimated through path coefficient analysis to understand how various independent traits, individually or in combination, influence yield.

Among the yield component traits, NPBPP showed high positive direct effects on TGLYPH followed by DLGLF, TGLYPP, LA, TCC and PH. Other traits like 50%DF, NGLH and TSPC expressed low positive direct effects on TGLYPH. The negative direct effects were exhibited by characters like DFF and DFGLH. Hence, direct selection through NPBPP, DLGLF, TGLYPP, LA, TCC and PH could be beneficial for yield improvement of fenugreek (Table 5). Residual effect of the path analysis was very low (0.0581) suggesting the inclusion of maximum green leaf yield determining characters in the present study. Previously, Choudhary et al. (2017), Mori et al. (2017), Krishnaveni et al. (2021) and Punia et al. (2021) reported similar kind of association of the traits with green leaf yield in fenugreek.

Table 5. Phenotypic path analysis for twelve characters of 21 genotypes. Residual effect = 0.0581, Direct effect = Bold diagonals.

Character	PH (cm)	DFF	D50F	NPBPP	DFGLH	DLGLH	NGLH	LA (cm²)	TCC (mg/g)	TSPC (%)	TGLYPP (g)	Correlation with TGLYPH at Phenotypic level
PH	**0.112**	−0.056	0.037	0.642	0.020	−0.045	0.015	0.074	0.092	0.002	−0.065	0.83 **
DFF	−0.051	**−0.072**	0.039	0.672	0.023	−0.046	0.015	0.082	0.097	0.003	0.108	0.86 **
D50F	−0.051	−0.059	**0.048**	0.623	0.024	−0.037	0.014	0.073	0.087	0.002	0.106	0.83 **
NPBPP	−0.057	−0.065	0.040	**0.739**	0.026	−0.051	0.017	0.087	0.101	0.003	0.120	0.95 **
DFGLH	−0.037	−0.047	−0.032	−0.532	**−0.036**	0.038	−0.011	−0.078	−0.069	−0.002	−0.092	−0.70 **
DLGLH	−0.047	−0.052	0.028	−0.063	0.021	**0.603**	0.014	0.084	0.087	0.003	0.100	0.79 **
NGLH	−0.041	−0.045	0.028	0.519	0.016	−0.038	**0.024**	0.061	0.071	0.002	0.082	0.69 **
LA	−0.039	−0.048	0.029	0.532	0.023	−0.043	0.012	**0.121**	0.071	0.002	0.079	0.74 **
TCC	−0.051	−0.060	0.036	0.645	0.021	−0.047	0.015	0.075	**0.116**	0.003	0.109	0.85 **
TSPC	−0.025	−0.033	0.017	0.360	0.013	−0.027	0.009	0.050	0.058	**0.006**	0.061	0.45 **
TGLYPP	−0.054	−0.057	0.037	0.655	0.024	−0.047	0.015	0.071	0.093	0.003	**0.136**	0.88 **

**: Significant at 1% level of probability.

CONCLUSIONS

It is necessary to develop the fenugreek genotypes with tall plants having more number of primary branches with maximum leaf area especially for vegetable purpose. The developed ideotype must also have late flowering habit, less interval between harvests (i.e., quick vegetative growth) with a good amount of chlorophyll and soluble protein in leaves. Plant height, number of primary branches per plant and total green leaf yield per hectare were characterized by high heritability coupled by high genetic advance. Characters like days to first flowering, days to 50% flowering, total chlorophyll content in leaves, total soluble protein content in leaves and total green leaf yield per plant revealed high heritability and medium genetic advance. These characters were conditioned by additive gene action and therefore, these characters would be more reliable for effective selection. Number of primary branches per plant, leaf area and total chlorophyll content in leaves were showing maximum positive direct effect on total green leaf yield per hectare. The genotypes 'Maxima—11', 'Pusa Early Bunching', 'Bckv—M—13', 'Bckv—M—48' were found most promising in respect to green leaf yield per plant and hectare.

AUTHORS CONTRIBUTION

S.M.: Conceptualization, Methodology, Writing—Original draft preparation; T.M.: Reviewing, Visualization; A.P.: Software, Data curation; P.S.N.: Writing—Original draft preparation; M.V.: Reviewing, Visualization; S.J.: Data curation, Investigation; P.B.: Supervision; V.H.K.R.: Reviewing and Editing; B.M.S.V.: Software, Validation; O.A.: Reviewing, Editing; N.D.: Data curation, Reviewing; S.C.: Writing—Original draft preparation, Supervision, Reviewing and Editing. All authors have read and agreed to the published version of the manuscript.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

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