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Genetic variability and association analysis for seed yield and its components in fenugreek (*Trigonella foenum-graecum* L.)

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Abstract

An investigation was carried out to study genetic diversity and associations between yield components and agronomical traits in 60 genotypes of fenugreek. Analysis of variance showed significant differences among cultivars for all the growth parameters studied. High genotypic and phenotypic coefficient of variance was recorded for seed yield followed by number of pods/plant and seed viogur-II. High heritability was also observed for seed yield (81.75%) and number of pods/plant (73.91%). Seed yield was significantly and positively correlated both at genotypic and phenotypic level to plant height, number of branches/ plant, number of pods/plant, number of seeds/pod, test weight, germination and vigour. Highest positive direct effect on test weight followed by seed vigour-I, plant height and number of seeds/pod were also recorded. The information generated on these statistical parameters would be beneficial to identify the accessions having better yield potential which can be utilized in improvement of fenugreek.

Key words: Genotypic coefficient of variance, phenotypic coefficient of variance, heritability, genetic advance, correlation

Introduction

Fenugreek (*Trigonella foenum-graecum* L.), is widely cultivated worldwide. The use of fenugreek is multi purpose as it contains high food and medicinal value. The most of the yield attributes/characters are quantitatively inherited and highly affected by environment. The knowledge of magnitude of variability, heritability and genetic advance are useful parameters to breeding of any crop. Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) helps in determining the amount of variability. Correlation coefficient between traits provide effective basis for selection, whereas path coefficient analysis is highly productive method to reveal the direct and indirect effect of such associations. The significant contribution of traits would be of worth and can be used as selection criteria in crop improvement programme. Hence, the present investigation was undertaken to estimate the genetic parameters of variability, correlation and path coefficient analysis in fenugreek.

The experimental material comprised of 60 diverse genotypes which were evaluated in randomised block design under field conditions at Vegetable Research Farm of CCS HAU, Hisar in *rabi* 2015-16 and 2016-17. The seeds were sown in 3 m rows 50 cm apart with plant to plant distance of 20 cm. Observation on randomly selected plants (10) were recorded on quantitative characters, namely, field emergence index, days to 50% flowering, plant height (cm), pods per plant, number of branches per plant, pod length (cm), number of seeds per pod, seed yield (q/ha), test weight,(g) seed germination(%), seed vigour index-I and seed vigour index-II as per standard procedures. Rolled towel method (BP) was used for seed germination test. Four hundred seeds in four replications of each genotype were taken to record the seed germination. First count of normal seedling was taken on 5^{th} day and final count on 14^{th} day.

Seedling vigour indices: seedling vigour indices which are vigour index-I and II were calculated by the method proposed by Abdul-Baki and Anderson (1973).

Vigour index-I = Standard germination (%) X Average

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seedling length (cm)

Vigour index-II = Standard germination (%) x Average seedling dry weight (g)

The data collected were pooled and statistically analysed. PCV and GCV were calculated as per Burton and Devane (1953); estimation of heritability in broad sense and genetic advance were calculated as per the procedure given by Johnson et al. (1955). Correlation coefficient both at phenotypic and genotypic level was computed as suggested by Al-Jibouri et al. (1958) and path coefficient analysis was done by adopting the method given by Dewey and Lu (1959).

The extent of variability with respect to twelve quantitative characters in 60 genotypes was quantified in terms of mean performance, PCV and GCV, heritability and genetic advance as per mean are presented in Table 1. The range of variation was high for plant height no. of pods/plant, seed vigour-I and seed yield. Highest GCV and PCV were observed for seed yield followed by no. of pods/plant and seed vigour-II, respectively and lowest coefficient of variance was observed for days to 50% flowering at both levels. Lowest phenotypic and genotypic variation for days to 50% flowering has been recorded earlier by Mamatha et al. (2017). The actual strength of variability can be gained by comparing the relative amount of phenotypic and genotypic coefficient of variance. PCV was estimated higher than GCV for all the traits under study displayed the presence of additive effect of environment on the trait expression. The presence of wide range of PCV and GCV revealed the larger extent of phenotypic and genetic variability, whereas closeness between PCV and GCV specify the less effect of environment on the expression of the trait and hence they are under genetic control as has also been observed earlier (Nasik 2012; Gujar et al. 2015). Adequate amount of information for the advancement via selection can be procured by genetic coefficient of variation along with heritability (Burton 1952). A wide range of variation was recorded for heritability (broad sense) for different traits observed in fenugreek genotypes. Presence of high heritability indicated the preponderance of additive gene action in the expression of all the traits studied. The present findings are in accordance with several researchers (Dashora et al. 2011; Meena et al. 2011; Prajapati et al. 2010) who worked on fenugreek.

Table 1. Genetic parameter of yield and yield attributing characters in fenugreek genotypes

Traits	MEAN	RANGE	PCV	GCV	h^2	GAM
Field emergence index	9.72	8.70-11.13	7.54	4.47	35.08	5.45
Days to 50% flowering	54.19	49.99-57.42	5.04	3.54	48.67	5.08
Plant height	93.23	82.03- 101.70	12.90	10.70	68.74	18.28
Branches per plant	5.64	4.95-6.60	13.19	8.64	42.88	11.66
Pods per plant	77.76	63.80-89.55	23.79	20.45	73.91	36.23
Pod length	9.73	8.76-10.58	12.78	9.86	59.56	15.68
Seeds per pod	17.80	15.84-19.83	15.41	11.41	54.83	17.41
Test weight	11.64	9.88-13.52	12.51	8.55	41.24	11.87
Seed germinatin (%)	95.17	89.83-98.17	4.62	3.90	49.29	5.75
Seed vigour index-I	1332.95	1156.44-1478.17	11.56	6.25	29.23	6.96
Seed vigour index-II	57.93	50.61-67.15	23.54	17.61	56.00	27.15
Seed yield	19.79	16.79-22.98	27.69	26.53	81.75	52.35

PCV = Phenotypic coefficient of variation; GCV = Genotypic coefficient of variation; h^2 = Heratibility; GAM = Genetic advance as per mean

The study of genetic advance is more functional than heritability alone in predicting the resultant effect for selecting the best individuals. Affinity among heritability and genetic advance is due to additive gene action which has prime role and more reliable for effective selection. The high heritability with high genetic advance as percent of mean was observed for seed yield and no. of pods/plant which revealed

the presence of additive gene action in trait expression and good chances of improvement of these traits through direct selection in the present material. Naik (2012) and Verma and Ali (2012) also found that additive gene action is important for the expression of above mentioned traits.

Correlation coefficient and path coefficient analysis

Generally, genotypic correlation coefficients were higher than the phenotypic correlation coefficients which indicated masking of modifying effects of environment and also the presence of strong association between the two corresponding characters (Table 2). Similar trends of strong inherent association have been observed by Jain et al. (2013) in fenugreek for various traits. Higher genotypic correlation coefficient indicated that the selection for the characters as described in Table 2 might be rewarding. Positive correlation among the traits indicate that the selection of one trait for improvement may simultaneously improve the other trait. The genotypic correlation contributes the measure of genetic association among characters and proves to be a better correlation of breeding value. It is evident from the data that the seed yield was significantly and positively correlated at both genotypic and phenotypic levels with plant height, no. of branches/plant, no. of pods/plant, pod length, no. of seeds/pod, test weight, field emergence index, seed germination, seed viogur-I and II. Significant and positive correlation of plant height with no. of branches/plant, no. of pods/plant, pod length and no. of seeds/pod showed that with the increase of plant height the associated characters can also be improved. Test weight was found to be positively and significantly correlated with plant height, no. of branches/plant, no. of pods/plant, germination, seed vigour-I and II, but it was negatively correlated with no. of seeds/pod. Kole and Saha (2013) also observed similar correlations between the traits as also recorded in the present study. Field emergence index showed positive association with most of the character except days to 50% flowering, no. of branches per plant and test weight.

Table 2. Phenotypic (below diagonal) and genotypic (above diagonal) correlation coefficients among twelve traits in fenugreek

Traits	FEI	DF	PH	BPP	PPP	PL	SPP	TW	SG	SVI	SVII	SY
FEI	**1.000**	-0.025	0.124**	-0.100**	0.089**	0.123**	0.085**	0.050	0.493**	0.441**	0.276**	0.119**
DF	-0.018	**1.000**	-0.497**	-0.355**	-0.251**	-0.214**	-0.225**	-0.441**	-0.185**	-0.275**	-0.211**	-0.378**
PH	0.055	-0.305**	**1.000**	0.297**	0.581**	0.508**	0.447**	0.510**	0.601**	0.633**	0.231**	0.810**
BPP	-0.057	-0.192**	0.240**	**1.000**	0.714**	0.285**	0.779**	0.114**	-0.021	0.205**	0.315**	0.413**
PPP	0.030	-0.154**	0.446**	0.426**	**1.000**	0.565**	0.776**	0.129**	0.397**	0.454**	0.339**	0.634**
PL	0.071**	-0.144**	0.371**	0.167**	0.413**	**1.000**	0.536**	0.421**	0.476**	0.393**	0.344**	0.715**
SPP	0.048	-0.130**	0.316**	0.442**	0.542**	0.385**	**1.000**	-0.286**	0.303**	0.396**	0.407**	0.666**
TW	0.037	-0.130**	0.179**	0.095**	0.058	0.166**	-0.122**	**1.000**	0.518**	0.246**	0.262**	0.711**
SG	0.236**	-0.110**	0.340**	0.051	0.246**	0.306**	0.234**	0.150**	**1.000**	0.694**	0.304**	0.634**
SVI	0.218**	-0.122**	0.309**	0.114**	0.238**	0.213**	0.223**	0.097**	0.423**	**1.000**	0.377	0.625**
SVII	0.135**	-0.107**	0.167**	0.156**	0.231**	0.193**	0.242**	0.095**	0.176**	0.172**	**1.000**	0.356**
SY	0.079**	-0.272**	0.664**	0.289**	0.550**	0.588**	0.274**	0.274**	0.465**	0.397**	0.262**	**1.000**

FEI = Field Emergence Index; DF = Days to 50% flowering; PH = Plant height ; PPP = Pods per plant; BPP = Branches per plant; PL = Pod length; SPP = Seeds per pod; TW = Test Weight; SG = Seed germination; SVI = Seed Vigour Index-I and SVII = Seed Vigour Index-II

Path coefficient analysis imparts more realistic picture of the relationship among the characters. It was evident from the data that maximum positive direct effect on seed yield was recorded for test weight (0.498) followed by plant height (0.282) and seed vigour-I (0.278), whereas minimum positive direct effect was due to days to 50% flowering (0.125). Negative direct effect was noticed due to field emergence index, no. of branches branches per plant, seed germination and seed vigour-II. Path coefficient analysis revealed that plant height, pods per plant, test weight, seeds per pod and seed vigour index-I

are the most important characters for selection based on these traits would be more rewarding for improvement of fenugreek. The several researchers have shown the importance of both coefficient for improving the yield and its attributes in fenugreek reported by Balai et al. (2006) and Fikreselassie et al. (2012).

Present investigation revealed the presence of considerable amount of variation and existence of high heritable traits like seed yield and no. of pods per plant among fenugreek cultivars studied. Correlation analysis measures the magnitude of association among the traits and keeping in view test weight, plant height, seed vigour, no. of pods per plant and seeds per pod are the most important yield contributing traits for seed yield. These traits were also found to be responsible for the observed relationship of different morphological characters with seed yield. Hence, due emphasis could be given to above discussed traits in yield improvement programme.

Authors' contribution

Conceptualization of research (SKT, MK); Designing of the experiments (SKT); Contribution of experimental materials (SKT); Execution of field/lab experiments and data collection (PY); Analysis of data and interpretation (PY); Preparation of manuscript (PY, MK).

Declaration

The authors declare no conflict of interest.

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