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Genetic Variability, Heritability, Genetic Advance and Correlation Coefficient Study in Fenugreek Cultivars (*Trigonella foenum-graecum* L.)

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ABSTRACT: A field experiment was conducted with twenty cultivars at College of Horticulture, Mandsaur (Madhya Pradesh) in Randomized Block Design with three replications during the year 2018-19. This investigation revealed that phenotypic coefficient of variation was higher than the genotypic due to influence of environment on the expression of the characters. The highest GCV was observed for number of pods plant^{-1} (27.13). The highest PCV % observed for number of pods plant^{-1} (27.62) followed by seed yield (21.09).The highest heritability was recorded in number of pods plant^{-1} (96.55) followed by days to 50% flowering (96.00) and number of secondary branches plant^{-1} (90.60). The highest genetic advance was recorded in number of pods plant^{-1} (33.69) followed by plant height (15.42) and fresh weight g plant^{-1} (14.72). The highest genetic advance as percent of mean was observed in number of pods plant^{-1} (54.93) afterward seed yield g plant^{-1} (34.84) and seed yield q ha^{-1} (34.84). Correlation studies showed that, at both genotypic and phenotypic levels, seed yield gram plant^{-1} was significantly and positively correlated with seed yield q ha^{-1} (1.00 and 1.00), pod length (0.987 and 0.560), dry weight g plant^{-1} (0.876 and 0.724) and number of seeds pod^{-1} (0.850 and 0.614). The maximum nitrogen (3.70 %) and protein (23.15 %) content of the seed were recorded in V_{10} PEB. Efforts should be initiated to develop stratagems for improving fenugreek dry matter production and genetic diversity among different germplasm, which will be needful for breeding and crop improvement programme in fenugreek.

Keywords: Genetic Variability, Heritability, Genetic Advance, Correlation Coefficient and *Trigonella foenum-graecum* L.

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is self-pollinated and destogamous annual diploid species and is belongs to the family "Fabaceae". It is native of Mediterranean region, extending to Central Asia. It having a chromosome number 2n=16. Fenugreekis cultivated as a leafy vegetable, condiments and medicinal plant. Bitter taste of seeds is due to the presence of an alkaloid "Trigonelline". The importance of fenugreek has been increased due to presence of asteroid called "*Diosgenin"* and it is used in the synthesis of sex hormones and contraceptives (Meena *et al.,* 2017 and Prasad *et al*., 2020). Both leaves and seeds have medicinal uses and act as anti-diabetic, lowering blood sugar and cholesterol level (Chouhan *et al.,* 2017). In India total annual production of about 220 thousand metric tons (NHB, 2017) and holding topmost position among the fenugreek growing countries in the world. It is mainly grown in Rajasthan, Madhya Pradesh, Andhra Pradesh, Uttar Pradesh, Gujarat and Punjab states (Kumar *et al.,* 2018 and Shakthi *et al*., 2020).Yield is a major parameter, which is influenced by several yield and yield attributing characters controlled by polygenes and also influenced by environment (Hosamath *et al.,* 2017). Phenotypic variability changes under different environmental conditions whereas genetic variability remains unchanged and more helpful to a plant breeder for exploitation in selection or hybridization. Studies on genetic variability with the help of proper biometrical tools such as variability, heritability, genetic advance gives an idea about the extent of genetic variability existing in the population (Kumar *et al.,* 2018).The correlation co-efficient help to judge existing relationship between the yield and yield attributing traitsand only discloses the direction and magnitude of association between any two characters (Verma *et al.,* 2018).

MATERIALS AND METHODS

The field experiment was carried out at the "Horticulture Research Farm" College of Horticulture, Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during *rabi* season of 2018-19.Investigation was carried out in randomized block besign with twenty cultivars includes seven local collected genotypes from the Mandsaur, Jaora and Tikamgarh district of Madhya Pradesh and thirteen released varieties obtained from different research centres. Observations were taken from five randomly selected plants of each plot and later on their mean was calculated. The experimental data were subjected to statistical analysis using analysis of variance technique suggested by Panse and Sukhatme (1985). Where the "F" test was found significant at 5 % level of significance, the critical differences for the treatment's comparison were worked out. The phenotypic and genotypic coefficient of variation was worked out as per Burton (1952) and heritability (broad sense) and genetic advance were determined following the methodology of Johnson et al. (1955). The phenotypic and genotypic correlation coefficients were calculated as per the methods given by Al- Jibouri *et al.* (1958).

RESULTS AND DISCUSSION

Genetic variability, Heritability and Genetic advance as a percent mean: Analysis of variance revealed that, there was significant difference among the cultivars for all the traits under investigation, except days to 50 % germination which was non-significant. Range for all the character is broadly indicating the presence of wide range of variation.

Genotypic and Phenotypic coefficient of variation: Data obtained from investigation revealed that phenotypic coefficient of variation is higher than the genotypic variation due to influence of environment on the expression of the characters. PCV and GCV were classified as suggested by Sivasubramanian and Menon (1973).

Table 1: Estimation of Genotypic coefficient of variation (GCV) and Phenotypic coefficient of variation (PCV), Heritability, and Genetic advance as percent of mean for different characters of fenugreek cultivars.

Traits	Mean	Range		Coefficient of variation		Heritability (%)	Genetic advance	GA as % over mean
		Min.	Max.	GCV %	PCV %			
PH	82.18	53.21	91.30	10.15	11.31	80.50	15.42	18.76
NL	41.89	34.20	57.39	11.28	12.70	78.95	8.65	20.65
PB	6.73	5.20	9.34	11.04	12.19	82.11	1.39	20.62
SB	8.24	6.90	14.07	17.53	18.42	90.60	2.83	34.37
FW	56.62	41.60	72.62	13.81	15.11	83.54	14.72	26.00
DW	20.63	14.75	25.63	13.61	14.67	86.13	5.37	26.03
LA	34.37	24.78	47.54	17.03	18.26	86.93	11.24	32.70
Chl	44.48	38.62	52.94	6.46	8.70	55.13	4.39	9.88
DG	4.70	4.33	5.67	4.06	11.00	13.58	0.14	3.08
DF	46.71	43.67	69.00	11.50	11.74	96.00	10.84	23.21
DM	121.65	119.00	129.00	1.62	1.99	66.07	3.30	2.71
NP	61.34	30.73	100.17	27.13	27.62	96.55	33.69	54.93
NS	14.70	11.85	15.83	7.06	8.90	62.84	1.69	11.53
PL	11.21	10.60	12.40	3.15	5.13	37.72	0.45	3.99
SY(g)	6.23	4.02	8.77	18.89	21.09	80.20	2.17	34.84
TW	14.31	11.08	19.55	14.65	15.48	89.48	4.08	28.54
S%	57.41	39.27	71.20	9.91	11.14	79.13	10.42	18.15
SY (q)	20.78	13.41	29.22	18.89	21.09	80.20	7.24	34.84
HI	30.23	23.28	36.11	11.66	13.50	74.60	6.27	20.74
N	3.05	2.43	3.70	10.88	12.99	70.10	0.57	18.76
P	19.04	15.18	23.15	10.88	12.99	70.10	3.57	18.76

PH- Plant height, **NL**- Number of leaves (plant^{-1}), **PB**- Primary branches (plant^{-1}), **SB**- Secondary branches (plant^{-1}), **FW**- Fresh weight (g plant^{-1}), **DW**- Dry weight (g plant^{-1}), **LA**-Leaf Area (cm^2 plant^{-1}), **Chl**-Chlorophyll content(SPAD value), **DG**-Days to 50% germination, **DF**-Days to 50 % flowering, **DM**- Days to maturity, **NP**- Number of pods (plant^{-1}), **NP**- Number of seeds (pod^{-1}), **PL**- Pod length (cm), **SY(g)** - Seed yield (g plant^{-1}), **TW**- Test weight (g), **S %**- Shelling percentage, **SY(q)**- Seed yield (q/ha), **HI**- Harvest index(%),**N %**- Nitrogen content of seed (%), **P%**- Protein content of seed (%),

Result revealed that, out of twenty-one characters studied, the GCV was high for one, low for six and moderate for the remaining characters. However, the highest genotypic coefficient of variation was observed for number of pods plant^{-1} (27.13) followed by seed yield (18.89) and secondary branches plant^{-1} (17.53). These findings are accordance with the findings of Patil *et al.* (2016) for number of pods plant^{-1} in fenugreek. The Lowest GCV % was observed for shelling % (9.91), number of seeds pod^{-1} (7.06), Chlorophyll content SPAD (6.46), days to 50 % germination (4.06), pod length (3.15) and days to maturity (1.62). These results were close proximate with the results of Kumar *et al.* (2018) for days to maturity. Prakash *et al.* (2017) for seeds pod^{-1} and pod length, Hosamath *et al.* (2017) for SPAD value. Similarly, the PCV was high for three characters, low for four characters and moderate for the remaining characters. Though, the highest PCV % observed for number of pods plant^{-1} (27.62) followed by seed yield (21.09) and secondary branches plant^{-1} (18.42). These results were agreement with the findings of Prakash *et al.* (2017) for number of pods plant^{-1} and seed yield g plant^{-1}. Whereas lowest PCV observed for number of seeds pod^{-1} (8.9) followed by SPAD value (8.7), pod length (5.13) and days to maturity (1.99). Similar findings are in close harmony with the Yadav *et al.* (2018), Prakash *et al.* (2017) for number of seeds pod^{-1}, pod length (cm) and days to maturity, Gurjar *et al.* (2016); Hosamath *et al.* (2017) for SPAD value in fenugreek.

Heritability: The heritability h^2 (b) was classified as suggested by Johnson *et al.*, (1955). In the present investigation out of twenty-one characters, the heritability was high for eighteen, low for one and moderate for two characters. Heritability is the ratio of the genotypic variance to phenotypic variance. It is very important biometrical tool for guiding plant breeders for adoption of appropriate breeding procedures. High heritability in broad sense is helpful in identifying suitable character for selection and enables the breeder to select superior genotypes on the basis of phenotypic expression of quantitative characters (Dhakad *et al.* 2017).

In the present study the heritability was ranged between 13.58 to 96.55 %. However, it was highest in number of pods plant^{-1} (96.55) followed by days to 50% flowering (96.00), number of secondary branches plant^{-1} (90.6), test weight (89.48), leaf area (86.93), dry weight (86.13), fresh weight (83.54), number of primary branches (82.11), plant height (80.5), seed yield , shelling % (79.13), number of leaves (78.95), harvest index (74.60), nitrogen and protein content of seed (70.10), days to maturity (66.07) and number of seeds (62.84). Similar observations made by Meena *et al.* (2011) and Hosamath *et al.* (2017) for number of pods plant^{-1}, days to 50% flowering, number of secondary branches, plant height, number of leaves, Gurjar *et al.* (2016) for protein content of the seed, Dashora *et al.* (2011) for harvest index in fenugreek. Whereas lowest heritability recorded in days to 50% germination (13.58). This finding is close harmony with the results of Dhakad *et al.* (2017) in coriander.

Genetic advance: Heritability indicates only the effectiveness with which selection of a genotype based on phenotypic performance, but fails to indicate the genetic progress. Heritability estimates along with genetic gains are more effective and reliable in predicting the improvement through selection (Dhakad *et al.* 2017).

In the present study the genetic advance was ranged between 0.14 to 33.69 %. The highest genetic advance was recorded in number of pods (33.69) followed by plant height (15.42), fresh weight (14.72), leaf area (11.24), days to 50% flowering (10.84), shelling percent (10.42), number of leaves (8.65) , seed yield q/ha (7.24), harvest index (6.27), dry weight (5.37), SPAD value (4.39), test weight (4.08), protein content of seed (3.57), days to maturity (3.30), number of secondary branches (2.83), seed yield g plant^{-1} (2.17), number of seeds (1.69), number of primary branches (1.39), nitrogen content of seed (0.57), pod length (0.45), days to 50% germination (0.14). Similar findings were reported by Verma and Ali (2012), Sharada *et al.* (2008); Dashora *et al.* (2011); Jain *et al.* (2013); Yogendra *et al.* (2013); Pathak *et al.* (2014); Gurjar *et al.* (2016) in fenugreek and Dhakad *et al.* (2017) in coriander.

Table 2: Genotypic correlation coefficient among yield and yield attributing characters in different fenugreek cultivars.

Traits	PH	NL	PB	SB	SPAD	DW	50 % F	DTM	NPP	PL	NSP	TW	S %	HI	N%	P %	SQH	SGP
PH	1.000	-0.397**	-0.467**	-0.667**	-0.462**	0.187NS	-0.802**	-0.669**	-0.056NS	0.694**	0.751**	0.121NS	0.472**	0.685**	-0.291*	-0.291*	0.503**	0.503**
NL		1.000	0.922**	0.834**	0.648**	0.565**	0.688**	0.582**	0.719**	-0.052NS	-0.001NS	-0.359**	0.535**	-0.246NS	0.416**	0.417**	0.266*	0.266*
PB			1.000	0.918**	0.603**	0.488**	0.814**	0.805**	0.728**	-0.125NS	-0.050NS	-0.548**	0.530**	-0.222NS	0.443**	0.444**	0.234NS	0.234NS
SB				1.000	0.751**	0.443**	0.945**	0.817**	0.698**	-0.247NS	-0.252NS	-0.324*	0.299*	-0.325*	0.614**	0.614**	0.159NS	0.159NS
SPAD					1.000	0.516**	0.674**	0.545**	0.633**	0.262*	-0.289*	0.081NS	0.253NS	-0.137NS	0.610**	0.611**	0.315*	0.315*
DW						1.000	0.263*	0.228NS	0.688**	0.836**	0.538**	0.062NS	0.682**	0.297*	0.603**	0.603**	0.876**	0.876**
50 % F							1.000	0.953**	0.572**	-0.319*	-0.273*	-0.320*	0.137NS	-0.335**	0.529**	0.529**	0.025NS	0.025NS
DTM								1.000	0.505**	-0.131NS	-0.153NS	-0.357**	0.176NS	-0.250NS	0.312*	0.312*	0.014NS	0.014NS
NPP									1.000	0.415**	0.503**	-0.425**	0.727**	0.362**	0.686**	0.686**	0.713**	0.713**
PL										1.000	0.971**	0.219NS	0.735**	0.704**	0.231NS	0.230NS	0.987**	0.987**
NSP											1.000	-0.309*	0.759**	0.883**	0.189NS	0.189NS	0.850**	0.850**
TW												1.000	-0.336**	-0.080NS	-0.097NS	-0.096NS	0.012NS	0.012NS
S %													1.000	0.650**	0.379**	0.379**	0.840**	0.840**
HI														1.000	0.141NS	0.141NS	0.780**	0.780**
N%															1.000	1.000**	0.571**	0.571**
P %																1.000	0.571**	0.572**
SQH																	1.000	1.000**
SGP																		1.000

** 1 % level of significance * 5 % level of significance

PH- Plant height, NL- Number of leaves (plant^{-1}), PB- Primary branches (plant^{-1}), SB- Secondary branches (plant^{-1}), SPAD- Chlorophyll content, DW- Dry weight (g plant^{-1}), 50 % F- Days to 50 % flowering, DTM- Days to maturity, NPP- number of pods (plant^{-1}), PL- Pod length (cm), NSP- Number of seeds (pod^{-1}), TW- 1000 seed weight (g), S %- Shelling percentage, HI- Harvest index(%),N %- N content of seed (%), P%- Protein content of seed (%),SQH- Seed yield (q/ha), SGP- Seed yield (g plant^{-1}).

Table 3: Phenotypic correlation coefficient among yield and yield attributing characters in different fenugreek cultivars.

Traits	PH	NL	PB	SB	SPAD	DW	50 % F	DTM	NPP	PL	NSP	TW	S %	HI	N%	P %	SQH	SGP
PH	1.000	-0.325*	-0.371**	-0.588**	-0.314*	0.140NS	-0.695**	-0.479**	-0.054NS	0.461**	0.551**	0.096NS	0.347**	0.532**	-0.210NS	-0.210NS	0.386**	0.386**
NL		1.000	0.768**	0.724**	0.421**	0.468**	0.599**	0.522**	0.629**	0.030NS	-0.047NS	-0.316*	0.459**	-0.126NS	0.304*	0.304*	0.257*	0.258*
PB			1.000	0.778**	0.409**	0.410**	0.725**	0.603**	0.644**	0.010NS	-0.038NS	-0.481**	0.427**	-0.176NS	0.332**	0.332**	0.203NS	0.204NS
SB				1.000	0.542**	0.384**	0.879**	0.623**	0.668**	-0.141NS	-0.141NS	-0.275*	0.257*	-0.247NS	0.583**	0.583**	0.141NS	0.141NS
SPAD					1.000	0.276*	0.462**	0.252NS	0.445**	-0.019NS	-0.047NS	0.050NS	0.203NS	-0.003NS	0.363**	0.363**	0.208NS	0.208NS
DW						1.000	0.257*	0.214NS	0.634**	0.445**	0.418**	0.052NS	0.587**	0.078NS	0.461**	0.461**	0.724**	0.724**
50 % F							1.000	0.793**	0.552**	-0.192NS	-0.196NS	-0.298*	0.113NS	-0.308*	0.430**	0.429**	0.009NS	0.009NS
DTM								1.000	0.399**	-0.165NS	-0.040NS	-0.284*	0.135NS	-0.231NS	0.197NS	0.197NS	0.061NS	0.062NS
NPP									1.000	0.250NS	0.416**	-0.381**	0.630**	0.299*	0.548**	0.548**	0.664**	0.664**
PL										1.000	0.335**	0.124NS	0.374**	0.461**	0.173NS	0.173NS	0.560**	0.560**
NSP											1.000	-0.216NS	0.493**	0.539**	0.152NS	0.151NS	0.614**	0.614**
TW												1.000	-0.301*	-0.088NS	-0.046NS	-0.046NS	0.043NS	0.044NS
S %													1.000	0.473**	0.264*	0.264*	0.676**	0.676**
HI														1.000	0.106NS	0.106NS	0.649**	0.649**
N%															1.000	1.000**	0.322*	0.322*
P %																1.000	0.322*	0.322*
SQH																	1.000	1.000**
SGP																		1.000

** 1 % level of significance * 5 % level of significance

PH- Plant height, NL- Number of leaves (plant^{-1}), PB- Primary branches (plant^{-1}), SB- Secondary branches (plant^{-1}), SPAD- Chlorophyll content, DW- Dry weight (g plant^{-1}), 50 % F- Days to 50 % flowering, DTM- Days to maturity, NPP- number of pods (plant^{-1}), PL- Pod length (cm), NSP- Number of seeds (pod^{-1}), TW- 1000 seed weight (g), S %- Shelling percentage, SGP- Seed yield (g plant^{-1}), HI- Harvest index(%), SQH- Seed yield (q/ha), N %- N content of seed (%), P%- Protein content of seed (%)

Genetic advance as percent of mean: In the present investigation out of twenty-one characters, the genetic advance as per cent of mean was high for twelve, low for four and moderate for five characters. The genetic advance as per cent of mean was classified as suggested by Johnson *et al.* (1955). The highest genetic advance as percent of mean was observed in number of pods (54.93) followed by seed yield (34.84), number of secondary branches (34.37), leaf area (32.7), test weight (28.54), dry weight (26.03), fresh weight (26.00), Days to 50% flowering (23.21), harvest index (20.74), number of leaves (20.65), number of primary branches (20.62). These results were in close proximate that of Verma and Ali (2012) for number of pods plant^{-1}, harvest index, seed yield g plant^{-1}, seed yield q/ha and 1000 seed weight, Singh *et al.* (2016) and Patil *et al.* (2016) for fresh weight and dry weight and number of primary branches, Singh and Kakani (2017) for 50 % flowering and seed yield, Hosamoth *et al.* (2017) for number of leaves, leaf area in fenugreek. Low Genetic advance as percent of mean was observed in SPAD value (9.88), pod length (3.99), days to 50% germination (3.08) and days to maturity (2.71). Similar findings were reported by Prajapati *et al.* (2010) for days to maturity, Hosamath *et al.* (2017) for SPAD value (chlorophyll content) in fenugreek.

Genotypic and phenotypic correlation coefficient studies: Correlation coefficients provide a clear picture of the extent of relationship between a pair of characters and indicate simultaneous improvement of the correlated characters may be possible. A positive correlation between the desirable characters is helpful to the plant breeder because it helps in simultaneous improvement of both the characters. A negative correlation on the other hand shall find the simultaneous expression of the both the characters with high value (Dhakad *et al.*, 2017). The correlation coefficient computed at phenotypic level and also genotypic level. The magnitude of the genotypic correlation was higher than the phenotypic correlation for all the traits that showed the inherent association between the various characters. Seed yield ha^{-1} (1.00** and 1.00**), pod length (0.987** and 0.560), dry weight g plant^{-1} (0.876 and 0.724), number of seeds pod^{-1} (0.850** and 0.614**), shelling percent (0.840** and 0.676**), harvest index (0.780** and 0.649**), number of pods (0.713** and 0.664**), plant height (0.503** and 0.386**), nitrogen content and protein content of the seed (0.780** and 0.322*), leaves plant^{-1} (0.266* and 0.258*) exhibited significant and positive correlation with seed yield gram plant^{-1}. SPAD value was significant at genotypic level (0.315*), whereas, non-significant at phenotypic level (0.208). These finding are in accordance with the report of Singh (2014), Sharma and Sastry (2008), Singh *et al.* (2013) for pod length, number of seeds pod^{-1}, number of pods, Seed yield q/ha, number of leaves per plant Dhakad *et al.* (2017), Patahk *et al.* (2014) for protein content of the seed, Singh *et al.* (2016) for SPAD (chlorophyll content of leaves) in fenugreek, Kumar *et al.* (2015) for shelling percent in garden pea, Lad *et al.* (2017) for harvest index in French bean. Gurjar *et al*. (2016) for dry weight of the plant in fenugreek.

Quality parameters: Significant differences were observed in nitrogen and protein (%) content of the seed. The investigation revealed that, the highest (3.70 and 23.15 %) nitrogen and protein content of the seed were recorded in V_{10} PEB while it was minimum (2.43 and 15.18 %) in variety V_{15} MDS Local-2. The variation in the quality parameters due to genetic makeup of the variety. Similar findings were reported by Latye *et al.* (2016); Sharanya *et al.* (2018); Gurjar *et al.* (2016) in fenugreek.

CONCLUSION

The highest genotypic variability is more convenient for the plant breeder for selection and further utilization. Highest heritability accompanied with high genetic advance or low heritability accompanied with high genetic advance selection may be effective in such cases. In correlation coefficient analyses measures the mutual relationship between the characters and determine the component of character on which selection can be done for improvement in seed yield., it could be concluded that out of twenty collections and varieties, AFg-2 and V_{12} GM-2 found best regarding leaf and seed yield and used for further breeding programme of fenugreek.

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