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Genetic Variability, Heritability and Genetic Advance in Fenugreek (*Trigonella foenum-graecum* L.) Genotypes

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ABSTRACT

The experimental material consisted of 20 accessions which were evaluated the estimates of genetic variability heritability and genetic advance in fenugreek. High coefficients of variation were recorded for seed yield per plant and number of pods per plant, while, lower coefficients of variation were recorded for days to 50 per cent flowering, pod length and 1000-seed weight. The highest heritability (broad sense) was observed for plant height 90 DAS (96.00%) followed by number of pod per plant (90.70%), seed yield per plant (88.30%), 1000-seed weight (82.30%), plant height 60 DAS (75.70%), seeds per pod (74.10%), days to 50% flowering (70.40%), number of primary branches per plant (46.20%), plant height 30 DAS (42.10%), pod length (24.00%). When variability, heritability and genetic advance are considered together seed yield per part, pods per plant and number of primary branches per plant may be the best table traits that could be exploited for hybridization and selection for improvement since these characters recorded high variability, high heritability and high to moderate genetic advance.

Key words: *Fenugreek, variability, yield, pcv, gcv, heritability and genetic advance.*

INTRODUCTION

India is known as the "Land of Spices" as foreign invaders invades India for spices in ancient times. India is the largest producer, consumer and exporter of spices and spice products. Fenugreek (*Trigonella foenum-graecum* L.) is an annual diploid species, popularaly grown by its vernacular name "*methi*", belonging to the sub-family "*papilionaceae*" of the family "*fabaceae*". It is native to the contries bordering the Eastern shores of *Mediterranean* region, extending to Central Asia. It is a self- pollinated crop with chromosome no. 2n=16[9] .The genus Trigonella is one of the largest genera of the tribe *Trifoliat* in the family Fabaceae and sub-family *Papilionaceae*. Among *Trigonella* species, *Trigonella foenum-graecum* (commonly known as fenugreek) is an annual species, It is indigenous to countries on the Eastern shores of the Mediterranean, but widely cultivated in India, Egypt, Ethiopia, Morocco and occasionlly in England[18].

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Fenugreek occupies a prime position among various seed spices grown in India. It is an annual herb belonging to sub-family *papilionaceae* of the family *leguminaceae*. Fenugreek has three culinary uses; as an herb (dried or fresh leaves, as a spice (seeds) and as a vegetable (fresh leaves and sprouts). It is mainly a condiment, but its seeds are also used as carminative and are an ingredient of several Ayurvadic medicines, mainly those prescribed for promoting appetite, correcting digestive disorder and for relieving the pain of joints particularly in old age of life. It is grown both for seed as well as for fodder purpose. Its green fodder compare very well with Lucerne and barseem. It is one of such crop in which every part is consumed in one or other form. Its tender leaves are consumed as leafy vegetables; chopped leaves are mixed in flour to prepare '*Parantha*'. Seed has corminative property and is also an important ingredient in concentrate feed for animals. It is also serves as a soil renovating crop. Being a legume crop, its root nodules containing bacteria '*Rhizobium*' improves the soil fertility by fixing atmospheric nitrogen. Medicinal properties of fenugreek are due to presence of antioxidant and antinflammatory compounds such as genistein, kaempferol, quercetin, rutin, apigenin, selenium and superoxidedismutase. Fenugreek is advised for breast-feeding mothers for increasing breast milk production. Fenugreek paste is used as a shampoo for preventing hair fall. Environmentally, fenugreek could help in preserving the integrity of agricultural land by reducing soil erosion. Compared to continuous corn, hay crops can reduce soil loss by about 90%. Reduction of soil erosion is a key component of soil conservation and improved water quality as large amount of phosphorus can be transported off the farm through soil loss. In addition, the roots of legumes help break up compacted soil layers and are effective soil builders. The ability of fenugreek to fix its own nitrogen lowers its fertility requirement during its production and in the following year's crop.

The leaves and shoots are quite rich in protein, minerals and vitamin A and C[21]. Reported that fenugreek seed contain protein (25.5%), fat (7.9%), mucilaginous matter (20%) and saponins (4.8%). The seeds also contain cellulose, hemicelluloses and major nutrients like phosphorus, potassium and mineral nutrients like calcium, iron and sodium, amino acids like leucine, valine, lysine and phenylalanine. Fenugreek is used both as whole seed and in powdered form and often roasted to reduce its bitterness and enhance the flavor. Seeds are bitter in taste due to presence of an alkaloid "*Trigonelline*".The importance of fenugreek has further increased due to presence of a steroid called "*Diosgenin". Diosgenin* is used in the synthesis of sex hormones and oral contraceptives. Further the crop attracted the attention of the farmers and agricultural scientist due to high remunerative prices. In India it is mainly cultivated in Rajasthan, Gujarat, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, Himachal Pradesh and Haryana with total area of 13100 ha. and production of 138000 MT[2].The knowledge of genetic variation is important for selection in crop improvement program[7]. Found significant variation for flowering time and duration, growth habit and seed yield. Yield is a complex character governed by several other yield attributing characters. Since, most of the yield attributing characters are quantitatively inherited and highly affected by environment, it is difficult to judge whether the observed variability is heritable or not. Assessment of genetic variability is very important in order to know the possibility of improvement in characters under consideration. A complex character like seed yield is affected by several component characters. Thus, assessment of genetic variability for these characters is also important. Moreover, response lo selection is directly proportional to the variability present In the genetic material. Knowledge of estimates of heritability along with genetic advance as percentage of mean is important in order to know about the type of gene action governing the character under consideration. Available variability is a prerequisite for planning any breeding programme on scientific line. The evaluation also helps to assess the relative merits of different genotypes with regard to different characters and for selection of appropriate parents for hybridization. The present study was undertaken at BBAU, Lucknow to estimate the variability present in active germplasm of fenugreek and to evaluate the extent of association among yield and yield contributing traits.

MATERIALS AND METHODS

The experimental materials comprised of 20 fenugreek genotypes (Table.1). Each genotype was planted in a plot having 1.20 x 1.20 m^2 area in randomized block design with three replications. Thus, there were 32 plants in each plot planted at row and plant spacing of 25 × 10 cm. All the standard package of practices and plant protection measures were timely adopted to raise the crop successfully. Five randomly selected plants from each replication were utilized for recording observations and drawing sample for estimating variability, heritability and genetic advance in the Department of Applied Plant Science (Horticulture), BBAU, Lucknow during the winter season of 2016 to 2017. Set or 20 germplasm lines of fenugreek were obtained from the "Department of Plant Breeding and Genetics, S.K.N. College Of Agriculture, Jobner-303329, Sri Karan Narendra Agriculture University Jobner. The observations were recorded on days to 50 per cent flowering. Plant height, number of primary branches per plant, pods per plant, and seeds per pod, pod length. 1000-seed weight and seed yield per plant.. The critical differences for the treatments comparison were worked out, wherever the "F" test was found significant at 5 per cent level of significance. The mean values obtained from 2 years data were used for estimating the analysis of variance[17]. The genotypic and the phenotypic coefficients of variation were calculated by the formulae given[3], heritability in broad sense and genetic advance as percent of mean were computed following the methods of Allard[1], Johnson[11], respectively.

RESULTS AND DISCUSSION

Analysis of variance for ten morphological traits revealed significant differences among the genotypes for all the traits under study. The estimates of genetic parameter of variability viz., phenotypic and genotypic coefficient of variation (PCV and GCV) along with heritability in broad sense (h2) and genetic advance (GA) as percentage of mean for different characters are given in (Table. 2). The study showed high range for plant height at 90 DAS (64.07 – 88.16), number of pods per plant (25.80 - 46.73) and days to 50 per cent flowering (61.33 - 77.33). The highest estimates of PCV and GCV were for seed yield per plant (PCV = 29.48, GCV = 27.71) followed by number of primary branches per plant (PCV =18.16, GCV = 12.34) and number of pods per plant (PCV = 15.26, GCV = 14.53) followed by low for pod length (PCV = 6.57, GCV = 3.21). Narrow differences between PCV and GCV gave evidence to the lines that the variability exiting in them was mainly due to their genetic makeup. High estimates of heritability was noticed for pant height 90 DAS (96.00%) followed by number of pods per plant (90.70%) and seed yield per plant (88.30%) and plant height 60 DAS (75.70) showed moderate heritability estimates Pant *et al.* (1984). Plant height 30 DAS (42.10%) and number of primary branches per plant (46.20%) showed low heritability estimates. High heritability in broad sense indicated that large proportion of phenotypic variance was attributable to the genotypic variance and were less influenced by environment. High % of genetic gain was observed for seed yield per plant (53.65%) whereas it was number of primary pods per plant (28.51%) and 1000-seed weight (19.73%). Hence, selection can bring worthwhile improvement in these traits. The analyses of variance for ten characters revealed that mean square were highly significant for all. The extent of variability with respect to various characters in different diverse genotypes of fenugreek measured in terms of general mean, range, coefficients of variation along with the amount of heritability in broad sense and expected genetic advance as percent of mean for ten morphological characters are presented in (Table. 3). A wide range variation was observed for all most all the traits. UM-410 recorded the maximum heights plant height at 90 DAS (88.16), plant height at 60 DAS (44.00), plant height at 30 DAS (13.27), number of primary branches per plant (5.13), number of pod per plant (51.80), seeds per pod (g) (16.60), 1000-seeds weight (g) (13.60), seed yield per plant (g) (12.12) However, absolute variability in different traits does not permit in deciding as to which character is showing the highest degree of variability, the relative values of phenotypic variance, genotypic variance and coefficients of variations (PCV and GCV). Therefore, to give an idea about the magnitude of variability present in a population. In the present investigation, the information obtained showed that the estimates of phenotypic coefficient of variation were higher than the genotypic coefficient of variation meaning thereby that the apparent variation was not only due to genotypes but environment also influenced. The phenotypic variance was higher the genotypic variance for each of the character studied, Indicating positive effect of environment on the expression of a character. The differences between GCV and PCV were however low. The results of present investigation thus support these earlier reports. The phenotypic and genotypic coefficient of variation was higher for yield (29.48 and 27.71) and lowest for plant height at 60 DAS (6.46 and 5.62). These results indicated that higher magnitude of genotypic coefficient of variation for the above traits offer a better opportunity for improvement through selection. High coefficients of variation were recorded for seed yield per plant and number of pods per plant, while, lower coefficients of variation were recorded for days to 50 per cent flowering, pod length and 1000-seed weight[19].Observed high coefficients of variation for seed yield per plant and pods per plant, while, lowest coefficients of variation were observed 1000-seed weight. High coefficients of variation were also observed for pods per plant by[6], pods per plant and seed yield by[14,20,16].Low genotypic coefficient of variation for pod length was observed by[22] and for days to 50 per cent flowering by[24]. The genotypic coefficient of variation provides help to measures the genetic variability in a character and accordingly, it is not possible to partition existing heritable variation in population based solely on this estimate[4]. Suggested that genotypic coefficient of variation together with heritability estimates would give the best result of the amount of genetic advance to be expected from selection.

Heritability and genetic advance are important selection parameters. Heritability estimates along with genetic advance are normally more helpful in predicating the gain under selection than heritability estimate alone. However it is not necessary that a character showing high heritability will also exhibited high genetic advance[11]. Estimation of heritability gives some idea about the gene action involved in the expression of various polygenic traits. The breeder is able to appropriate the variation that due to genotypic (broad sense heritability) or additive (narrow sense heritability) effects, that is the heritable portion of variation of the first case, and the portion of genotypic variation that is fixable in pure lines is the later case. If the heritability of a character is very high e.g. $\geq$ 70%, selection for such a character should be fairly easy and effective, This is because there would be close correspondence between genotypic and phenotypic variation due to a relatively small contribution of environment to the phenotype, but for a character low heritability ($<$ 40%) selection may be considerably difficult or virtually impractical due to masking effect of environment on the genotypic effect. High estimates of heritability (broad sense) were obtained for all the characters except pod length and plant height at 30 DAS. The heritability in broad sense ranged from (24.00-96.00). Higher values of heritability were obtained for plant height at 90 DAS (96.00) while pod length (24.00) showed the lowest values of heritability which indicate that they were least affected by environment modification and selection based on phenotypic performance would be reliable. It indicates that the characters is least influenced by the environmental factor, the selection for improvement of such characters may not be useful, because broad sense heritability is based on total genetic variance which includes both fixable (additive) and non fixable (dominance and epistemic) variance, Pod length and 1000-seed weight had moderate heritability i.e. less than 70%. The similar pattern of high heritability was recorded for plant height, seed yield per plant, primary branches per plant, and pods per plant and low heritability for 1000-seed weight by[14]. Low heritability for 1000-seed weight was also observed by Naik[15].

High genetic advance is another parameter to assess the expected improvement in a character by hybridization and selection. The genetic advance as per cent of mean ranged between 3.23 and 53.65 %. High genetic advance was recorded for seed yield per plant (g) (53.65%), number of pods per plant (28.51) and 1000 seed weight (g) (19.73). However, the heritability estimates along with genetic advance is more useful than heritability values alone for selecting individual. From this point of view, seed yield per plant (g) and 1000 seed weight (g) possessed greater estimates of genetic advance as per cent of mean coupled with high amount of heritability indicating that these traits are governed by additive gene action and continued selection would be helpful in modifying the selection procedure. The characters like pod length (cm) and plant height at 30 DAS showed low heritability with moderate to low genetic advance as per cent of mean indicated non-additive gene action and can be improved through multiple crosses. High genetic advance value >40% was recorded for seeds yield per plant and pods per plant. Similar results were also obtained by[19,8] for yield and pods per plant in fenugreek. Moderate to low genetic advance was observed for number of primary branches per plant, plant height, seeds per pod, pod length, 1000-seed weight and days to 50 per cent flowering. This also confirms the earlier findings of low genetic advance for days to 50 per cent flowering by[12] for 1000-seed weight and pod length and days to 50 per cent flowering and length of pod by[5]. It indicates that the characters are governed by non-additive gene action. High heritability coupled with high genetic advance was observed for seed yield per plant and number of pods per plant. According to[13].The estimates of broad sense heritability are reliable if combined with high genetic advance and indicate role of additive gene action which given batter response to phenotypic selection than those characters having low values. Similar result was obtained by[10] for seed yield per plant and number of pods per plant. High heritability coupled with high genetic advance for pods per plant were also observed by[16]. In present investigation plant height had high heritability coupled with moderate genetic advance and similar result was observed by[23] in fenugreek. Thus the results of the present investigation are in line with the earlier reports[17].Expressed that if a character is governed by additive gene action, heritability and genetic advance both would be high. High estimates of heritability along with high genetic advance provide good scope for further improvement in advance generation if characters subject to mass progeny or family selection.

Table 1: Analysis of variance for different morphological and yield characters in fenugreek

Source of variance	Degree of freedom	Characters									
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
		Plant height 30 DAS (cm)	Plant height 60 DAS (cm)	Plant height 90 DAS (cm)	Days to 50 per cent flowering	Number of primary branches per plant	Number of pods per plant	Pod length (cm)	Number of seeds per pod	1000-seed weight (g)	Seed yield per plant
Replications	2	1.24	3.95	2.26	16.54	0.54	12.41	4.23	6.11	0.09	0.59
Treatments	19	3.26**	17.62**	117.85**	74.17**	1.12**	86.66**	0.66**	3.96**	4.57**	10.83**
Error	38	1.02	1.71	1.60	9.11	0.31	2.85	0.34	0.41	0.30	0.45

Table 2: Estimate of variability for yield and its components in fenugreek

Character	Mean	Range		Genotypic coefficient of variation (GCV)%	Phenotypic coefficient of variation (PCV)%	Heritability in broad sense %	Genetic advance as percentage of mean
		Min.	Max.				
Plant height 30 DAS (cm)	10.74	9.24	13.27	8.04	12.39	42.10	10.80
Plant height 60 DAS (cm)	41.16	35.91	44.43	5.62	6.46	75.70	10.08
Plant height 90 DAS(cm)	73.69	64.07	88.16	8.45	8.62	96.00	17.05
Days to 50 per cent flowering	69.70	61.33	77.33	6.68	7.96	70.40	11.54
Number of primary branches/plant	4.21	3.26	5.26	12.34	18.16	46.20	17.33
Number of pods /plant	36.37	25.80	46.73	14.53	15.26	90.70	28.51
Pod length (cm)	10.19	9.53	11.58	3.21	6.57	24.00	3.23
Number of seeds / pod	13.58	11.73	16.60	8.01	9.31	74.10	14.21
1000-seed weight (g)	11.30	9.90	13.60	10.50	11.63	82.30	19.73
Seed yield /plant	6.71	4.74	12.12	27.71	29.48	88.30	53.65

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