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To estimate genetic variability analysis among different characters in germplasm of fenugreek [*Trigonella foenum-graecum* L.]

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Abstract

The field experiment was laid out in Augmented Block Design with 120 genotypes along with three checks in six blocks. The present investigation was conducted during November 2015 to March 2016 at Main Experimental Station of Vegetable Science, Narendra Deva University of Agriculture & Technology, Kumarganj, and Faizabad (U.P.). The characters studied were Days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, number of pods per plant, length of pod (cm), number of seed per pod, 1000 seed weight (g), seed yield per plant (g) and yield (q/ha). Data was analyzed statistically for their genetic divergence using non-hierarchical Euclidean cluster analysis. The study revealed genetic variation for all studied traits in fenugreek. Analyses of variance for the design of experiment of fenugreek showed that block were highly significant for all the characters. The P.C.V. was higher in magnitude than G.C.V. The maximum genotypic and phenotypic variances were observed for branches per plant and plant height. Number of branches / plant and Plant height (cm) showed very high genetic advance in percent of mean. Path coefficient analysis carried out at genotypic as well as phenotypic level revealed pods per plant, seed per pod and 1000 seed weight had positive direct effect on seed yield per plant, this indicates that selection for these traits will be useful.

Keywords: Genetic variability, GCV, PCV, genetic variation

Introduction

India has always been recognized as a "Home of Spices" in which the seed spices constitute an important group of agricultural commodities and play a significant role in national economy. India is the largest producer, consumer and exporter of spices in the world, where 63 kinds of spices are grown (Pruthi, 1998). India occupies a prime position among the fenugreek growing countries of the world. Fenugreek is both a tropical and temperate crop.

It has a wide adaptability and is grown in a wide range of climatic condition. It is tolerant to frost and freezing weather. It is grown from sea level up to an altitude of 2000 m. The crop is adopted to all type of soil, but its performance is good in well drained loamy soils. The optimum pH should be 6.0-7.0 for its better growth and development. However, national to the domestic need and the export target beyond 2000 A.D., their production requirement is 3-4 folds, up gradation of the existing level (Thomas *et al.* 1989, Edison and Johny 1991 and Peter, 1996) ^[21, 3]. India exports around 1205 tonnes of fenugreek to many countries like Saudi Arabia, Japan, Sri Lanka, South and North Korea, Singapore, UAE, Netherlands, USA and UK.

The volume of global trade is highly varying and the peak was in the year 1994-95 where in India exported a quantity exceeding 7,000 tonnes valued more than 12 crores rupees. There are two species of the genus *Trigonella*, which are of economic importance, viz., *Trigonella foenum-graecum* L. or the commonly called "methi" and *Trigonella corniculata* L. or the "Kasuri methi." Fenugreek is an annual herb, 30 to 90 cm tall and has light green leaves which are pinnately trifoliate. The flowers are papilionaceous and white or yellow in colour. Anthesis takes place between 9AM to 6PM with a peak at 11.30AM. The anthers dehisce between 10.30AM to 5.30PM with a peak between 11.30AM to 12.30NOON. Stigma become receptive 12 hours before flower opening and remains receptive for about 10 hours after the opening of flowers. The plants flower in about 30-37 days after sowing and the duration of flowering phase in 7-18 days. The species is typically self-pollinated and cleistogamous. Pollen fertility ranges from 95-98% in the unopened flower buds and 67-80% in the open flowers. The pods of approximately 10-15 cm long and each pod contains 10-20 small hard yellowish brown seed possessing smooth and oblong, about 3 mm long, each grooved across one corner, giving them a hooked appearance.

Fruits are legumes, long, narrow, curved and are tapering with a slender point which contains small deeply furrowed seeds. The pods mature within 60-70 days of sowing. The common methi is quick growing with upright shoot, white flower produced at the base of leaf and long (6-8 cm) straight pods. *Kasuri methi* is slow-growing with rosette shoots, flower bright orange to yellow produced on long flower stalk and pods small and curved or sickle-shaped. The genetic improvement of any crop depends upon its judicious exploitation through efficient breeding methods. Few high yielding varieties dominate in cultivation which often leads to genetic homogeneity. It is also well established that genetic homogeneity leads to genetic vulnerability to biotic and abiotic stresses. In any crop breeding programme, germplasm serve as the most valuable reservoir in providing variability for various traits. Most of the economically important plant characters are polygenic. Fenugreek is a self-pollinating crop with cleistogamous flowers. The breeding procedures commonly adopted in self-pollinating crops can be used in fenugreek. These breeding methods may be pure line selection, hybridization, pedigree method of selection and backcrossing. Mass selection is useful for maintenance of cultivars. Selection and hybridization approaches are easily followed in bringing about the quantitative improvement in order to bring about desired improvement. It is essential to assess nature and magnitude of variability, heritability and genetic advance for various characters in respect of germplasm available for maximizing the correlated response to selection. Beside knowledge of inter-character association and direct and indirect effect on seed yield is also essential. The crop plays an important role in our national economy (Devakaran, 1989) [2]. To cater the domestic and export requirement, their production requires 3-4 times of this multi-purpose crop.

Materials and Methods

The present investigation was carried out during Rabi season of 2015-16 at Main Experiment Station (Vegetable Research Farm), of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) India. The experiment was conducted in Augmented Block Design. The material used in the experiment comprised of 120 selected germplasm lines of fenugreek and three checks. Geographically the experimental site falls under humid subtropical climate and is located at 26° 47' N latitude and 82° 12' E longitudes at an elevation of altitude of 113 meter above the mean sea level. Geographically it falls in north east gangetic alluvial plains of eastern U.P. Faizabad region. The climate of district Faizabad is semi-arid with hot summer and cold winter. Maximum rains in this area are received from July to the end of September. The winter months are usually cool and dry but occasional light showers are also not uncommon whereas, summer months are extreme hot and dry. The data was recorded at meteorological observatory of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) One hundred twenty genotypes of fenugreek maintained in All India Co-ordinated Research Project on Spices were taken for this investigation. These Narendra Methi (NDM-1) to genotypes Narendra Methi (NDM-120) were collected from Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad, Uttar Pradesh. The check varieties were Hisar Sonali (C.C.S.H.A.U., Hisar, Haryana), PEB (IARI, New Delhi) and Rajendra Kranti (R.A.U., Bihar). A random selection of five plants was made in each plot for

recording the observations on different characters under study. The experimental materials were evaluated in Augmented Block Design (ABD) with spacing of 30cm × 10cm with plot size of 2.0m × 1.2m. The observations were recorded on ten quantitative characters viz. days to 50 percent flowering, days to maturity, plant height, branches per plant, pods per plant, length of pod, seeds per pod, 1000-seed weight (g), seed yield per plant (g) and seed yield (q/ha). Mean data for each trait was used for statistical analysis. The statistical analysis was done by using the techniques of analysis of "Augmented Block Design". These designs were developed by Federer (1956) [4]. The analysis of variance for different characters in augmented design was done following Federer (1956) [4]. Variability of different characters was estimated as suggested by Burton and de Vane (1953) [1].

Result and Discussion

The range, general mean, phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV), heritability in broad sense (h^2_b), genetic advance and genetic advance in percent of mean for different characters of fenugreek (*Trigonella foenum-graecum* L.) germplasm are presented in Table-1. The phenotypic coefficient of variation was estimated for one hundred twenty genotypes for ten characters. The number of branches per plant (22.48%) showed highest phenotypic coefficient of variation followed by plant height (20.16%), seed yield q/ha (15.92%), seed yield per plant (15.89%), pods per plant (15.75%), seeds per pod (13.19%), 1000-seed weight (12.37%) and length of pod (7.65%). The remaining two characters viz., days to maturity (2.10), and days to 50% flowering (2.01), showed low value of PCV. The estimate of genotypic coefficient of variation (GCV) for ten characters viz., branches per plant (21.96%), plant height (19.57%), showed highest GCV. Aim of any plant breeding programme is to develop high yielding varieties with better quality superior over existing one. The variability for selection of superior type can be obtained through vigorous screening and evaluation of germplasm. The knowledge of association between characters and their direct and indirect contribution towards expression of seed yield is the additional help to plant breeder in deciding the selection criteria. Germplasm collections provide the richest source of variability (Frankel and Hawkes, 1975). In the present study, experimental material comprised of one hundred twenty genotypes of fenugreek (*Trigonella foenum-graecum* L.) collections, exhibition of wide spectrum of variation for various characters, were evaluated in field conditions during, 2015-2016. The experiment was conducted in Augmented Block Design at Main Experiment Station of Vegetable Research Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) India. The observations were recorded on ten quantitative characters viz. days to 50 percent flowering, days to maturity, plant height, branches per plant, pods per plant, length of pod, seeds per pod, 1000-seed weight (g), seed yield per plant (g) and seed yield (q/ha). The analysis of variance revealed highly, significant differences among the genotypes for all the ten characters, which validated further statistical and genetical analysis presented in table. The assessment of existing variability in germplasm collections was done by computing coefficients of variation at phenotypic and genotypic levels. In Analysis of variance (ANOVA) table, the variance is divided in three parts, due to replication, treatment and error. In Analysis of variance, the variances due to replication were highly significant for all the characters,

except days to maturity In Analysis of variance, the variance due to treatment plant height, branches per plant, seeds per pod, 1000-seed weight were non-significant except the remaining characters. A very wide range of variation in mean performance of genotypes was observed for all the characters under study. The genotypes, NDM-1 and NDM-28 showed highest seed yield (q/ha) (20.00 q/ha) and significantly exceeded the general mean as well as rest of the entries, thereby, constituting top non-significant group for seed yield (q/ha) alone. NDM-1 also exhibited above average mean performance for plant height, branches per plant, pods per plant, seed yield per plant. Thus, NDM-1 emerged as most promising genotype for exploitation in breeding programme because it showed high mean performance for most of the yield contributing traits under study. Besides NDM-1, ten others genotypes showed significantly higher seed yield (q/ha) than general mean and these genotypes were NDM-28 (20.00 q/ha), NDM-25 (19.33 q/ha), NDM-119 (18.67 q/ha), NDM-4 (17.67 q/ha), NDM-7 (17.33 q/ha), NDM-84 (17.33 q/ha), NDM-2 (17.00 q/ha), NDM-11 (17.00 q/ha), NDM-49 (17.00 q/ha) and NDM-8 (16.67q/ha).

The second highest genotype for seed yield (q/ha) was NDM-28 (20.00 q/ha) possessing high mean performance for plant height, pods per plant, 1000-seed weight and seed yield per plant. The genotype, NDM-25 (19.33 q/ha), ranked third for seed yield (q/ha) showed above average mean performance for plant height, branches per plant, pods per plant and length of pod. The fourth ranked genotype for seed yield (q/ha) was NDM-119 (18.67 q/ha) having above average mean performance for 1000-seed weight and seed yield per plant. The three entries, mentioned above along with NDM-119, emerged at most important genotypes having very high mean performance for most of the seed yield attributes. These genotypes merit special consideration for exploitation in hybridization programme for developing high yielding better fenugreek varieties. NDM-4 (17.67 q/ha) and NDM-7 (17.33q/ha) ranked fifth and sixth for seed yield (q/ha) respectively. These two genotypes, NDM-4 variably showed high mean performance for days to branches per plant, 1000-seed weight and seed yield per plant, while NDM-7 showed high mean performance for branches per plant, pods per plant and seed yield per plant. NDM-84 (17.33 q/ha), NDM-2 (17.00 q/ha) and NDM-11 (17.00q/ha) ranked seventh, eighth and ninth in respect of seed yield (q/ha). These three genotypes showed high mean performance for seeds per pod for NDM-84, plant height, branches per plant, pods per plant, seeds per pod and seed yield per plant for NDM-2 and plant height, branches per plant, length of pod and seed yield per plant for NDM-11 respectively. NDM-49 (17.00 q/ha)

appeared mean performance for seeds per pod, 1000-seed weight and seed yield per plant. On the other hand NDM-8 (16.67 q/ha) showed mean performance for branches per plant, pods per plant, seeds per pod and seed yield per plant. These genotypes may serve as valuable parents for hybridization programme, planned for developing high yielding varieties possessing better seed yield attributes. The genotypes mentioned above may serve as promising parent's/donors for seed yield (q/ha) and others characters for which they showed high mean performance. Similarly, some other genotypes showing very high mean performance for other characters can be used as donors for improving these characters in a component breeding approach even if they have medium or low seed yield (q/ha). The genotype mentioned above may be used in hybridization programme aimed at improving the characters for which they showed very high mean performance. The genotypic and phenotypic coefficients of variation are computed to assess the nature and magnitude of existing variability in the germplasm. The high magnitude of genotypic coefficient of variation (GCV) along with phenotypic coefficients of variation (PCV) are recorded for branches per plant (PCV=22.48%, GCV=21.96%). On the other hand plant height showed high PCV along with moderate GCV (PCV= 20.16%, GCV=19.57%). This indicated greater scope of obtaining high selection response for these two traits owing to presence of high genetic variability. The existence of high variability for branches per plant and plant height in fenugreek was in conformity with the findings of earlier workers [Shukla and Sharma (1978); Raghuvanshi and Singh (1982); Pant *et al.* (1984); Mehta *et al.* (1992); Singh (2000); Kumar and Choudhary (2003); Kole and Mishra (2006); Sarada *et al.* (2008); Singh and Pramila (2009); Naik *et al.* (2009); Prajapati *et al.* (2010); Muniappan *et al.* (2010); Naik *et al.* (2011); Singh *et al.* (2014)]^[17, 15, 12, 8, 18, 7, 6, 16, 20, 10, 19]. The moderate estimates of coefficients of variation at genotypic and phenotypic level was found for pods per plant (PCV=15.75%, GCV=15.46%), seed yield (q/ha) (PCV=15.92%, GCV=15.18%), seed yield per plant (PCV=15.89%, GCV=15.15%), seeds per pod (PCV=13.19%, GCV=12.11%), 1000-seed weight (PCV=12.37%, GCV=12.30%), and low estimates of coefficients of variation at genotypic and phenotypic level was found for length of pod (PCV= 7.65%, GCV= 4.72%), days to maturity (PCV= 2.10%, GCV= -2.05%) days to 50% flowering (PCV= 2.01%, GCV= 1.25%) which suggested that selection directly based on these traits would not be much rewarding. The estimates of phenotypic coefficients of variation are slightly higher than genotypic coefficients of variation for all the ten characters, which indicates least influence of environmental effects.

Table 1: Estimates of range, grand mean, phenotypic (PCV) and genotypic (GCV) coefficient of variation, heritability in broad sense [$h^2_{(bs)}$], genetic advance in percent of mean (\bar{G}_a %) for ten characters in Fenugreek genotypes

S. No.	Characters	Range		Grand mean	PCV (%)	GCV (%)	Heritability broad sense (%) (h^2_{bs})	Genetic advance	Genetic advance in percent of mean (\bar{G}_a)
		Lowest	Highest						
1.	Days to 50% flowering	65.00	77.67	70.12	2.01	1.25	38.57	1.12	1.59
2.	Days to maturity	123.67	135.67	128.58	2.10	2.05	95.77	5.33	4.14
3.	Plant height (cm)	24.33	103.33	60.85	20.16	19.57	94.27	23.82	39.14
4.	Number of branches / plant	2.67	13.00	5.36	22.48	21.96	95.45	2.37	44.21
5.	Number of pods /plant	24.00	60.67	33.96	15.75	15.46	96.34	10.62	31.27
6.	Length of pod (cm)	6.67	14.67	11.16	7.65	4.72	38.13	0.67	6.00
7.	Number of seed /pod	7.33	23.33	15.61	13.19	12.11	84.18	3.57	22.86
8.	1000-seed weight (g)	4.80	10.60	6.93	12.37	12.30	98.84	1.75	25.25
9.	Seed yield/plant (g)	2.60	6.00	3.70	15.89	15.15	90.91	1.10	29.72
10.	Yield (q/ha)	8.67	20.00	12.33	15.92	15.18	90.92	3.68	29.84

Table 2: Analysis of variance for ten characters in Fenugreek genotypes

Character	Source of variation		
	Block	Check	Error
	5	2	10
Days to 50% flowering	54.380**	12.283	6.117
Days to maturity	36.853**	23.731**	1.541
Plant height (cm)	1978.175**	80.264	43.081
Branches/plant	19.468**	0.018	0.350
Pods/plant	31.89**	7.776	5.229
Length of pod (cm)	2.313	0.559	2.253
Seeds/pod	3.513	3.072	3.358
1000-seed weight (g)	0.500**	1.257**	0.042
Seed yield/plant (g)	1.589**	0.090	0.157
Seed yield (q/ha)	17.769**	1.007	1.749

*- Significant at 5 percent probability level

**-. Significant at 1 percent probability level

Conclusion

Based on overall findings of the present study, it was concluded that there was a wide range of variation among the germplasm lines for all the characters indicating that considerable scope existed for the improvement of fenugreek cultivars through hybridization and subsequent selections. Minimum variation was observed between phenotypic coefficient of variation and genotypic coefficient of variation in majority of the traits indicating least influence of environmental factors. Genetic parameters in association with correlation study indicated that for selection of superior genotypes primary, emphasis should be given on pods per plant, seeds per pod and length of pod. Out of one hundred twenty genotypes and three checks NDM-1, followed by NDM-28, NDM-25, NDM-119, NDM-4, NDM-7, NDM-2, NDM-11 and NDM-49 were found superior for yield and these germplasm may be recommended for large scale cultivation among the farmers after proper testing in multi location trials and these superior genotypes can be used as donors in breeding programme.

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