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Studies on genetic variability in fenugreek (*Trigonella foenum-graecum* L.)

Hareesh Kumar Maurya, Dr. DP Mishra, Himanshu Singh and Aditya Vikram Singh

Abstract
The present investigation was executed at Main Experiment Station of Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) during Rabi 2019-20, to estimate the genetic variability among the genotypes, to work out the heritability in broad sense and genetic advance in percent of mean, to estimate correlation coefficient among the growth and yield traits, to work out the path coefficient analysis for different traits and to estimate the genetic divergence D2 among the genotypes for various traits. Experimental material for the study consisted of 72 genotypes including 3 checks (Hisar Sonali, P.E.B. and NDM-1). The experiment was conducted in Augmented Block Design in 6 blocks (12 genotypes + 3 checks in each block). Observations were recorded on 11 quantitative traits *viz*. days to 50% flowering, plant height, primary branches per plant, secondary branches per plant, days to maturity, pods per plant, length of pods, seeds per pod, 1000 seed weight (g), seed yield per plant (g) and seed yield q/ha. The analysis of variance for the design of experiment indicated highly significant differences among the genotypes for all the characters. Based on mean performance of seed yield and yield components, the genotypes NDM-97 followed by NDM-116, NDM-1, NDM-37, NDM-137, NDM-20, NDM-57, NDM-76, NDM-14 and NDM-132 were identified as most promising genotypes for yield and major component traits**.** High magnitudes of variability were observed for length of pod and primary branches per plant.

Keywords: genetic variability, fenugreek, *Trigonella foenum-graecum* L.

1. Introduction
Fenugreek (*Trigonella foenum-graecum* L.) is an diploid species, populary grown by its localism name "Methi", belongs to the family "fabaceae". The word "*Trigonella*" is a Latin ward, having meaning from little tringle; refers to its triangular shape of flower. The species name "foenum-graecum" means "Greek-hay" indicated that it was used as a forage crop in the past. Fenugreek is a native of West Asia and South- eastern Europe. The genus Trigonella comprises of 50 species mostly of Mediterranean and oriental origin. It is self pollinated crop and its chromosome number 2n=16. It is an important spices and condiment crop grown for both seed as well as leaves purpose. It is grown widely in part of North India and cultivated in all over the subcontinent for its green leaves and seeds. There are two species of the genus *Trigonella* which are of economic importance, viz. *T. foenum graecum* L., the common methi and *T. corniculata*, the kasthuri methi. It is an annual herb reaching to a height of approximately 90.0 cm. Leaves are light-green and are pinnately trifoliate. The flowers are papilionaceous nature. Fruits arelong, narrow, legumes, tapering and curved and with a slender point which contain small extremely furrowed seeds. The flowers are white are yellow in colour. Anthesis takes placewith a peak at 11.30am and normally between 9am and 6pm. Spices value of fenugreek is a valuable source of several highly dsirable biologically active compounds such asdiosgenin, trigonelline and other most valuable bioactive constituents present in fenugreek.
India has been well known as land of spices since very long time period of recorded history. The history of Indian spices crops is well known to be dates back to the inception of human enlightenment. Moreover, references are also available with regard to the Indian spices and their use in Vedas (6000 B.C.) by Manu (4000B.C.). Among the seed spices from an important group of crop which are extensively grown throughout the country as pure or intercrop, both under rain-fed and irrigated condition. These crops play an important role in our national economy. However, national domestic need and the export target beyond 2000 A.D., their production requirement is 3-4 folds, up-gradation of the existing level.

Study of variability is a prerequsite for improvement of yield in any crop. In crop improvement the genetic component of variation is important since, only this component is transmitted to the next generation. According to Hanson *et. al*. (1956) [4], heritability in broad sense is the ratio of genotypic variance to total variance in non-segregating population. Thus, heritability contributes the proportion of phenotypic variance that is due to germplasm, which is inherited.

Material and Methods

Experiment was conducted at Main Experiment Station of Vegetable Research Farm at Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) in well leveled field having proper facility of drainage. Geographically Narendra Nagar falls under humid sub-tropical climate and is located in between 24.470 and 26.560 N latitude and 82.120 and 83.980 E lonitude at an altitude of 113 m above from sea level in the Gangetic Alluvial plains of eastern Uttar Pradesh. There are total Seventy five genotypes including 3 checks of fenugreek were collected from Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj) Ayodhya, Uttar Pradesh. The check varieties were Hisar Sonali (C.C.S.H.A.U., Hisar, Haryana), Pua Early Bunching (IARI, New Delhi) and NDM-1(A.N.D.U.A.T., Kumarganj, Ayodhya, Uttar Pradesh). The present experiment was carried out in Augmented Block Design. The material involved in the experiment comprised of 75 selected germplasm of fenugreek among which three were the checks. Each genotype consisted of two row spaced 30 cm apart with plant to plant spacing of 10 cm. Observation were recorded for eleven different characters of fenugreek

i.e. Days to 50% flowering , Plant height (cm) , Plant height (cm) , Primary branches per plant , Secondary branches per plant , Days to maturity , Pods per plant , Length of pod (cm) , Seeds per pod , 1000-seed weight (g) , Seed yield per plant (g) , Seed yield (q/ha).

The mean values of data were subjected to the analysis of variance as per the procedure described by Federer (1956) [2]. The genotypic and phenotypic co-efficient of variation were calculated as per formulae given by Burton and De-Vane (1953) [1]. Heritability and genetic advance were according to Hanson *et al*. (1963) and Johnson *et al*. (1955) [5].

Result and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized as under.

Analysis of variance for Augmented Block Design recorded for different characters from the experiment conducted in the year 2019-20 was subjected to analysis of variance to test the significance of differences among 75 genotypes of fenugreek for 11 characters prenented in Table 1.

The analysis of variance for 11 traits partitioned the total variation into the variation due to genotypes and other sources. The analysis of variance for seed yield and its components traits.

The analysis of variance showed that significant amount of variability was available in the genotype for all yield and yield attributing character. All characters showed highly significant mean sum of square due to check. It indicates the presence of considerable variability found among the different characters under study. The estimate of genotypic coefficient of variation is of prime importance to breeder because genetic variance alone does not allow a decision as to which characters were showing the highest degree of variability. Therefore, accurate relative comparison can be made with the help of phenotypic and genotypic coefficients of variation. The range, general means, phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV), heritability in broad sense, genetic advance and genetic advance in percent of mean for different characters of fenugreek germplasm are presented in table 3. The phenotypic coefficient of variation was estimated in seventy-five genotype for 11characters.

Phenotypic coefficient of variation ranged from 1.59% (days to maturity) to 93.61% (length of pod). Genotypic coefficient of variance ranged from 1.55% (days to maturity) to 93.57% (length of pod). The phenotypic co-efficient of variation (PCV) was higher than genotypic co-efficient of variation (GCV) for all the characters.

The high estimate (>20%) of phenotypic (PCV) and genotypic (GCV) coefficient of variation were recorded for length of pod (PCV=93.61% & GCV= 93.57%) followed by primary branches per plant (PCV=24.74% & GCV= 23.99%). Moderate estimate (10%-20%) of PCV and GCV were noted for secondary branches per plant (PCV=19.69% & GCV= 18.91%) followed by nods per plant (PCV=16.55% & GCV= 16.51%), plant height (PCV=14.19% & GCV= 14.18%), seeds per pod (PCV=10.88% & GCV= 10.60%) whereas, the low estimate (<10%) of phenotypic and genotypic coefficients of variation were observed for seed yield per plant (PCV=11.29% & GCV= 9.68%) followed by 1000-seed weight (PCV=6.00% & GCV= 5.22%), seed yield q/ha (PCV=5.52% & GCV= 5.12%), days to 50% flowering (PCV=4.64% & GCV= 4.57%), days to maturity (PCV=1.59% & GCV= 1.55%).

The analysis of variance for all eleven traits may showed existence of variability among the seventy five germplasm. The phenotypic variability may be due to genetic constitution of the material as well as environment influences. The genotypic and phenotypic coefficient of variations was computed to assess to existing variability in the genotypes (Table 3). The high estimates of GCV and PCV for these traits were reported by several workers Prajapati *et al*. (2010) [10], Narolia *et al*. (2017) [13], Panvar *et al*. (2017) [9] Yadav *et al.* (2018) [12], Ali *et al.* (2019), Gaikwad *et al.* (2020),.Heritability estimates assess the amount of transmissible genetic variability to the total variability and happens to most important basic factor that determines the genetic improvement or response to selection. However, the degree of improvement attained through selection is not only depend upon heritability but also on the amount genetic variation present in breeding population and extent of the selection pressure applied by the breeder. The estimates of heritability and genetic advance for different characters had been present in table 3. The high heritability (>75%) was expressed by plant height (99.83) followed by pods per plant (99.47), length of pods (99.42), days to 50% flowering (97.00), days to maturity (95.26), seed per pod (94.94), primary branches per plant (94.03), secondary branches per plant (92.67), seed yield quintal per ha (86.00) and 1000-seed weight (75.51) while moderate heriatbility (50-75%) was expressed by seed yield per plant (73.58%). None of the character show low estimate of heritability in broad sense. The highest genetic advance (>20) was expressed by length of pod (27.26) and plant height (24.23), moderate genetic advance (10-20) was expressed by pods per plant (12.20) and low genetic advance (<10) was expressed by days to 50%

flowering (7.19), Days to maturity (4.14), seed yield q/ha (1.44), seed yield per plant (1.00) and 1000-seed weight (0.78). Prajapati *et al*. (2010) [10],

Genetic advance in percent of mean (>20%) was highest in case of length of pods (92.67) followed by primary branches per plant (47.92), secondary branches per plant (37.43), pods per plant (33.92), plant height (29.18), seeds per pod (21.28) and moderately (10-20) in seed yield per plant (17.11) while lowest genetic advance (<10) in percent of mean was showed seed yield q/ha (9.79) followed by 1000-seed weight, days to 50% flowering (9.27) days to maturity (3.12).

High heritability is not always an indication of high genetic gain (Johnson *et al*. 1955) [5] High heritability and high genetic advance are important for the improvement (genetic gain) of any character. Heritability estimates in broad sense when used in conjunction with the genetic advance would give better information than the heritability alone.

In present study high heritability coupled with the high genetic advance as percent of mean were noted for plant height followed by pods per plant, length of pod, seed per pod, primary branches per plant, and secondary branches per plant. Similar observations were recorded by Pathak *et al*. (2014) [8], Kumar *et al*. (2018) [6] and Singh *et al.* (2019) [11]

Table 1: Analysis of Variance for 11 Characters in Fenugreek Genotypes

Character		Source of variation		
		Blocks	Checks	Errors
		(b-1)	(c-1)	(b-1) (c-1)
d. f.		3	2	6
1.	Days to 50% flowering	2.283*	70.213**	0.390
2.	Plant height (cm)	243.323**	790.039**	0.236
3.	Primary branches/plant	0.957**	2.140**	0.030
4.	Secondary branches/plant	3.940**	7.405**	0.106
5.	Days to maturity	1.585*	14.39**	0.211
6.	No. of pods/plant	30.795**	245.802**	0.189
7.	Length of pods (cm)	180.248**	14.32**	0.145
8.	Seeds/pod	2.050**	5.738*	0.195
9.	1000-seed weight	0.316*	0.725*	0.062
10.	Seed yield/plant (g)	0.156	5.245**	0.016
11	Seed yield (q/ha)	0.201	2.034**	0.093

Table 2: Mean performance of 75 genotypes for eleven characters in fenugreek

Germplasm	Days to 50% flowering	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Days to maturity	Pods per plant	Length of pod (cm)	Seeds per pod	1000-seed weight (g)	Seed yield per plant (g)	Seed yield (q/ha)
NDM-11	76.41	74.97	3.43	5.24	130.57	33.43	11.50	17.64	8.09	5.20	12.88
NDM-12	74.31	75.57	4.43	3.74	129.03	40.44	14.72	16.60	7.93	5.91	13.87
NDM-13	73.03	76.07	3.68	6.24	127.91	35.39	12.06	15.90	8.17	6.10	13.62
NDM-14	75.50	78.02	3.18	5.74	131.56	31.84	11.82	20.70	7.87	6.69	13.89
NDM-15	79.53	87.07	3.93	5.99	132.67	29.01	15.18	17.54	8.33	5.93	14.85
NDM-16	80.31	93.87	2.68	5.49	133.19	33.33	12.76	16.90	8.60	5.72	15.17
NDM-17	74.51	73.77	1.93	5.24	131.81	36.43	12.12	17.30	7.93	5.58	14.12
NDM-18	76.53	99.07	3.43	6.74	131.03	42.54	19.76	19.84	8.94	5.23	14.61
NDM-19	85.81	102.97	3.18	6.99	134.99	33.43	9.72	17.34	8.07	5.09	14.63
NDM-20	76.41	96.07	3.43	6.49	131.43	47.54	11.76	18.30	7.63	7.21	13.61
NDM-31	73.48	89.57	3.18	3.79	128.27	37.31	10.22	16.54	7.94	6.09	13.88
NDM-32	77.53	97.07	2.18	6.19	131.49	40.39	12.26	15.70	8.07	5.91	13.61
NDM-33	73.96	81.68	2.16	5.79	133.25	29.81	11.18	16.52	8.31	6.10	14.53
NDM-34	75.09	101.68	1.66	6.04	132.99	39.07	12.02	25.66	8.35	5.93	14.52
NDM-35	81.16	89.68	3.16	7.84	134.91	32.47	15.44	20.08	8.75	6.51	15.27
NDM-36	79.07	89.53	1.66	6.89	132.77	33.35	11.88	16.06	8.21	5.81	15.48
NDM-37	78.73	82.43	1.91	5.79	133.47	38.51	13.68	16.12	9.25	5.47	14.57
NDM-38	76.29	90.68	2.41	4.79	131.21	28.87	11.86	20.56	8.26	7.46	13.42
NDM-39	74.06	93.18	2.66	4.54	132.11	31.69	10.57	16.78	8.23	5.42	14.55
NDM-40	86.06	89.78	2.91	5.79	136.24	37.41	13.68	16.00	8.07	5.83	14.12
NDM-51	77.06	96.73	1.91	6.44	131.74	29.09	13.62	18.46	8.75	6.12	14.26
NDM-52	79.63	85.33	1.91	7.29	132.27	36.51	13.41	19.06	7.89	5.43	13.97
NDM-53	74.28	90.53	2.41	7.59	130.77	52.51	16.08	17.88	7.97	5.31	13.61
NDM-54	72.19	82.63	2.66	4.29	130.25	37.55	11.42	20.04	8.71	5.38	13.68
NDM-55	75.59	69.97	2.05	5.16	132.60	34.56	13.45	16.45	7.82	5.67	14.85
NDM-56	78.39	76.92	2.30	6.91	133.05	39.62	13.21	17.11	8.09	5.85	14.07
NDM-57	74.69	73.69	3.30	4.36	131.13	30.14	9.85	20.55	9.34	7.16	15.67
NDM-58	81.82	79.76	3.05	4.16	136.13	27.66	14.91	18.51	8.80	4.85	15.85
NDM-59	79.66	81.67	2.30	7.66	134.17	33.38	13.35	16.49	8.28	6.59	15.38
NDM-60	75.85	59.62	2.80	6.41	132.94	48.34	14.35	16.11	8.44	5.79	14.49
NDM-71	76.87	57.42	3.30	7.91	131.61	50.62	13.25	16.01	8.31	5.99	15.64
NDM-72	75.85	87.72	3.05	8.01	131.21	30.34	12.21	16.75	8.39	5.10	14.45

NDM-73	77.70	84.76	4.05	6.41	132.47	36.54	11.51	20.03	8.13	5.48	14.67
NDM-74	73.72	80.76	4.30	7.41	130.11	35.69	12.05	18.53	7.38	4.98	14.09
NDM-75	88.60	81.94	4.55	4.91	136.27	38.28	15.65	17.81	9.34	5.14	13.94
NDM-76	80.19	97.75	2.55	4.16	133.13	36.94	10.60	19.11	7.84	7.15	14.75
NDM-77	77.09	92.62	2.23	3.66	132.37	39.15	11.97	17.18	8.67	6.59	16.26
NDM-78	76.14	91.47	3.73	3.91	132.23	29.03	12.34	25.35	7.49	5.22	17.10
NDM-79	73.20	107.79	3.23	4.66	130.36	36.47	13.57	17.82	8.90	5.64	15.20
NDM-80	76.52	101.80	1.73	3.76	132.25	38.39	17.15	15.34	8.10	5.55	15.35
NDM-91	76.96	69.65	2.23	4.76	132.61	52.47	10.91	15.86	7.69	6.25	14.86
NDM-92	74.98	75.59	1.73	3.91	132.81	49.03	13.59	16.68	7.72	5.84	15.46
NDM-93	73.97	78.69	2.48	3.66	130.71	42.46	12.43	16.88	8.00	5.25	15.05
NDM-94	79.53	64.59	3.98	6.16	132.84	34.63	14.47	16.02	8.50	5.07	12.69
NDM-95	72.09	88.98	3.48	5.66	131.71	32.48	16.17	19.43	7.96	6.59	14.46
NDM-96	81.89	77.64	2.98	6.66	134.01	31.38	11.97	15.34	10.76	5.24	15.99
NDM-97	85.99	107.59	3.23	6.91	136.07	30.08	10.13	24.12	8.11	8.50	16.45
NDM-98	80.06	72.94	2.73	5.66	132.87	42.03	10.67	18.08	8.19	5.43	15.70
NDM-99	76.21	71.10	2.59	6.21	131.96	36.67	11.13	17.82	8.63	5.59	13.55
NDM-100	74.11	69.36	2.84	6.46	130.62	32.46	12.99	17.18	8.26	5.24	14.53
NDM-111	75.22	68.16	3.09	3.96	131.96	31.47	9.77	16.82	8.57	5.88	14.28
NDM-112	78.88	70.36	2.84	4.76	132.46	30.04	9.89	17.58	7.89	5.57	14.09
NDM-113	88.43	85.37	2.59	5.71	142.64	28.14	10.23	19.82	7.94	5.93	13.28
NDM-114	82.34	72.45	1.84	4.71	134.16	33.77	10.09	19.44	8.35	6.34	14.47
NDM-115	74.22	108.82	4.09	4.46	132.82	29.02	15.23	20.09	8.63	5.89	15.16
NDM-116	79.32	97.14	4.59	6.46	133.59	47.42	12.19	16.20	8.94	7.61	16.53
NDM-117	86.34	91.26	3.84	7.46	140.76	44.62	12.23	17.88	8.68	5.95	16.58
NDM-118	73.29	69.15	3.34	7.21	127.84	32.42	9.90	20.68	9.09	5.24	16.89
NDM-119	74.39	71.74	2.34	6.96	131.12	27.97	11.69	17.12	8.07	5.10	14.15
NDM-120	75.34	68.65	1.84	6.36	131.26	28.72	14.17	17.84	8.06	5.21	14.19
NDM-131	79.87	103.20	3.26	5.65	132.20	32.17	13.73	17.64	7.92	6.27	15.69
NDM-132	74.27	91.96	3.51	5.90	131.04	35.35	11.16	19.31	8.84	6.73	14.50
NDM-133	76.37	79.37	2.26	6.40	131.60	31.42	13.41	16.63	9.12	5.36	15.04
NDM-134	77.42	68.04	2.01	7.65	133.40	29.44	12.42	21.29	8.68	5.33	13.74
NDM-135	85.87	59.00	1.76	7.40	136.04	51.17	9.92	16.69	8.17	5.97	14.04
NDM-136	72.32	85.94	2.26	5.90	131.14	42.20	9.73	20.26	7.99	6.01	14.68
NDM-137	79.22	82.87	2.76	7.40	132.38	39.44	9.52	16.72	9.18	7.33	14.94
NDM-138	80.16	67.05	3.01	7.65	131.92	33.27	14.88	15.91	8.19	5.69	16.04
NDM-139	75.32	64.87	3.26	7.75	131.04	29.04	12.92	17.62	8.13	5.67	16.74
NDM-140	76.33	78.91	1.76	7.15	130.24	31.12	13.02	16.72	8.30	5.42	14.68
NDM-151	79.05	106.93	4.01	7.15	133.04	31.12	8.92	16.63	8.66	6.04	15.64
NDM-152	76.49	67.07	2.26	6.90	131.60	32.42	11.52	17.92	8.13	5.32	14.38
Hisar Sonali	80.95	105.51	3.24	5.39	132.83	35.91	13.27	19.40	8.75	6.32	14.98
P.E.B.	85.28	84.49	3.88	7.62	135.03	48.23	15.21	21.34	9.26	5.62	15.51
NDM-1	78.52	87.03	2.69	6.48	132.05	39.08	16.33	20.53	8.63	7.47	15.71
Mean	77.78	83.40	2.87	5.96	132.51	36.16	12.59	18.11	8.37	5.90	14.76
Minium	72.09	57.42	1.66	3.66	127.84	27.66	8.92	15.34	7.38	4.85	12.69
Maximum	88.60	108.82	4.59	8.01	142.64	52.51	19.76	25.66	10.76	8.50	17.10
S.E.D.	0.77	0.6	0.21	0.4	0.57	0.54	0.47	0.55	0.3	0.42	0.38
C.D.	1.73	1.35	0.48	0.9	1.27	1.2	1.05	1.22	0.69	0.94	0.84

Table 3: Estimates of range, grand mean, phenotypic (PCV) and genotypic (GCV) coefficient of variation, heritability in broad sense [h2 %], genetic advance (Ga) and Ga (in percent of mean) for eleven characters in fenugreek genotypes

Character	Range		Grand mean (X)	PCV (%)	GCV (%)	Heretability broad scence (h2%)	Genetic Advance (G.A.)	Genetic Advance in percent of mean (G.A.)
	Highest	Lowest						
Days to 50% flowering	72.09	88.60	77.78	4.64	4.57	97.00	7.19	9.27
Plant height (cm)	57.42	108.82	83.40	14.19	14.18	99.83	24.23	29.18
Primary branches/plant	1.66	4.59	2.87	24.74	23.99	94.03	1.36	47.92
Secondary branches/plant	3.66	8.01	5.96	19.69	18.91	92.27	2.22	37.43
Days to maturity	127.84	142.64	132.51	1.59	1.55	95.26	4.14	3.12
No. of pods/plant	27.66	52.51	36.16	16.55	16.51	99.47	12.20	33.92
Length of pod (cm)	8.92	19.76	14.19	93.61	93.57	99.42	27.26	192.67
Seeds/pod	15.34	25.66	18.11	10.88	10.60	94.94	3.83	21.28
1000- seed weight	7.38	10.76	8.37	6.00	5.22	75.51	0.78	9.34
Seeds yield/plant	4.85	8.50	5.90	11.29	9.68	73.58	1.00	17.11
Seed yield q/ha	12.69	17.10	14.76	5.52	5.12	86.00	1.44	9.79

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