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Path analysis for seed yield and its component characters in fenugreek (*Trigonella foenum-graecum* L.)

K C Sharma & E V D Sastry

Department of Plant Breeding and Genetics
S.K.N. College of Agriculture, Jobner, (Rajasthan Agricultural University) Rajasthan, India

Abstract

Fenugreek (*Trigonella foenum-graecum* L.) is an important spice crop of Rajasthan. A vast germplasm collection is maintained at S.K.N. College of Agriculture, Jobner. Two hundred forty lines from this germplasm along with five promising varieties namely RMt-1, RMt-143, UM-144, UM-303 and local check were evaluated in an augmented block design at the research farm of S.K.N. College of Agriculture, Jobner on light textured soil. Results indicate that the genotypes showed significant differences for all the characters under study. All the character had more than 80% broad sense heritability but only seed yield per plant, biological yield and pods per plant had above 50% genetic advance expressed as % of mean. The association analysis revealed that the seed yield per plant was significant and positively associated with plant height, primary branches per plant, pods per plant, pod length, seeds per pod and biological yield at both phenotypic and genotypic levels and with test weight at phenotypic level. Further path coefficient analysis revealed that characters such as biological yield, pods per plant and primary branches per plant were the important characters for the selection of high yielding genotypes as they exerted positive direct effect as well as showed positive correlation with seed yield at both genotypic and phenotypic levels.

Key words: Variability, correlation, fenugreek path coefficient.

Introduction

Fenugreek (*Trigonella foenum-graecum* L.), is a multipurpose crop grown during winter season in northern Indian. It is one of the most important leafy vegetables in India which is also grown for fodder, spices and condiments purpose. In recent past, its high market price has attracted the farmers to include this crop in their cropping system. Its seed has both feed and medicinal value particularly against digestive disorders. Whereas its leaves are rich source of protein, mineral and vitamin C. Being a leguminous crop, the root nodules enrich the soil with atmospheric nitrogen. In the recent years, the importance of fenugreek seed has further enhanced due to the presence of alkaloids 'diosgenin' and 'trigonellin' having pharmaceutical use. Therefore in true sense it is multipurpose crop having paramount importance. Because of low water requirement, the crop fits well in the cropping system in the semi arid agro climatic system of Rajasthan. Despite the economic importance it is cultivated on the marginal land with poor fertility; the productivity is still very low. Lack of improved varieties results in the cultivation of local genotypes.

Therefore, an experiment was conducted to study on genetic parameters such as variances, heritability (broad sense) and genetic advance for different morphological characters in the germplasm collection and also to determine association of different characters among each other with grain yield.

Material and methods

The experiment material consisted 240 fenugreek genotypes collected from different geographical areas of Rajasthan, India and maintained under All India Coordinated Spices Improvement Project at Jobner along with five promising varieties as checks (RMt-1, RMt-143, UM-144, UM-303 and local). These lines were evaluated in a field trial conducted in an augmented complete block design (Federer, 1956) during rabi at the research farm S.K.N. College of Agriculture Jobner on light textured soil. These genotypes were divided into six blocks, each blocks consisted of forty five genotypes along with five checks. Each plot of 4 x 0.6 m2 size accommodate two four m long rows spaced 30 cm apart. Plant to plant distance was adjusted at 10 cm by thinning at three leaf stage. At the time of maturity data were recorded on ten randomly selected plants in each plot for plant height (cm), primary branches per plant, pods per plant, pod length (cm) seeds per pod, test weight (g), biological yield per plant (g) and seed yield per plant (g). Days to 50% flowering was recorded on whole plot basis. The average value of ten plants for various characters were used for statistical analysis. The analysis of variance was calculated as per the method suggested by Federer (1956). The genetic parameters were studied by working out the genotypic and phenotypic coefficient of variation (Burton, 1952), heritability in broad sense (Hanson *et al.* 1956) and genetic advance (Johnson *et al.* 1955) for all traits. The genotypic and phenotypic correlations were estimated according to (Johnson *et al.* 1955). Path analysis was done to partition total correlation into direct and indirect effects as suggested by Dewey and Lu (1959).

Results and discussion

Analysis of variance (Table 1) revealed that significant difference between check varieties for days to 50 per cent flowering, plant height, primary branches per plant, pods per plant, pod length, seeds per pod, biological yield and seed yield per plant. Significant difference between checks indicates that checks themselves are diverse. Significant differences

Table 1. Mean sum of squares and variance for different characters of fenugreek.

Source of variance	DF	Mean sum of squares								
		Days to 50% flowering	Plant height (cm)	Primary branches per plant	Pods per plant	Length of pods (cm)	Seeds per pod	Bio-logical yield (g)	Test weigh (g)	Seed yield per plant (g)
Blocks (ignoring genotypes & checks	5	98.946**	19.32**	0.04	2.525	1.51**	1.32	0.20	0.30	0.24
Checks + genotypes (Eliminating blocks)	244	22.830**	52.64**	0.88	157.94**	0.68**	3.35**	7.85**	2.71**	2.54**
Checks	4	11.949**	2.974**	0.29*	65.29*	0.30**	2.14**	12.79**	0.17	7.66**
Genotypes	239	22.177**	53.02**	0.89**	159.65**	0.68**	3.37**	7.74**	2.71**	2.37**
Checks v/s genotypes	1	224.328**	52.85**	0.00	116.29**	0.02	4.46**	15.44**	14.17**	21.82-**
Error	20	1.907	4.32	0.10	18.08	0.05	0.34	0.69	0.14	0.22
Genotypic variance	-	20.270	48.71	0.80	141.57	0.64	3.03	7.05	2.30	2.15
Phenotypic variance	-	22.177	53.02	0.90	159.65	0.70	3.37	7.74	2.71	2.37

* Significant at p= 0.05 and ** Significant at p=0.01

between 240 genotypes were found for all the characters indicating existence of sufficient diversity among genotypes. In an augmented design the error variance is inflected and thus the difference between the genotypes may not be estimated that precisely. Perusal of Table 2 indicated that the range was highest for pods per plant (14.0-85.7) followed by days to 50% flowering (55.6-94.2) and plant height (31.6-74.6) among all the characters, while lowest range was observed for primary branches per plant (2.3-7.5) followed by length of pod (7.2-13.0). When the variation is compared on the basis of coefficient of variation the magnitude of phenotypic variance was higher as compared to genotypic variance was higher as compared to genotypic variance for all the characters in the present investigation indicating a positive effect of environment on the characters. The difference between GCV and PCV were however low. High coefficient of variation was recorded for seed yield per plant followed by pods per plant and biological yield, while, lowest variability was recorded for days to 50 per cent flowering followed by length of pod and seeds per pod. Pant *et al.* (1983) observed high coefficient of variation for seed yield per plant and pods per plant, while lowest coefficient of variation was observed for test weight. Such observations were also reported by Shukla and Sharma (1977) and Sharma *et al.* (1990). The results of the present investigation thus support these earlier reports.

Table 2. General mean, range, coefficient of variation, heritability (In broad sense) and expected genetic advance in fenugreek

Characters	Mean	Range	Genotypic coefficient of variation (%)	Phenotypic coefficient of variation	Heritability % (broad (%) sense)	Expected genetic advance (as % of mean)
Days to 50% flowering	67.30	55.6-94.2	6.68	6.99	91.40	13.17
Plant height (cm)	49.80	21.6-74.6	14.0	14.62	91.85	27.65
Primary branches per plant	4.75	2.3-7.5	18.83	19.92	89.20	36.59
Pods per plant	39.67	14.0-85.7	29.99	31.85	88.67	58.13
Length of pods (cm)	10.31	7.2-13.0	7.75	8.07	92.20	15.32
Seeds per pod	15.65	11.0-21.2	11.55	11.72	89.87	21.67
Biological yield (g)	8.94	4.4-21.1	29.70	31.11	91.11	58.39
Test weight (g)	12.55	5.2-19.4	12.07	13.11	84.79	22.88
Seed yield per plant (g)	4.33	1.1-10.8	33.83	33.56	90.55	66.29

The broad sense heritability was found to be higher for almost all characters. It was above 80 per cent for all the characters. Highest heritability was observed for length of pod (92.20%) followed by plant height (91.85%) and days to 50% flowering (91.40 %), supporting the reports by Shukla and Sharma (1977), Sharma *et al.* (1990). Genetic advance (as percentage of mean) for the characters ranged from 13.17% (days to 50% flowering) to 66.29% (Seed yield per plant). The highest genetic advance was found for seed yield per plant followed by biological yield and pods per plant. Low genetic advance was found for days to 50 percent flowering, followed by length of pod. Low variation for these traits is a common occurrence supporting the report by Kailash Chandra (1992). Based upon the study on variability analysis it may be concluded that besides seed yield higher genetic advance was recorded for pod per plant, biological yield and primary

Table 3. Correlation coefficient on the basis of unadjusted value (phenotypic level) and on the basis of adjusted value (genotypic level) between difference characters of fenugreek

Characters		Plant height (cm)	Primary branches per plant	Pods per plant	Length of pods (cm)	Seeds per pod	Biological yield (g)	Test weigh (g)	Seed yield per plant (g)
Days to 50%	rg	0.1275	-0.1053	0.1032	0.1474*	-0.1572*	-0.0141	-0.3724**	0.1013
flowering	rp	-0.0437	-0.0243	0.0109	0.0685	0.1295	0.0138	-0.1590*	-0.0146
Plant	rg		0.2291**	0.4368**	0.4573**	0.5136**	0.2482**	-0.3520**	0.3213**
height (cm)	rp		0.3955**	0.4405**	0.4178**	0.4631**	0.3055**	-0.1000	0.2529**
Primary branches	rg			0.5806**	0.2808**	0.3510**	0.2004**	0.1986*	0.2840**
per plant	rp			0.6156**	0.2934**	0.3361**	0.2554**	0.624	0.3296**
Pods per plant	rg				0.3373**	0.4201**	0.2280**	0.0758	0.3404**
	rp				0.3623**	0.3199**	0.2891**	0.0459	0.3921**
Length of pods	rg					0.3922**	0.1416*	-0.2089**	0.2680**
(cm)	rp					0.4181**	0.1796*	-0.0690	0.1533*
Seeds per pod	rg						0.1408*	-0.0437	0.1251**
	rp						0.1472*	-0.0158	0.1583*
Biological yield	rg							0.0263	0.7830**
(g)	rp							0.0945	0.8291**
Test weight (g)	rg								-0.0509
	rp								0.1769
Seed yield per	rg								
plant (g)	rp								

rg- genotypic level rp- phenotypic level.
*significant at p = 0.05 and ** significant at p- 0.01

branches per plant. These traits had higher heritability and higher variation. Thus, indirect selection based upon these traits may be effective in increasing yield.

A comparison of phenotypic and genotypic correlation obtained in the present investigation indicated that in general the association at genotypic level was stronger than that of phenotypic level. The seed yield per plant exhibited positive and significant association with almost all the traits namely plant height, primary branches per plant, pods per plant, pod length, seeds per pod and biological yield at genotypic and phenotypic level, while, with test weight only at phenotypic level. Days to 50 per cent flowering and test weight at genotypic level showed negative and non significant correlation, while, days to 50 per cent flowering and test weight at phenotypic level showed negative and non significant correlation, while, days to 50 per cent flowering at genotypic level showed positive and non significant correlation with seed yield per plant. Such observations were also reported by Shukla and Sharma (1977) and Sharma *et al*. (1990). Shukla and Sharma (1977) also reported negative correlation for days to flowering similar to the present study, significant negative association with seeds per pod and length of pod was also reported by Pant *et al*. (1983b), negative and significant correlation with pod per plant reported by Berwal *et al*. (1996). Differences in the association reported by different studies are the result of variation in the experimental material.

Path coefficient analysis indicated that maximum direct contribution on the seed yield was through biological yield (0.780)

Table 4. Direct and Indirect effect of different characters on seed yield in fenugreek at phenotypic and genotypic level.

Characters		Days to 50% flowering	Plant height (cm)	Primary branches per plant	Pods per plant	Length of pods (cm)	Seeds per pod	Biological yield (g)	Test weigh (g)	Correlation with seed yield (g)
Days to 50%	rp	-0.0140	0.0030	-0.0010	0.0020	-0.0024	0.0027	0.0108	-0.0155	-0.0146
flowering	rg	0.0888	0.0016	-0.0075	0.0084	0.0117	-0.0045	-0.0103	0.0130	0.1013
Plant	rp	0.0006	-0.0677	0.0169	0.0796	-0.0149	-0.0096	0.2385	0.0098	0.259**
height (cm)	rg	0.0113	0.0129	0.0163	0.0353	0.0369	0.0146	0.1822	0.0123	0.3213**
Primary										
branches	rp	0.003	-0.0268	0.0428	0.1120	-0.0105	0.0070	0.1994	0.0061	0.3296**
per plant	rg	-0.0093	0.0029	0.0710	0.0470	0.0223	0.0100	0.1471	-0.0069	0.2840**
Pods per plant	rp	-0.0002	-0.0298	0.0263	0.1807	-0.0129	0.0066	0.2258	-0.0045	0.3921**
	rg	0.0092	0.0056	0.0142	0.0810	0.0268	0.0119	0.1673	-0.0026	0.3404**
Length of pods	rp	-0.0010	-0.0283	0.0126	0.0655	-0.0357	0.0086	0.1402	-0.0067	0.1553*
(cm)	rg	0.0131	0.0059	0.0199	0.0273	0.0795	0.0111	0.1039	0.0073	0.2680*
Seeds per pod	rp	-0.0018	-0.0314	0.0144	0.0578	-0.0149	0.0207	0.1150	-0.0015	0.1583*
	rg	-0.0140	0.0066	0.0249	0.0340	0.0310	0.0284	0.1033	0.0015	0.2151**
Biological yield	rp	-0.0002	-0.0207	0.0109	0.0522	-0.0064	0.0030	0.7809	0.0092	0.8291**
(g)	rg	-0.0012	0.0032	0.0142	0.0185	0.0113	0.0040	0.7340	-0.0009	0.7830
Test weight (g)	rp	0.0022	0.0068	0.0027	-0.0083	0.0025	-0.0003	0.0738	0.0976	0.1769**
	rg	-0.0331	-0.0045	0.0141	0.0061	-0.0166	-0.0012	0.0193	-0.0350	-0.0509

Under lined figures indicated direSct effects,
Residual = 0.2696
* Significant at p=0.05 and **Significant at p=0.01

followed by primary branches per plant (0.0428) and pods per plant (0.180) at both genotypic as well as phenotypic level. Kailash Chandra (1992) reported a high positive direct effect plant height, number of pods per plant, test weight and biological yield on seed yield. The positive association between yield traits and yield was primarily because of direct effects. In case (plant height, primary branches per plant and seeds per pod) where the direct effects are low or negative their indirect effects via biological yield on seed yield were found to be high. This may be interpreted that these traits whose direct effect are low on seed yield effects seed yield through indirectly influencing total biological yield. A positive association observed between seed yield and biological yield indicate good partitioning of photosynthesis into seed yield.

Biological yield had high direct effect and it also had high correlation coefficient with seed yield. Magnitude of correlation coefficient between a causal factor and the effect is almost equal to its direct effect. Therefore, correlation explains the true association with each characters and suggest that a direct selection through this trait will be effective.

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