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Stability analysis for yield and yield attributes in fenugreek

Meghraj*, A.S. Shekhawat and S.K. Bairwa**
Department of Plant Breeding and Genetics and **Department of Horticulture,
College of Agriculture, SK Rajasthan Agriculture University, Bikaner, Rajasthan 334006, India
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Abstract

Stability analysis was carried out in twenty-five fenugreek (*Trigonella foenum-graecum* L.) genotypes over three environments created by three dates of sowing with the interval of fifteen days to identify phenotypically stable genotypes for yield and yield traits. A joint regression analysis of variance revealed that variances due to genotypes were found significant for seed yield per plant and number of seeds per pod. Mean squares due to environment were found significant for almost all the characters except number of pods per plant. Mean square due to environment (E) + Genotype (G) x environment (G X E) was found significant for plant height, number of primary branches per plant and number of seeds per pod. Mean squares due to G x E interaction were found significant for number of primary branches per plant and number of seeds per pod. Mean squares due to linear components of G X E were found significant for number of primary branches per plant and number of seeds per pod. Thus, role of environment and G x E interactions must be taken into account while devising and implementing selection or breeding programmes in fenugreek.

Key words: *Fenugreek, G X E interaction, Stability, Yield*

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is an important seed spices crop widely grown in north-western India. It is originated between South East Europe and West Asia (Smith, 1982). It is native to the countries bordering the Eastern shores of Mediterranean region, extending to Central Asia. Fenugreek is self- pollinated crop with chromosome no. 2n=16 (Frayer, 1930). It is an important condiment crop grown for both seed as well as leaves purpose. It can be grown under a wide range of climatic conditions and extensively used as fresh leaves (green leafy vegetable), chopped leaves (flavouring agent), sprouts (salad), micro greens (salad), pot herbs (decoration), seeds (spice, condiments or medicines), extracts and powders (medicines). Fenugreek seed contains carbohydrate (48%), protein (25.5%), mucilaginous matter (20.0%), fat (7.9%) and saponin (4.8%). The seed also contains major nutrients and minor nutrients with amino acid *viz.*, leucine, valine, lysine and phenylalanine. The fenugreek seeds are bitter in taste due to presence of alkaloids known as "*Trigonellin*". A potential use of fenugreek is for extraction of diosgenin. Diosgenin is a steroid precursor, which is used as a basic material in the synthesis of sex hormones and contraceptives. Fenugreek also has a high degree of medicinal value as it is used in certain Ayurvedic medicines for curing colic flatulence, dysentery, diabetes, diarrhoea and dyspepsia with loss of appetite.

More than 80 per cent area and production of the country is contributed by Rajasthan state alone. In Rajasthan the area under fenugreek is 82.35 thousand ha with production of 87.38 thousand tonnes (Anonymous, 2012-13). Fenugreek can be grown under wide range of climatic conditions. It requires cool climate and dry weather at the time of maturity. It can be grown on all types of soil, which is well drained. Unlike other legumes, fenugreek is fairly tolerant to salinity (Habib *et al.*, 1971). Cloudy weather particularly during the time of grain feeling stage increases the incidence of diseases and pests, which adversely affect the yield as well as quality of the produce. A successful evaluation of stable genotypes, which could be used in a breeding programme to develop promising genotypes, can be done through the study of stability of different genotypes under different environmental conditions. A specified genotype does not exhibit same phenotypic characteristics under all the environments and different genotypes respond differently to a specified environment. This variation arising from the lack of correspondence between genetic and non-genetic

*Corresponding authors's e-mail:
mr.mghraj1987@rediffmail.com

factors is known as G x E interaction. Keeping in view, the study has been under taken to find out stable genotype of fenugreek under and conditions of Rajasthan.

Materials and Methods

Twenty five elite genotypes of fenugreek were received from the germplasm collection of AICRP on Spices located at S.K.N. College of Agriculture, Jobner (Rajasthan). These genotypes were tested in randomized block design with three replications under three environments created by three dates of sowing (25 Oct., 10 Nov. and 25 Nov, 2011) with the interval of fifteen days at Research Farm, College of Agriculture, Bikaner (Rajasthan) during *Rabi* 2011-12. The data were collected on ten randomly selected plants from each replication and environment for plant height, number of primary branches per plant, number of pods per plant, number of seeds per pod and seed yield per plant. For statistical analysis, mean values were used. The data were analyzed for stability parameters according to Eberhart and Russell (1966).

Results and Discussion

Mean squares due to genotype were significant for number of seeds per pod and seed yield per plant (Table1). Mean squares due to environment were significant for almost all the characters except number of pods per plant. G x E interaction variance was significant for number of primary branches per plant and number of seeds per pod. Mean squares due to environment linear were significant for almost all the characters except number of pods per plant so indicating that environments differed significantly. Significant differences attributable to genotype, environment and G x E interaction were also reported by Singh and Singh (1990) and Sood *et al*. (2001).

Mean squares due to (E) +G X E was found significant for plant height, number of primary branches per plant and number of seeds per pod. Significant difference in E+G X E were also reported by Manikannan *et al*. (2002) in urd bean. Linear components of G x E were significant for number of primary branches per plant and number of seeds per pod. Significant linear components of G x E were also reported by Solanki and Choudhary (1996). Pooled deviation (non linear) was found non-significant for almost all the characters except number of primary branches per plant. Non-Significant Pooled deviation (non linear) were also reported by Rao and Rao (2004) and Datke and Gandhi Prasad (2000).

Plant height

Genotypes with short mean plant height than population mean are more suitable for this character (Table 2). Out of twenty five genotypes, thirteen genotypes viz., Rmt-143, Rmt-35, Rmt-305, UM-117, UM-120, UM-122, UM-131, UM-133, UM-171, UM-190, UM-201, UM-205 and UM-207 exhibited short mean plant height than population mean (38.14 cm). On the basis of mean and regression coefficient, genotypes Rmt-305, UM-117 and UM-190 showed above average stability as they had lower mean than general mean along with regression coefficient higher than unity (b_i >1) and non-significant deviation (S^2d_i) from regression. Genotypes UM-120, UM-122, UM-133, UM-201, UM-205 and UM-207 had lower mean than general mean and regression coefficient lower than unity (b_i<1) showed below average stability. Genotypes Rmt-351, UM-131 and UM-171 showed average stability as they had lower mean than general mean and regression coefficient equal to unity (b_i=1). Therefore, these genotypes were stable and desirable.

Table 1. Analysis of variance for stability in fenugreek genotypes over three environments.

Source of Variation	D F	Plant height (cm)	No. of primary branches per plant	Number of pods per plant	Number of seed per pod	Seed yield per plant (g)
Genotypes (G)	24	6.856	0.373	17.383	1.548##	0.877#
Environment (E)	2	535.439##	1.405##	17.474	105.812##	3.866##
Gen. x Env. (G x E)	48	8.996	0.514*	27.078	0.208**	0.528
(E + G x E)	50	30.058**++	0.550**	26.694	4.432**++	0.662
E (Linear)	1	1070.879**++	2.810*++	34.949	211.63**++	7.732**++
G x E (Linear)	24	10.445	0.511**	22.840	0.405**++	0.387
Pooled Deviation	25	7.244	0.497**	30.064	0.011	0.642
Pooled Error	150	8.112	0.285	23.813	0.074	0.466

#, ## significant at 5% and 1% level against G x E, respectively

*, ** significant at 5% and 1% level against pooled error, respectively

+, ++ significant at 5% and 1% level against pooled deviation, respectively

Table 2. Stability parameters for plant height, number o f primary branches per plant and number of pod s per plant in fenugreek genotypes.

Genotypes	Plant height (cm)			Number of primary branches per plant			Number of pods per plant		
	x	b_i	S^2d_i	x	b_i	S^2d_i	x	b_i	S^2d_i
Rmt-143	34.67	1.47	24.72*	3.06	-3.42	0.35	17.62	-5.83	19.56
Rmt-305	34.96	1.18**	3.73	3.73	-1.21	0.09	21.58	-1.04	50.95
Rmt-351	37.16	1.01**	-7.11	3.93	-0.98	-0.27	20.58	3.13	-1.76
UM-114	38.69	0.93**	-6.56	3.51	-0.05	2.60**	20.74	-4.28	57.23
UM-117	36.44	1.32**	-8.08	3.21	2.60**	-0.28	14.64	5.28*	-17.25
UM-120	36.96	0.50**	6.81	2.87	0.00	-0.21	17.64	-1.07	14.41
UM-122	37.82	0.88	1.47	3.50	-1.21	-0.14	18.11	-2.34	-21.99
UM-125	39.49	2.11**	0.81	2.99	4.10**	-0.27	19.43	8.67**	-14.47
UM-128	38.84	1.33**	-7.28	3.19	-0.27	-0.12	21.57	4.09	18.60
UM-131	37.48	1.09**	-3.72	3.45	-0.41	-0.14	23.77	0.46	21.77
UM-133	36.44	0.82**	-4.75	3.78	3.59**	1.2	20.99	1.25	8.84
UM-138	41.20	1.21**	-8.11	3.12	2.51	-0.25	22.76	-0.00	-15.33
UM-165	38.48	1.46**	-6.05	2.87	3.03**	0.13	22.94	2.52	-4.41
UM-166	40.44	1.44*	14.84	3.17	5.59**	0.45	19.71	9.69	41.81
UM-169	39.17	1.87**	-2.41	3.21	2.93	-0.15	22.19	6.80	-19.42
UM-171	38.12	0.92**	-7.96	3.28	0.53	-0.16	22.36	-5.54	1.60
UM-190	38.07	1.24**	4.15	3.13	-0.51	3.27	16.99	0.91**	95.85
UM-196	38.36	1.19**	-7.79*	3.68	-1.42	-0.27	21.62	-2.55	-17.80
UM-201	37.92	0.57*	-5.32	3.86	0.43	-0.04	20.93	1.01	9.09
UM-202	39.13	0.37*	-7.30	3.73	0.24	-0.28	21.33	3.33	-20.08
UM-205	38.11	0.62	11.92	3.38	1.37	-0.01	17.62	-0.42	-21.50
UM-206	38.23	0.21	-6.13	3.31	3.78	.011	19.62	2.25	32.18
UM-207	38.07	0.11	-7.05	3.23	1.21	-0.01	20.57	-4.19	-15.85
UM-209	39.61	0.55*	-6.40	2.84	2.48	-0.04	16.28	2.36**	-23.78
UM-211	39.66	0.58	25.52	2.56	0.08	-0.23	16.36	0.49	-21.89
Population mean	38.14	1.00		3.31	1.00		19.92	1.00	
SE(b_i) ±		0.31			1.27			3.42	

Number of primary branches per plant

Genotypes Rmt-305, Rmt-351, UM-114, UM-122, UM-131, UM-133, UM-196, UM-201, UM-202, UM-205 and UM-206 showed higher number of primary branches per plant (Table 2) as they had higher mean than population mean (3.31). Genotypes UM-133, UM-205 and UM-206 had greater mean than general mean and regression coefficient higher than unity (b_i >1) and non-significant deviation (S^2d_i) from regression exhibited above average stability. Genotypes Rmt-305, Rmt-351, UM-122, UM-131, UM-196, UM-201 and UM-202 had higher mean than general mean and regression coefficient lower than unity (b_i<1) exhibited below average stability.

Number of pods per plant

A close perusal of (Table 2) showed that fourteen genotypes viz., Rmt-305, Rmt-351, UM-114, UM-128, UM-131, UM-133, UM-138, UM-165, UM-169, UM-171, UM-196, UM-201, UM-202 and UM-207 showed higher number of pods per plant as they had high mean than general mean (19.92). Six genotype Rmt-351, UM-128, UM-133, UM-165, UM-169 and UM-202 exhibited above average response as they had higher mean than general mean and regression coefficient higher than unity (b_i>1) and non-significant deviation (S^2d_i) from regression. Seven genotypes Rmt-305, UM-114, UM-131, UM-138, UM-171, UM-196 and UM-207 had greater mean than general mean and regression coefficient lower than unity (b_i<1) exhibited below average stability while only one genotypes UM-201 had greater mean than general mean and regression coefficient equal to unity (b_i =1) exhibited average stability.

Number of seeds per pod

Genotypes Rmt-143, Rmt-305, Rmt-351, UM-122, UM-131, UM-166, UM-169, UM-202, UM-

Table 3. Stability parameters for number of seeds per pods and seed yield per plant in fenugreek genotypes.

Genotypes	Number of seeds per pod			Seed yield per plant (g)		
	x	b_i	S^2d_i	X	b_i	S^2d_i
Rmt-143	13.50	0.99**	-0.06	2.54	2.82	2.46**
Rmt-305	13.00	0.79**	-0.07	3.28	1.73	-0.14
Rmt-351	13.70	0.70**	-0.07	2.14	1.22**	-0.42
UM-114	11.72	0.72**	-0.06	2.48	2.83	0.13
UM-117	12.31	0.98**	-0.07	3.12	-0.15	-0.28
UM-120	11.63	0.92**	-0.07	3.08	0.23	-0.45
UM-122	12.86	0.94**	-0.06	3.45	-0.64	-0.43
UM-125	12.32	0.83**	-0.05	3.78	1.89*	-0.29
UM-128	12.54	1.34**	-0.07	2.92	0.06	-0.40
UM-131	14.05	0.93**	-0.07	3.72	-0.29	-0.40
UM-133	12.00	0.72**	-0.05	2.82	2.91	0.56
UM-138	12.41	0.81**	-0.07	2.61	1.44	0.92
UM-165	12.51	1.02**	-0.07	3.08	-0.50	-0.38
UM-166	13.08	0.96**	-0.06	3.92	1.23*	5.15
UM-169	12.64	1.02**	-0.06	3.36	1.95	-0.46
UM-171	11.61	1.25**	-0.07	4.04	2.69**	0.61
UM-190	11.57	1.26**	-0.04	2.45	0.31	-0.33
UM-196	12.30	1.26**	-0.05	3.11	1.21	0.13
UM-201	12.17	1.53**	-0.07	3.88	-0.39	-0.13
UM-202	12.80	1.33**	-0.07	2.53	0.63	-0.14
UM-205	14.02	0.90**	-0.06	2.83	2.08**	-0.39
UM-206	12.91	0.95**	-0.03	2.15	0.98	-0.17
UM-207	11.80	0.87**	-0.02	2.68	-0.45	-0.25
UM-209	12.22	0.85**	-0.05	2.81	0.51	-0.22
UM-211	13.12	0.96**	-0.06	2.71	1.01	-0.24
Population mean	12.59	1.00		3.02	1.00	
SE (b_i)±		0.04			0.92	

205, UM-206 and UM-211 showed greater number of seeds per pod (Table 3) as they depicted higher mean than population mean (12.59)**.** Genotypes UM-202 had higher mean than general mean and regression coefficient higher than unity (b_i>1) and non-significant deviation (S^2d_i) from regression exhibited above average stability. Genotypes Rmt-305, Rmt-351 had greater mean than general mean and regression coefficient lower than unity (b_i <1) exhibited below average stability while genotypes Rmt-143, UM-122, UM-131, UM-166, UM-169, UM-205, UM-206 and UM-211 had greater mean than general mean and regression coefficient equal to unity (b_i =1) exhibited average stability.

Seed yield per plant

Data presented (Table 3) showed that twelve genotypes namely Rmt-305, UM-117, UM-120, UM-122, UM-125, UM-131, UM-165, UM-166, UM-169, UM-171, UM-196 and UM-201 showed higher seed yield per plant as they depicted higher mean than population mean (3.03g). Joint consideration of mean performance and stability parameters revealed that genotypes Rmt-305, UM-125, UM-166, UM-169, UM-171 and UM-196 had higher mean than general mean and regression coefficient higher than unity (b_i >1) and non-significant deviation (S^2d_i) from regression exhibited above average stability. Genotypes UM-117, UM-120, UM-122, UM-131, UM-165 and UM-201 exhibited below average stability as they had greater mean than general mean and regression coefficient lower than unity (b_i<1).

On the basis of present study, genotype UM-205 was identified as a stable genotype for number of seeds per pod over varied environments as it had regression coefficient equal to unity with non-significant deviation (S^2d_i) from regression. Genotype UM-171 was stable for seed yield per plant, Rmt-305 was stable for seed yield per plant and plant height, genotype UM-165 was also stable for plant height, and number of pods per plant. These genotypes perform better under favorable environment. All above genotypes showed regression coefficient higher than unity with non significant deviation (S^2d_i) from regression. Superior genotypes were identified for poor environment. Genotype UM-131 was stable for seed yield per plant, number of primary branches per plant, number of pods per plant, genotype UM-122 was stable for seed yield per plant, plant height and number of primary branches per plant, genotype UM-120 was also stable for seed yield per plant, plant height. All above genotype showed regression coefficient less than unity with non-significant deviation (S^2d_i) from regression and this identified for poor environment.

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