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Evaluation of early generation progenies (F_2) of fenugreek (*Trigonella foenum-graecum* L.) crosses for seed yield and yield related characters

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Abstract

F_2 generation of five crosses of fenugreek were evaluated for seed yield and its components along with parents. F_2 generation had wider range than the parents for most of the characters in the crosses. Genetic parameter of variation also indicated that substantial amount of variability was generated in F_2 of all the crosses which will be very useful in fenugreek improvement. Pods per plant had high PCV, GCV, heritability and genetic advance as percentage of mean in all the five crosses. Association analysis indicated that pods per plant had positive association with seed yield per plant in all the five crosses. On the basis of the present study, selection for pods per plant in F_2 generation of fenugreek crosses will be useful for improvement in seed yield.

Key words: genetic variation, selection criteria, *Trigonella foenum-graecum*

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is a self-pollinated crop grown as a seed spice in India and occupies a prime position among the seed spices grown in Rajasthan. Inspite of the multifarious importance of this crop, attempts to improve its genetic potential are limited, particularly due to narrow range of genetic variability for seed yield and its components (Shukla & Sharma 1978). Therefore, hybridization programme involving genetically diverse parents was undertaken with an objective to generate genetic variability. Assessment of generated genetic variability and identification of selection criteria in segregating generations such as F_2 and F_3 are the basic requirements in any breeding programme (Weber & Moorthy 1952; Shebeski 1967; Yonezawa & Yamagata 1981). In fenugreek there has been no report on evaluation of segregating generations. Therefore, in the present investigation F_2 generation of five crosses of fenugreek were evaluated to assess genetic variability and to identify the selection criteria for improvement of seed yield.

Materials and methods

Five crosses (UM-305 x RMt-143, UM 305 x UM-128, UM 305 x UM-117, RMt-1 x UM-117 and Co-1 x RMt-143) involving six parents (UM-305, RMt-143, UM-128, UM-117, RMt-1 and Co-1) were made in *rabi* season of 1996-1997.

The F_1s of all crosses were grown during *rabi* season of 1997-98 and were harvested to collect the F_2 seeds. As the F_1 plants were not large in number and were variable in different crosses, variable number of F_2 plants were obtained in different crosses. In *rabi* 1998-1999 the

six parents and the F_2 generation of the five crosses were evaluated in RBD with two replications. In each replication, the parents and F_2 generation of the five crosses were randomized. The row to row distance and plant to plant distance were kept at 30 cm and 10 cm, respectively. In each replication of 4 m row length, each parent was grown in single row plot while the five crosses were grown in 7, 6, 1, 1 and 1 row(s), respectively depending upon the number of F_2 seeds available in each cross. Observations were recorded for seed yield per plant and its components on five randomly selected plants of each parent in each replication. In the F_2 generation of the crosses, observations on seed yield and its components were recorded on 74, 50, 15, 12 and 10 randomly sampled plants, respectively in each replication. Thus, in total over the two replications, observations were recorded on 148, 100, 30, 24 and 20 F_2 generation plants of the respective crosses. As the replication of an F_2 generation population of a cross was not a true replication of the segregating genotypes (Weber & Moorthy 1952). In the present investigation the mean variance of the two non segregating homogeneous generation of a cross (the two parental generations i.e., parent 1 and parent 2 of a cross) was used as the best available estimate of the environmental variance for the segregating F_2 generation (Allard 1960). Thus, for estimation of mean variance of the two parents of a cross, variance of each parent was estimated for each of the observed character. The variance of each parent for each of the observed character was estimated by calculating variance of 10 observations recorded on 10 randomly sampled plants of a parent over the two replications. The mean variance of the parent 1 and parent 2, involved in a particular cross was calculated as per Allard (1960) and was used as the best estimate of environmental variance for F_2 generation of that particular cross. This estimate of environmental variance of a particular cross was used to calculate genotypic variance of the F_2 generation of that particular cross. Phenotypic and genotypic coefficient of variation (Burton 1952), heritability (Hanson *et al.* 1956) and genetic advance (Johnson *et al.* 1955) were also estimated for the F_2 generation. Correlation coefficients were estimated in F_2 generation of all the crosses at phenotypic level as per the procedure given by Miller *et al.* (1958).

Results and discussion

Range and mean for all the characters in parents and the F_2 generation of the crosses are given in Table 1. In the F_2 generation of all the crosses the range was wider than that of the parents for pods per plant and seed yield per plant while for 100 seed weight the range was wider than parental range in the crosses UM-305 x UM117. This indicated a possible transgressive segregation. The range for the character 100 seed weight in the F_2 plants of the crosses RMt-1 x UM-117 and Co -1 x RMt-143 and for seeds per pod in cross RMt-1 x UM-117 exceeded only lower limit of the range in their parents. In the F_2 plants of cross Co-1 x RMt-143 the range exceeded the parental upper limit for 100 seed weight. Thus, range in F_2 plants indicated that parental types were recovered in the F_2 generation of all the crosses. In fenugreek Pant *et al.* (1983) reported wide range for many of the characters in the indigenous and exotic accessions of fenugreek evaluated. Arora & Lodhi (1993) also reported wide range for branches per plant, pods per plant and seed yield per plant, while medium range for 100 seed weight whereas narrow range for days to flowering, plant height, pod length and seeds per pod in four parents and their twelve hybrids in fenugreek.

The mean performance of parents was also determined and the order of six parents with respect to the mean performance was also studied. Earliest maturing parent was Co-1 (Table 1), followed by RMt-143, RMt-1, UM-128, UM-117 and UM-305. For plant height, highest mean was recorded for UM-117, followed by UM-128, RMt-143, RMt-1,Co-1 and UM-305. UM-305 had lowest mean plant height as it was having determinate growth habit. The mean values of F_2 generation were also compared with that of parents. For plant height in the crosses UM-305 x UM-128 and RMt-1 x UM-117 the mean values were approximately midway between parental mean values. For the

Table 1. Seed yield and its components in parents and F_2 generation in fenugreek

Parent	Days to maturity			Plant height (cm)			Number of primary branches plant^{-1}			Number of pods plant^{-1}		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
UM-305	138.6	137	139	25.30	22	31	5.2	3.0	6.0	41.3	32	52
RMt-143	132.2	129	136	64.10	52	76	4.3	3.0	6.0	35.7	25	53
UM-128	134.5	133	136	68.30	56	85	4.3	1.0	6.0	39.2	27	52
UM-117	134.9	132	137	69.50	62	79	4.9	3.0	6.0	47.7	28	58
RMt-1	133.3	132	134	57.28	53	61	4.7	2.0	6.0	40.1	27	48
Co-1	126.8	126	128	53.70	52	56	5.2	4.0	6.0	34.8	32	37
F_2 generation												
UM-305 x RMt-143	130.65±0.27	117	137	54.60±1.87	16	103	5.58±0.13	0.0	9.0	57.12±2.85	6	173
UM-305 x UM-128	130.60±0.32	125	137	47.79±2.002	17	81	6.03±0.16	1.0	9.0	66.76±4.07	15	222
UM-305 x UM-117	134.63±0.46	124	138	61.00±3.643	22	87	6.07±0.38	0.0	9.0	87.60±7.34	6	171
RMt-1 x UM-117	132.21±0.53	128	137	63.38±2.09	43	82	5.75±0.444	1.0	8.0	78.08±9.34	14	203
Co-1 x RMt-143	131.90±0.46	129	135	67.40±1.96	53	80	6.80±0.48	3.0	11.0	66.85±7.03	24	132

Parent	Pod length (cm)			Number of seeds pod^{-1}			100-seed weight (g)			Seed yield plant^{-1} (g)		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
UM-305	10.86	9.4	11.7	16.32	14.9	20.0	1.385	1.185	1.792	5.40	3.89	8.45
RMt-143	10.00	9.3	11.2	16.18	14.7	17.5	1.155	1.007	1.302	5.24	3.90	6.80
UM-128	9.38	8.8	10.1	16.40	15.0	17.0	1.187	1.012	1.377	5.32	2.74	7.78
UM-117	9.35	8.7	9.8	16.63	16.1	17.8	1.126	1.051	1.345	7.39	3.68	9.90
RMt-1	9.51	9.3	9.8	17.32	16.3	18.4	1.242	1.109	1.441	6.14	3.51	9.55
Co-1	10.44	10.2	10.7	16.34	15.2	17.7	1.176	1.128	1.230	5.96	5.5	6.30
F_2 generation												
UM-305 x RMt-143	10.09±0.09	7.1	17.9	15.49±0.15	9.8	20.0	1.171±0.016	0.479	2.268	7.77±0.44	0.80	31.19
UM-305 x UM-128	9.68±0.079	7.3	12.4	15.91±0.174	9.7	19.2	1.090±0.020	0.0948	2.296	9.14±0.657	1.18	37.78
UM-305 x UM-117	8.58±0.179	7.0	10.9	10.81±0.73	6.2	17.8	1.288±0.0583	0.758	1.828	8.05±0.77	0.48	20.07
RMt-1 x UM-117	8.94±0.12	8.0	10.10	14.35±0.31	12.5	18.4	1.048±0.0359	0.7040	1.408	9.58±1.070	1.53	24.60
Co-1 x RMt-143	10.58±0.14	9.3	11.7	17.47±0.36	14.7	20.3	0.782±0.037	0.397	1.025	7.21±0.747	2.23	13.85

Table 2. Genetic parameters of variation for seed yield and its components in F_2 generation in fenugreek

Character	Cross	σ^2e	σ^2p	σ^2g	PCV	GCV	$h^2_{(B.S)}$	GA	GA as % of mean
Days to maturity	UM-305 x RMt-143	0.65	11.53	10.88	2.59	2.52	94.36	6.60	5.05
	UM-305 x UM-128	0.60	10.40	9.80	2.46	2.39	94.23	6.26	4.79
	UM-305 x UM-117	0.50	6.51	6.01	1.89	1.82	92.31	4.85	3.60
	RMt-1 x UM-117	0.45	6.78	6.33	1.96	1.90	93.36	5.00	3.78
	Co-1 x RMt-143	0.75	4.41	3.66	1.59	1.45	82.99	3.59	2.72
Plant height (cm)	UM-305 x RMt-143	7.50	522.20	514.70	41.85	41.55	98.56	46.39	84.96
	UM-305 x UM-128	15.15	401.10	385.95	41.90	41.10	96.22	39.69	83.05
	UM-305 x UM-117	8.42	398.20	389.78	32.71	32.36	97.88	40.23	65.95
	RMt-1 x UM-117	5.63	105.72	100.09	16.22	15.78	94.67	20.05	31.63
	CO-1 x RMt-143	3.50	77.30	73.80	13.04	12.74	95.47	17.29	25.65
Primary branches plant^{-1}	UM-305 x RMt-143	1.12	2.80	1.68	29.98	23.22	59.86	2.06	36.91
	UM-305 x UM-128	1.57	2.67	1.10	27.09	17.39	41.14	1.38	22.88
	UM-305 x UM-117	0.90	4.54	3.64	35.01	31.43	80.17	3.52	57.99
	RMt-1 x UM-117	1.37	4.71	3.34	37.74	31.78	70.91	3.17	55.13
	CO-1 x RMt-143	0.82	4.80	3.98	32.21	29.33	82.81	3.73	54.85
Pods plant^{-1}	UM-305 x RMt-143	48.62	1205.91	1157.29	60.79	59.55	95.96	68.64	120.16
	UM-305 x UM-128	53.97	1663.19	1609.22	61.08	60.08	96.75	81.28	121.74
	UM-305 x UM-117	59.25	1617.55	1558.30	45.91	45.06	96.33	79.81	91.10
	RMt-1 x UM-117	78.12	2097.81	2019.69	58.66	57.55	96.27	90.83	116.32
	CO-1 x RMt-143	26.95	989.71	962.76	47.06	46.41	97.27	63.03	94.28
Pod length (cm)	UM-305 x RMt-143	0.457	1.401	0.944	11.73	9.62	67.34	1.64	16.25
	UM-305 x UM-128	0.304	0.636	0.332	8.23	5.95	52.20	0.857	8.85
	UM-305 x UM-117	0.304	0.965	0.661	11.44	9.47	68.49	1.38	16.08
	RMT-1 x UM-117	0.068	0.374	0.306	6.84	6.18	81.81	1.03	11.52
	CO-1 x RMt-143	0.233	0.444	0.211	6.29	4.34	47.52	0.652	6.16
Seeds pod^{-1}	UM-305 x RMt-143	1.392	3.757	2.365	12.51	9.92	62.94	2.51	16.20
	UM-305 x UM-128	1.262	3.049	1.787	10.97	8.40	58.60	2.10	13.19
	UM-305 x UM-117	1.258	16.014	14.756	37.01	35.53	92.14	7.59	70.21
	RMt-1 x UM-117	0.404	2.359	1.955	10.70	9.74	82.86	2.62	18.25
	CO-1 x RMt-143	0.761	2.619	1.858	9.26	7.80	70.93	2.36	13.50
100 seed weight (g)	UM-305 x RMt-143	0.0195	0.039	0.0195	16.86	11.92	51.28	0.208	17.76
	UM-305 x UM-128	0.0208	0.043	0.0222	19.02	13.66	53.48	0.228	20.91
	UM-305 x UM-117	0.0209	0.102	0.0811	24.79	22.11	80.39	0.528	40.99
	RMt-1 x UM-117	0.0108	0.031	0.0202	16.80	13.56	67.74	0.245	23.37
	CO-1 x RMt-143	0.0045	0.028	0.0235	21.39	19.60	85.71	0.295	37.72
Seed yield plant^{-1} (g)	UM-305 x RMt-143	1.55	29.28	27.73	69.64	67.77	94.70	10.55	135.85
	UM-305 x UM-128	2.51	43.27	40.76	71.96	69.85	94.19	12.76	139.64
	UM-305 x UM-117	2.75	18.16	15.41	52.93	48.76	84.85	7.44	92.52
	RMt-1 x UM-117	3.32	27.48	24.16	54.71	51.30	87.91	9.49	99.09
	CO-1 x RMt-143	0.98	11.18	10.20	46.37	44.29	91.23	6.28	87.10

Table 3. Phenotypic correlation coefficients among seed yield and its components in F_2 generation of two fenugreek crosses UM-305 x RMt-143 (above diagonal) and UM-305 x UM –128 (below diagonal).

Character	Days to maturity	Plant height (cm)	Number of primary branches plant^{-1}	Number of pods plant^{-1}	Pod length (cm)	Number of seeds pod^{-1}	100 seed weight (g)	Seed yield plant^{-1} (g.)
Days to maturity	1	0.347**	-0.036	0.229**	0.187*	0.194*	0.072	0.202*
Plant height (cm)	0.230	1	-0.096	0.380**	-0.091	0.374**	-0.174*	0.347**
Number of primary branches plant^{-1}	0.040	-0.137	1	0.572**	0.247**	0.117	0.194*	0.538**
Number of pods plant^{-1}	0.349**	0.281**	0.335**	1	0.318**	0.438**	0.047	0.943**
Pod length (cm)	0.049	-0.078	0.357**	0.228*	1	0.427**	0.065	0.335**
Number of seeds pod^{-1}	0.169	0.400**	0.122	0.276**	0.395**	1	-0.055	0.482**
100 seed weight (g)	0.237*	0.109	-0.033	0.006	-0.124	-0.035	1	0.179*
Seed yield plant^{-1} (g)	0.366**	0.374**	0.307**	0.932**	0.224*	0.360**	0.051	1

Significant at 5 % PL; Significant at 1 % PL

Table 4. Phenotypic correlation coefficients among seed yield and its components in F_2 generation of two fenugreek crosses UM-305 x UM-117 (above diagonal) and RMt-1 x UM-117 (below diagonal)

Character	Days to maturity	Plant height (cm)	Number of primary branches plant^{-1}	Number of pods plant^{-1}	Pod length (cm)	Number of seeds pod^{-1}	100seed weight (g)	Seed yield plant^{-1} (g.)
Days to maturity	1	0.092	-0.198	0.059	-0.261	-0.437*	0.415*	-0.205
Plant height (cm)	0.607**	1	0.025	0.187	-0.441*	0.006	0.169	0.361*
Number of primary branches plant^{-1}	0.247	0.567**	1	0.655**	-0.004	0.0589	0.218	0.553**
Number of pods plant^{-1}	0.305	0.774**	0.640**	1	-0.353	-0.264	0.307	0.743**
Pod length (cm)	0.453*	0.700**	0.325	0.651**	1	0.803**	-0.735**	0.018
Number of seeds pod^{-1}	0.069	0.339	0.326	0.551**	0.496*	1	-0.760**	0.274
100 seed weight (g.)	0.398	0.212	-0.096	0.163	0.089	-0.128	1	-0.081
Seed yield plant^{-1} (g.)	0.317	0.764**	0.636**	0.974**	0.695**	0.639**	0.118	1

Significant at 5% PL; Significant at 1% PL

character days to maturity, F_2s of all the crosses had lower mean values than mean of both the parents except for cross Co-1 x RMt-143, for which mean of F_2 was between means of both the parents. Mean of F_2 plants of the crosses UM-305 x RMt-143, UM-305 x UM-128, UM-305 x UM-117 and RMt-1 x UM-117 were between the mean of both the parents for plant height, while mean of cross Co-1 x RMt-143 was greater than both the parents. For the characters primary branches per plant, pods per plant and seed yield per plant the mean of F_2 generation was higher than the mean of the parents in all the crosses. For pod length and seeds per pod of F_2 plants only the means of F_2 of the cross Co-1 x RMt-143 were higher than that of both parents. Comparison of mean values and ranges of various characters in F_2 and parental generation indicated that substantial amount of genetic variability was generated for the characters pods per plant, seed yield per plant, plant height and primary branches per plant in all the five crosses. This genetic variability can be further exploited. Early maturing genotypes than their parents were observed in all the crosses, which will be useful in further breeding for early maturing genotypes. Moreover, in fenugreek the available genetic variability for 100 seed weight is low. In the crosses UM-305 x RMt-143, UM-305 x UM-128 and UM-305 x UM-117 the F_2 range exceeded the upper limit of the range of two parents and it was highest in cross UM-305 x UM-128 (2.296 g). This is very significant as the available reports indicate that the maximum value of range for this character in indigenous material is 1.9 g (Pant *et al.* 1983). The range for 100 seed weight in the crosses UM-305 x RMt-143 and UM –305 x UM-128 was also wider. Thus, significant amount of genetic variability was generated for further exploitation through selection.

Genetic parameters of variation were estimated in all the crosses for all the observed characters. In all the crosses, phenotypic variance was higher than genotypic variance (Table 2). Similarly in all the crosses phenotypic coefficient of variation was higher than the genotypic coefficient of variation for all the observed characters. Comparison of PCV for various characters among the crosses indicated that cross UM-305 x UM-128 followed by UM 305 x RMt-143 had highest PCV for plant height, pods per plant and seed yield per plant among the crosses. Cross UM-305 x RMt-143 had highest PCV for days to maturity and pod length. Cross RMt-1 x UM-117 had highest PCV for primary branches per plant while UM-305 x UM-117 had highest PCV for seeds per pod and 100 seed weight. In all the crosses high PCV and GCV were recorded for pods per plant and seed yield per plant (Table 2). The, PCV and GCV estimates indicated presence of substantial amount of genetic variability in all the crosses for pods per plant and seed yield per plant, while relatively moderate variability for plant height and primary branches per plant in most of the crosses. In cross UM-305 x UM-117 high PCV and GCV was recorded for seeds per pod, which is important with respect to fenugreek improvement. This generated variability can be exploited by further selection. Similar findings of high variability for pods per plant and seed yield per plant were recorded by Arora & Lodhi (1993) and for pods per plant by Mehta *et al.* (1992).

High heritability estimates were recorded for days to maturity, plant height, pods per plant and seed yield per plant in all the five crosses (Table 2). High heritability was recorded for primary branches per plant, seeds per pod and 100 seed weight in cross UM-305 x UM-117, for primary branches per plant and 100 seed weight in the cross CO-1 x RMt-143 and for pod length and seeds per pod in the cross RMt-1 x UM-117. High heritability estimates in all the five crosses for the characters days to maturity, plant height and pods per plant indicated that the environmental variance and genotype x environment interaction were minimum.

High heritability along with high genetic advance estimated as % of mean was recorded for pods per plant in all the five crosses (Table 2). Similar findings of high heritability along with high genetic advance as percentage of mean for pods per plant was earlier recorded in fenugreek in varietal evaluation studies (Arora & Lodhi 1993; Mehta *et al.* 1992). Thus,

Table 5. Phenotypic correlation coefficients among seed yield and its components in F_2 generation of cross Co-1 x RMt-143 in fenugreek

Character	Days to maturity	Plant height (cm)	Number of primary branches plant^{-1}	Number of pods plant^{-1}	Pod length (cm)	Number of seeds pod^{-1}	100seed weight (g)	Seed yield plant^{-1} (g)
Days to maturity	1	0.7861**	0.0412	-0.0297	0.1226	-0.3044	-0.6607**	-0.4314
Plant height(cm)		1	0.0317	-0.0997	-0.0552	-0.2747	-0.5380*	-0.3280
Number of primary branches plant^{-1}			1	0.8250**	0.2243	0.0813	-0.2505	-0.6242**
Number of pods plant^{-1}				1	0.3467	0.2036	-0.1963	0.6585**
Pod length (cm)					1	0.5877**	-0.0041	-0.1003
Number of seeds pod^{-1}						1	0.2300	0.2801
100 seed weight (g)							1	0.2377
Seed yield plant^{-1} (g)								1

*Significant at 5 % PL; Significant at 1% PL

on the basis of high heritability and high genetic advance, it could be concluded that the character pods per plant was mainly under the control of additive gene action in all the crosses and thus, selection for pods per plant will be effective in the segregating generation of all the crosses. Thus, selection for seeds per pod in cross UM-305 x UM-117 will also be responsive. Character plant height seemed to be under the control of non additive gene action in the crosses UM-305 x RMt-143, UM-305 x UM-128 and UM-305 x UM-117 as it had high heritability and moderate genetic advance as per cent of mean.

Association analysis (Tables 3, 4 & 5) indicated that seed yield per plant was positively correlated with days to maturity, plant height, primary branches per plant, pods per plant, pod length, seeds per pod and 100 seed weight in the cross UM-305 x RMt-143; with days to maturity, plant height, primary branches per plant, pods per plant, pod length and seeds per pod in cross UM-305 x UM-128; with plant height, primary branches per plant and pods per plant in the cross UM-305 x UM-117; with plant height, primary branches per plant, pods per plant, pod length and seeds per pod in the cross RMt-1 x UM-117 and with primary branches per plant and pods per plant in the cross Co-1 x RMt-143. Thus, in all the five crosses seed yield per plant was positively associated with pods per plant and primary branches per plant. These findings are in accordance with the findings of Mehta *et al.* (1992) and Kohli *et al.* (1988) which were based on varietal evaluation studies. Seed yield per plant had positive correlation with plant height, primary branches per plant and pods per plant in the first three crosses i.e., UM305 x RMt-143, UM-305 x UM-128 and UM 305 x UM-117, this may be due to common female parent (UM 305) in these three crosses. In the crosses UM-305 x RMt-143, UM-305 x UM-128 and RMt-1 x UM-117, pods per plant was positively correlated with plant height, primary branches per plant and pod length. In the crosses UM-305 x UM-117 and Co-1 x RMt-143 pods per plant was positively associated with primary branches per plant. Thus, on the basis of association analysis it seems that selection

for pods per plant, plant height and primary branches per plant will be effective in the crosses UM-305 x RMt-143, UM-305 x UM-128, UM-305 x UM-117 and RMt-1 x UM-117 for the improvement in seed yield per plant. While selection for pods per plant and primary branches per plant will be effective in the improvement of seed yield per plant in the cross Co-1 x RMt-143. Similar findings of positive correlation between seed yield per plant and pods per plant were earlier reported in fenugreek varietal evaluation studies (Mehta *et al.* 1992; Singh & Raghuvanshi 1984; Kohli *et al.* 1988).

In all the crosses pods per plant in addition to having high PCV, GCV, high heritability and high genetic advance as percentage of mean, also had positive correlation with seed yield per plant. Similar findings were earlier reported in varietal evaluation studies in fenugreek (Arora & Lodhi 1993; Mehta *et al.*, 1992; Singh & Raghuvanshi 1984). Thus, selection for pods per plant will be highly responsive in all the five crosses for improvement of seed yield per plant. On the basis of present investigation it can be concluded that substantial amount of genetic variability was generated which will be very useful in fenugreek improvement and this variability can be further exploited by direct selection for pods per plant in the segregating generation for improvement of seed yield per plant.

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