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Assessment of Genetic Variability, Heritability and Genetic Advance for Biometrical Traits in Fenugreek

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ABSTRACT

Background: Fenugreek is a seed spice crop grown in arid and semi-arid areas of the world. The predominant growing areas are lacking with high yielding varieties and adopting poor crop husbandry. Therefore, the present study was focused on assessing the genetic variability among the diverse genotypes for their biometrical traits.

Methods: Thirty genotypes of fenugreek were sown in randomized block design with three replications during *rabi* season 2019-20.

Result: Presence of wide spectrum of variability among the genotypes for all the biometrical traits under study was evident. High GCV and PCV (>20), heritability in broad sense (>60) coupled with high genetic advance as percentage of mean (>20%) was observed for proline content in leaves (mg/g) at 60 days after sowing (DAS) and physiological maturity, seed yield per plant, number of branches per plant, number of pods per plant, crude protein content and test weight suggesting that these characters are genetically governed by additive gene action and can be improved through selection.

Key words: Environments, Fenugreek, Genetic advance, Heritability, Variability.

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is a self-pollinated crop belonging to family Leguminosae with the number of chromosomes 2n=2x=16 (Frayer, 1930). It is grown both for seed spice as well as leafy vegetable purpose. Its seeds have carminative property and its containing protein (25.50%), fat (7.90%), mucilaginous matter (20.00%) and saponins (4.80%) (Rao and Sharma, 1987). In India, it is mainly cultivated in Rajasthan, Gujarat, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, Himachal Pradesh and Haryana. The crop was grown over an area of 1,81,000 hectares with a production of 2,40,000 metric tonnes (Anonymous, 2018). In Rajasthan, it occupies a prime position among the seed spices. More than 80 per cent of area and production of fenugreek in the country is contributed by Rajasthan state but the average productivity is very less. Its means there is no availability of suitable high yielding verities of fenugreek in this area. Therefore, it is an urgent need to identify new fenugreek genotypes with high genetic yield potential to achieve effective breeding programme. Genetic variability in fenugreek is still highly needed. Moreover, relative values of GCV and PCV give a reliable idea of the extent of variability in the population. It is also important to determine the amount of heritable variation by the estimate of heritability (Hanson, 1956). Therefore; this study was carried out to identify the potential fenugreek genotype with a distinct genetic variability to improve the fenugreek genotypes.

MATERIALS AND METHODS

The present study was conducted at Vegetable Farm, College of Horticulture and Forestry, Jhalawar. The experimental materials consisting of thirty genotypes of fenugreek are given in Table 1. The experiments were laid out in randomized block design with three replications during *Rabi* season 2019-20. Seeds of each genotype were sown in a two rows of 3 m row length in each replication with a spacing of 30×10 cm. All the recommended cultural practices were adopted uniformly in order to ensure a healthy crop stand. All the biometrical traits under study were recorded on five randomly plants in each genotype and each replication except days to 50 per cent flowering and days to maturity which were recorded on plot basis. Observations were recorded *namely* days to 50 per cent flowering, days to maturity, plant height at maturity (cm), number of branches per plant, number of pods per plant, pod length (cm), number of seeds per pods, test weight (g), seed yield per plant (g), total chlorophyll content in leaves (mg/g) at 60 days after sowing (DAS) and physiological maturity, proline content in leaves at 60 days after sowing (DAS) and physiological

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maturity and crude protein content (%). The mean values were subjected to statistical analysis to work out ANOVA for all the biometrical traits, as suggested by Goulden (1959). The phenotypic and genotypic coefficient of variation was calculated as per the procedure given by Burton (1952). Heritability in broad sense was estimated based on the formula proposed by Lush (1940). Furthermore, genetic advance as per cent of mean was computed adopting the method given by Johnson *et al*. (1955).

RESULTS AND DISCUSSION

Analysis of variance was conducted to eliminate the variation due to causes other than genotypes from total variation. The ANOVA revealed highly significant variation among the genotypes ($p<0.01$) for all the biometrical traits under study (Table 2). This suggests that the material had adequate genetic variability and response to selection may be accepted in the breeding programme for seed yield and its attributing traits. These results are in agreement with the findings of Ahari *et al.* (2009), Dashora *et al*. (2011), Verma and Ali (2012), Yadav *et al*. (2013), Kole and Saha (2014),

Table 1: List of thirty genotypes of fenugreek used in the study.

S. no	Genotype
1	RMt-305
2	GM-1
3	MP local-1
4	MP local-2
5	Jaipur local
6	Karnataka local
7	Chittorgarh local
8	Jhalawar local
9	Nagour local-2
10	RMt-303
11	RMt-143
12	Rajendra Kranti
13	Hisar Suvarna
14	AFG-1
15	Pant Ragni
16	Jhunjhunu local
17	Azad Methi
18	Nagour local-1
19	Hisar Mukta
20	CO-2
21	Hisar Sonali
22	RMt-351
23	GM-2
24	AFG-3
25	RMt-1
26	AFG-2
27	Lam selection
28	Sikar local
29	AFG-4
30	Hisar Madhavi

Table 2: Analysis of variances for fourteen biometrical traits in fenugreek.

Source of variance	d. f.	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10	C-11	C-12	C-13	C-14
Replication	3	0.011	3.033	7.327	0.593	0.426	0.160	0.549	0.0003	0.041	0.343	0.079	6.031	89.876	0.314
Genotype	29	19.120**	60.040**	249.840**	20.240**	190.878**	2.965**	7.419**	5.5282**	18.779**	2.645**	13.632**	2107.956**	8491.40**	11.746**
Error	58	1.804	2.884	2.675	1.097	6.228	0.132	0.394	0.0118	0.118	0.301	0.188	2.216	65.779	0.162

*and ** represent 5% and 1% level of significant, respectively

Biometrical traits details: C-1: Days to 50 (%) flowering, C-2: Days to maturity, C-3: Plant height at maturity (cm), C-4: Number of branches per plant, C-5: Number of pods per plant,C-6: Pod length (cm), C-7: Number of seeds per pod,C-8: Test weight (g),C-9: Seed yield per plant (g),C-10: Total chlorophyll content in leaves at 60 DAS,C-11: Total chlorophyll content in leaves at maturity,C-12: Proline content in leaves at 60 DAS,C-13: Proline content in leaves at maturity and C-14: Crude protein content (%).

Table 3: Mean value for fourteen biometrical traits of fenugreek genotypes.

Genotype	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10	C-11	C-12	C-13	C-14
RMt-305	50.33	105.33	53.99	17.11	75.88	12.14	18.24	12.86	15.25	38.73	28.98	113.68	224.40	17.94
GM-1	54.67	116.33	85.78	8.66	58.66	10.42	20.44	13.88	16.14	38.95	26.20	151.44	305.32	15.89
MP local-1	57.33	118.33	78.66	7.66	49.78	9.91	14.00	11.78	8.49	39.58	26.83	95.58	192.54	20.14
MP local-2	57.67	115.33	82.22	7.88	52.11	10.10	13.89	13.25	9.85	39.09	26.49	68.42	133.99	15.56
Jaipur local	58.33	116.33	69.33	7.88	50.11	9.13	14.99	11.72	8.73	39.05	23.75	101.70	202.03	17.58
Karnataka local	57.33	117.67	81.55	11.33	55.33	9.25	16.50	16.06	13.07	38.67	26.52	67.73	138.31	19.13
Chittorgarh local	58.00	119.67	87.89	9.11	59.22	9.50	13.55	13.73	11.09	38.92	25.36	70.42	141.58	20.22
Jhalawar local	57.33	116.33	77.66	8.33	58.78	11.23	14.61	13.06	10.49	39.81	26.94	63.77	131.98	15.99
Nagour local-2	58.33	116.33	77.33	9.55	55.99	8.98	13.66	11.36	7.94	38.69	26.54	66.99	135.99	20.25
RMt-303	51.67	118.00	84.11	11.21	58.66	10.64	16.61	12.86	14.20	37.90	24.54	73.85	150.44	19.36
RMt-143	52.67	119.67	74.77	10.33	68.88	9.99	18.44	13.05	15.94	38.98	28.42	65.99	134.30	19.94
Rajendra Kranti	53.00	106.33	85.11	13.22	71.33	11.05	16.11	11.09	14.05	39.95	27.71	35.71	71.00	14.37
Hisar Suvarna	55.67	123.00	71.55	10.88	56.44	8.46	15.39	11.93	10.81	39.24	26.70	90.78	186.74	18.15
AFG-1	57.33	116.67	73.33	12.89	57.33	10.79	14.94	13.18	12.43	38.87	28.31	69.16	139.37	16.03
Pant Ragni	60.33	126.33	77.78	11.77	48.88	9.51	17.38	13.24	11.18	39.16	21.06	83.03	172.07	17.46
Jhunjhunu local	57.67	119.33	65.66	12.66	53.11	11.81	14.38	12.92	9.70	37.80	23.38	68.68	138.94	21.39
Azad Methi	56.00	116.67	64.55	9.77	51.44	9.63	15.05	12.58	8.97	37.97	28.81	70.37	142.11	21.46
Nagour local-1	58.00	120.00	73.55	12.22	54.22	10.51	14.77	11.55	8.53	38.22	25.51	90.52	191.80	19.55
Hisar Mukta	54.67	124.33	61.66	14.88	67.22	12.37	16.05	14.06	13.50	38.60	22.72	46.47	93.37	15.63
CO-2	59.00	118.00	69.89	14.22	66.22	11.07	15.89	12.37	12.20	36.80	22.04	40.04	67.73	16.79
Hisar Sonali	54.33	122.33	88.11	11.22	62.89	10.26	15.55	11.07	10.42	36.95	23.69	71.58	141.68	16.65
RMt-351	51.67	115.67	62.89	17.05	68.33	11.47	14.38	13.21	12.56	36.97	28.95	33.55	70.26	18.46
GM-2	53.33	113.67	81.44	13.77	54.66	11.20	14.16	12.01	7.72	37.41	24.98	41.46	95.16	18.41
AFG-3	54.33	123.67	82.00	13.77	70.11	12.41	14.78	15.06	14.48	36.80	27.88	40.25	83.03	19.79
RMt-1	52.00	114.33	64.22	12.55	52.22	10.30	16.50	11.73	10.00	39.63	28.90	62.19	118.16	17.56
AFG-2	55.67	121.33	74.00	13.22	48.22	10.09	16.55	14.08	8.63	37.77	27.03	55.81	116.47	18.54
Lam selection	57.33	116.33	66.78	10.99	58.66	9.89	14.55	14.28	11.71	37.83	28.04	51.01	99.28	22.58
Sikar local	56.00	120.33	64.11	10.66	45.66	10.30	14.00	16.52	7.52	37.23	27.11	35.18	68.37	19.28
AFG-4	54.00	120.67	66.33	12.99	50.22	10.34	15.89	13.57	10.13	38.55	26.01	30.65	72.48	18.28
Hisar Madhavi	54.67	116.67	60.77	15.89	47.77	11.06	15.00	14.50	10.46	37.17	25.93	52.64	112.68	16.86
CD	2.20	2.78	2.67	1.71	4.08	0.59	1.03	0.18	0.56	0.90	0.71	2.43	13.26	0.66
CV	2.41	1.44	2.22	8.88	4.33	3.47	4.04	0.83	3.06	1.43	1.65	2.22	5.98	2.20

Biometrical traits details: C-1: Days to 50 (%) flowering, C-2: Days to maturity, C-3: Plant height at maturity (cm), C-4: Number of branches per plant,C-5: Number of pods per plant, C-6: Pod length (cm), C-7: Number of seeds per pod, C-8: Test weight (g), C-9: Seed yield per plant (g), C-10: Total chlorophyll content in leaves at 60 DAS, C-11: Total chlorophyll content in leaves at maturity, C-12: Proline content in leaves at 60 DAS, C-13: Proline content in leaves at maturity and C-14: Crude protein content (%).

Sharma *et al.* (2015), Meena *et al.* (2017) and Singh and Naula (2017).

Further, the data obtained from the mean performance of the biometrical traits were presented in Table 3 and 4. These data had sufficient variability among the genotypes. The results revealed that the traits such as days to 50 per cent flowering ranged from 50.33 days (RMt-305) to 60.33 days (Pant Ragini) with the mean value of 55.62 days, days to maturity varied from 105.33 days (RMt-305) to 126.33 days (Pant Ragini) with the mean value of 117.83 days, plant height at maturity was observed in minimum in RMt-305 (53.99 cm) and maximum in Hisar Sonali (88.11cm) with the mean value of 73.57 cm number of branches per plant varied from 7.66 (MP local-1) to 17.11 (RMt-305) with the mean value of 11.79 minimum number of pods per plant was observed in Sikar local (45.66), while it was maximum in RMt-305 (765.88) with the mean value of 57.61,pod length ranged from 8.46 cm (Hisar Suvarna) to 12.41 cm (AFG-3) with the mean value of 10.46 cm number of seeds per pod ranged from 13.55 (Chittorghar local) to 20.44 (GM-1) with the mean value of 15.54 test weight ranged from 11.07 g (Hisar Sonali) to 16.62 g (Sikar local) with the mean value of 13.09 g, mean seed yield per plant was recorded lowest in Sikar local (7.52 g), while highest in GM-1 (16.14 g) with the mean value of 11.21 g, total chlorophyll content in leaves at 60 DAS ranged from 33.80 mg/g (AFG-3) to 39.95 mg/g (Rajendra Kranti) with the mean value of 38.38 mg/g, and physiological maturity ranged from 21.06 mg/g (Pant Ragni) to 28.98 mg/g (RMt-305) with the mean value of 26.18 mg/g, proline content in leaves at 60 DAS ranged from 30.65 mg/100g (AFG-4) to 151.45 mg/100g (GM-1) with the mean value of 66.96 mg/100g and physiological maturity ranged from 67.73 mg/100g (CO-2) to 305.32 mg/100 g (GM-1) with the mean value of 135.72 mg/100g and crude protein content ranged from 14.37 per cent (Rajendra Kranti) to 22.58 per cent (Lam selection) with the mean value of 18.31 per cent.

In the present study the magnitude of phenotypic coefficient of variation (PCV) were found higher than the corresponding genotypic coefficient of variation (GCV) for all the biometrical traits studied (Table 4). It means the apparent variation is not only due to genotypes but also due to environment. Thus, the selection could be made on the basis of phenotypic performance offering scope for crop improvement. The estimation of phenotypic coefficients of variation (PCV) and genotypic coefficients of variation (GCV) were highest (>20%) for proline content in leaves at 60 DAS (39.63 and 39.57) and physiological maturity (39.50 and 39.05), seed yield per plant (22.47 and 22.26) and number of branches per plant (23.19 and 21.43). Thus, selection might be more effective for these biometrical traits because the response to selection is directly proportional to the variability present in the experimental material. Similar findings were also reported by Pathak *et al.* (2014), Narolia *et al.* (2017) and Panwar *et al.* (2017).

The magnitude of broad sense heritability ranged from 72.18 (total chlorophyll content in leaves at 60 DAS) to 99.69

Table 4: Mean, range, estimate of variance, coefficient of variation, heritability (broad sense) and genetic advance as (%) of mean for the fourteen biometrical traits.

Characters	Mean	Range	Variance		Coefficient of variance		h^2_{bs} (%)	GA as (%) of mean
			Genotypic	Phenotypic	Genotypic	Phenotypic		
Days to 50 (%) flowering	55.62	50.33-60.33	5.77	7.58	4.32	4.95	76.19	7.77
Days to maturity	117.83	105.33-126.33	19.05	21.94	3.70	3.98	86.85	7.11
Plant height at maturity (cm)	73.57	53.99-88.11	82.39	85.06	12.34	12.54	96.86	25.01
Number of branches per plant	11.79	7.66-17.11	6.38	7.48	21.43	23.19	85.34	40.77
Number of pods per plant	57.61	45.66-75.88	61.55	67.78	13.62	14.29	90.81	26.73
Pod length (cm)	10.46	8.46-12.41	0.94	1.08	9.29	9.92	87.73	17.92
Number of seeds per pod	15.54	13.55-20.44	2.34	2.74	9.85	10.64	85.62	18.77
Test weight (g)	13.09	11.07-16.52	1.84	1.85	10.36	10.40	99.37	21.28
Seed yield per plant (g)	11.21	7.52-16.14	6.22	6.34	22.26	22.47	98.14	45.42
Total chlorophyll content in leaves at 60 DAS	38.38	36.80-39.95	0.78	1.08	2.31	2.71	72.18	4.04
Total chlorophyll content in leaves at maturity	26.18	21.06-28.98	4.48	4.67	8.09	8.25	95.98	16.32
Proline content in leaves at 60 DAS	66.96	30.65-151.45	701.91	704.13	39.57	39.63	99.69	81.38
Proline content in leaves at maturity	135.72	67.73-305.32	2808.54	2874.32	39.05	39.50	97.71	79.51
Crude protein content (%)	18.31	14.37-22.58	3.86	4.02	10.73	10.96	95.96	21.66

(proline content in leaves at 60 DAS). All the studied traits showed high heritability (Table 4). Similar findings were also reported by Singh and Naula (2017), Singh *et al.* (2019) and Verma *et al.* (2016).

Johnson *et al.* (1955) has pointed out that heritability estimate along with genetic advance were more useful than heritability estimates alone in predicting the response to selection. Therefore, genetic advance as percentage of mean was calculated in order to determine the relative merits of different traits that can be further utilized in the selection programme. The expected genetic advance as percentage of mean (>20%) recorded maximum with proline content in leaves at 60 DAS (81.38) and physiological maturity (64.38), seed yield per plant (45.42), number of branches per plant (40.77), number of seeds per pod (26.73), plant height at maturity (25.01), crude protein content (21.66) and test weight (21.28). These results are in agreement with Pathak *et al.* (2014), Mamatha *et al.* (2017) and Naroliya *et al.* (2017).

High heritability(>60%) coupled with high genetic advance as a percentage of mean (>20%) was observed for proline content in leaves at 60 DAS and physiological maturity, seed yield per plant, number of branches per plant, number of pods per plant, crude protein content and test weight indicating the presence of additive gene action.

The rest of biometrical traits, days to 50 per cent flowering, days to maturity, pod length, total chlorophyll content in leaves at 60DAS and physiological maturity and plant height at maturity showed high heritability associated with low genetic advance as percent of mean due to less GCV value. The reported results are in agreement with the findings of Kumari *et al.* (2015).

CONCLUSION

Present study of variation indicated substantial variability among the genotypes as well as the biometrical traits. The traits *viz.*, Proline content in leaves at 60 DAS and physiological maturity, seed yield per plant, number of branches per plant, number of pods per plant, crude protein content and test weight showed high value for GCV, heritability in broad sense and expected genetic advance as percentage of mean. Thus, these traits should be considered during selection. Further, the promising genotypes which showed high values for the above-mentioned important traits were RMt-143, RMt-305, GM-1, AFG-3, RMt-303 and Rajendra Kranti.

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