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ORIGINAL ARTICLE

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Genetic Variability, Correlation and Path Analysis in Fenugreek Grown under Sub-humid Sub-tropical Red Lateritic Belt of Eastern India

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Thirty genotypes of fenugreek were grown during two consecutive winter seasons in sub-humid sub-tropical red lateritic belt of eastern India. Genetic variability, correlation and path coefficients were studied on eight agronomic characters, viz., plant height, days to flowering, branches per plant, pods per plant, pod length, seeds per pod, test weight and seed yield per plant. Analysis of variance pooled over the seasons revealed that the mean squares due to genotypes for all the characters studied were highly significant indicating presence of genetic variation in the test population. The estimates of genotypic and phenotypic coefficient of variation were high for branches per plant, moderate for plant height and test weight, and low for days to flowering and pod length. Heritability estimates were high for plant height, days to flowering, branches per plant and test weight and low for pod number, pod length, seeds per pod and seed yield The results of phenotypic and genotypic coefficient of variability, heritability and genetic advance revealed that improvement through selection for branches per plant, pods per plant and test weight would be effective in this population. Seed yield was positively and significantly correlated with plant height, branch number, pods per plant and seeds per pod at both genotypic and phenotypic levels indicating the importance of these characters for seed yield. The results of path analysis indicated that selection for tall plant height, late flowering with reasonable branch number, high number of seeds per pod and pods per plant are important which will help improve seed yield in this population.

Key words: Correlation, fenugreek, genetic variability, path coefficient, seed spice, quantitative characters

Fenugreek (*Trigonella foenum-graecum* L.) often called 'Greek hayes' is a self-pollinated annual crop grown for use as a leafy vegetable, condiment, fodder, green manure crop or for medicinal purposes. Leaves are very rich in protein containing about 18.6 - 40.9% at different stages of growth on dry weight basis. Seeds are used for fever, vomiting, anorexia, cough, bronchitis and colonitis. Because of its complex chemical composition, fenugreek seeds have numerous pharmacological properties: emollient, anti-inflammatory, internal healer, antiulcer, CNS (central nervous system) and sexual stimulant (Mishkinsky *et al.*, 1977), hypocholesterolemic (Oakenfull and Sidhu, 1990), glycemia lowering (Raghuram *et al.*, 1994), antitumor (Alkofahi *et al.*, 1996), lower hepatic toxicity (Sharma *et al.*, 1991), diuretic (Tanira *et al.*, 1989) and antioxidant (Ravikumar and Anuradha, 1999). Aqueous extract of the seeds has antibacterial properties.

Fenugreek is a leguminous seed spice, native to South-east Europe and West Asia. It is cultivated in India, Argentina, Egypt and Mediterranean countries like Southern France, Morocco, Algeria, Ethiopia and Lebanon. It is the third important seed spice in India. Fenugreek seeds are exported from India to different foreign countries. The major international markets for fenugreek seeds are Saudi Arabia, Japan, Srilanka, Korea and the United Kingdom.

In India, the productivity of fenugreek is very low (about 1225 Kg/ha) in comparison to other fenugreek growing countries. Unavailability of suitable high yielding varieties for various agro-climatic regions, cultivation in the marginal lands, poor crop husbandry, and inadequate plant protection measures are the main reasons behind the low productivity. Cultivation of fenugreek in sub-humid sub-tropical red lateritic belt of West Bengal, a province in eastern part of India, is limited. Study of variability is a pre-requisite for initiating breeding programme. Therefore, the present investigation was undertaken to assess the genetic variability, correlation and path coefficients in a population of 30 genotypes of fenugreek grown under sub-humid sub-tropical red lateritic belt of West Bengal.

MATERIALS AND METHODS

The experimental materials comprising 30 diverse genotypes of fenugreek were grown during two consecutive winter season at the Agricultural Farm of Institute of Agriculture (23º 39 N latitude and 87º42 E longitude with an average altitude of 58.9 metres above mean sea level), Visva-Bharati University, West Bengal. The farm is situated under sub-humid, sub-tropical, lateritic belt of West Bengal, a province in the eastern part of India. In each season, the date of sowing was 1st week of November with a spacing of 25 × 7.5 cm., fertilizer dose of 30:60:60 (N:P:K) kg ha^{-1} and need based crop management practices like proper time of thinning, weeding, hoeing, irrigation etc. were adopted. The genotypes were grown in a randomized block design with three replications. Each plot consisted of six rows of three-meter length. Data were recorded on five randomly selected plants from middle rows for eight agronomic characters, *viz.* plant height, days to flowering, branches per plant, pods per plant, pod length, seeds per pod, test weight and seed yield per plant. Data were subjected to analysis of phenotypic and genotypic coefficients of variability (Burton, 1952), heritability and genetic advance (Johnson *et al.*, 1955), correlation coefficients (Al-Jibouri *et al.*, 1958) and path coefficients (Dewy and Lu, 1959).

RESULTS AND DISCUSSION

The analysis of variance of 30 genotypes pooled over two seasons revealed that the mean squares due to genotypes for all the above characters were highly significant which indicated genetic variability among the experimental materials. The estimates of genotypic and phenotypic coefficient of variation (GCV and PCV) were high (>20%) for branches per plant (Table 1), moderate (10-20%) for plant height and test weight, and low (<10%) for days to flowering and pod length. But pod number and seed yield exhibited moderate GCV and high PCV values, while seeds per pod exhibited low GCV and moderate PCV values. Similar results were reported earlier by Gangopadhyay *et al.* (2010), Prajapati *et al.* (2010), Panwar *et al.* (2018), Mishra *et al.* (2021), Tariyal *et al.* (2021) and Roba *et al.* (2022). The estimates of PCV and GCV values for pod number, pod length, seeds per pod and seed yield showed large difference which indicated the greater role of environmental factors influencing the expression of this character. Very small difference was

observed for days to flowering indicating low sensitivity to environment and consequently greater role of genetic factors influencing the expression of these characters. This was reflected in the estimates of heritability in broad sense (Table 1) which were high for plant height, days to flowering, branches per plant and test weight and low for pod number, pod length, seeds per pod and seed yield. The results are in agreement with Banerjee and Kole (2004), Ahari *et al.* (2010), Prajapati *et al.* (2010), Panwar *et al.* (2018), and Roba *et al.* (2022). Genetic advance as per cent of mean (Table 1) were high for branches per plant, moderate for pod number and test weight, and low for plant height, days to flowering, pod length, seeds per pod and seed yield. According to Johnson *et al.* (1955) heritability used in conjunction with genetic advance provides better information for selecting the best individuals than the heritability alone. High to moderate estimates of heritability accompanied with high to moderate genetic advance for branches per plant and test weight indicated the predominance of additive gene action for the expression of these characters. Hence, selection for the above characters would be effective in this population.

Analysis of the genotypic and phenotypic correlations (Table 2) revealed that seed yield was positively and significantly correlated with plant height, branch number, pods per plant, pod length and seeds per pod at both genotypic and phenotypic levels indicating the importance of these characters for yield improvement. Similar correlations of seed yield with plant height and branch number (Dash and Kole, 2000), plant height and pods per plant (Gangopadhyay *et al.*, 2009; Panwar *et al.*, 2018; Tariyal *et al.*, 2021), seeds per pod (Prajapati *et al.*, 2010; Tariyal *et al.*, 2021) and pod length (Banerjee and Kole, 2004) have been reported. While selecting characters having direct bearing on yield, their associations with other characters are to be considered simultaneously as this will indirectly affect yield. Positive and significant correlations were observed at both phenotypic and genotypic levels in case of plant height with pods per plant, pod length, seeds per pod; branches per plant with days to flowering, pods per plant, seeds per pod; days to flowering with pods per plant, seeds per pod; pods per plant with pod length, seeds per pod; pod length with seeds per pod. Significant negative correlations in this experiment were observed for seed yield with days to flowering at both the levels and with test weight at genotypic level indicating negative influence of these characters in increasing seed yield. Days to flowering showed negative correlations with plant height and pod length. In general, test weight showed negative correlation with majority of the characters. Such type of negative association may arise primarily from developmentally induced relationship (Adams, 1967). The developing structures of the plant compete for a common factor, possibly limited nutrient supply and if one structure is more favoured than the other for any reason, a negative correlation may arise between them. Pleiotropy and / or linkage may also be the genetic reasons for this type of negative association. The results of correlation coefficient implied that plant height, branch number, pods per plant, pod length and seeds per pod may be considered for selection for yield improvement in this population of fenugreek.

The results of genotypic path analyses (Table 3) revealed that plant height (1.468) had the highest positive direct effect followed by days to flowering (1.19) and Seeds per pod (0.992). Branch number (-3.618), test weight (-1.901) and pod length (-0.327) showed very high negative direct effects. Moreover branch number and pod length showed negative indirect effects in the pathway of almost all the characters except test weight. Test weight, in addition to its high negative direct effect, showed negative indirect effects through days to flowering, seeds per pod and pod number which ultimately resulted in significant negative correlation with seed yield. High positive direct effects for plant height (Mahey *et al.*, 2003; Tariyal *et al.*, 2021), days to flowering (Prajapati *et al.*, 2010), seeds per pod (Datta *et al.*, 2005), and pod number (Gangopadhyay *et al.*, 2009; Prajapati *et al.*, 2010; Tariyal *et al.*, 2021) have been reported earlier.The residual effect (0.468) indicated that the seven characters included in this study explain 53 per cent of variation in grain yield in this population. The results of path analysis indicated that selection for tall plant height, late flowering with reasonable branch number, high number of seeds per pod and pods per plant are important which will help improve seed yield in the population under study.

Table 1: Phenotypic and genotypic coefficients of variability, heritability and genetic advance for eight quantitative characters in Fenugreek

Characters	Grand mean	Range	Coefficient of variation %		Heritability %	Genetic advance	Genetic advance as per cent of mean
			GCV	PCV			
Plant height (cm)	40.63	32.67-52.63	10.77	13.90	60.1	6.99	17.20
Days to flowering	57.44	52.33-74.50	09.35	09.66	93.6	10.70	18.63
Branches per plant	5.70	3.33-11.53	35.16	38.96	81.5	3.73	65.44
Pod number	23.04	14.83- 32.87	16.90	25.58	43.7	5.30	23.00
Pod length (cm)	7.15	6.23-8.85	6.35	10.19	38.8	0.58	8.11
Seeds per pod	10.21	6.83-13.22	8.84	16.05	30.3	1.02	9.99
Test weight (g)	11.11	6.72-13.55	11.64	13.70	72.2	2.26	20.36
Seed yield (g)	2.19	1.53-3.01	10.35	21.98	22.2	0.21	9.91

Table 2: Genotypic (G) and Phenotypic (P) correlation coefficients for eight quantitative characters in fenugreek

Characters		Days to flowering	Branch number	Pod number	Pod length	Seeds per pod	Test weight	Seed yield per plant
Plant Height	**G**	-0.400**	0.195**	0.820**	0.706**	0.624**	-0.033	0.979**
	P	-0.306**	0.130	0.459**	0.396**	0.375**	-0.047	0.674**
Days to flowering	**G**		0.942**	0.395**	-0.245**	0.466**	-0.955**	-0.362**
	P		0.816**	0.240**	-0.124	0.286**	-0.758**	-0.152*
Branch number	**G**			0.999**	0.142	0.708**	-1.054**	0.583**
	P			0.728**	0.069	0.383**	-0.821**	0.309**
Pod number	**G**				0.499**	0.706**	-0.944**	0.691**
	P				0.187*	0.269**	-0.533**	0.624**
Pod length	**G**					0.739**	-0.050	0.981**
	P					0.569**	0.054	0.623**
Seeds per pod	**G**						-0.598**	0.950**
	P						-0.240**	0.482**
Test weight	**G**							-0.424**
	P							-0.085

*, ** : Significant at P=0.05 and 0.01, respectively.

Table 3: Genotypic path coefficient analysis of seven quantitative characters on seed yield

Characters	Plant Height	Days to flowering	Branch number	Pod number	Pod length	Seeds per pod	Test weight	Correlation with seed yield
Plant height	**1.4679**	-0.4760	-0.7056	0.2463	-0.2374	0.6210	0.0627	0.979**
Days to flowering	-0.5872	**1.1900**	-3.4086	0.1187	0.0474	0.4623	1.8154	-0.363**
Branch number	0.2862	1.1210	**-3.6184**	0.3001	-0.0464	0.7023	1.8382	0.583**
Pod number	1.2037	0.4701	-3.6148	**0.3004**	-0.1631	0.7004	1.7945	0.691**
Pod length	1.0657	-0.1726	-0.5138	0.1499	**-0.3269**	0.7331	0.0456	0.981**
Seeds per pod	0.9189	0.5545	-2.5619	0.2121	-0.2416	**0.9920**	1.0759	0.950**
Test weight	-0.0484	-1.1365	3.4990	-0.2836	0.0078	-0.5615	**-1.9009**	-0.424**

Residual =0.468 Bold figures indicate direct effects

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

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