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Satish Kumar Gautam
Ph.D., Scholar, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Parades, India

CN Ram
Associate Professor, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Parades, India

GC Yadav
Associate Professor, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Parades, India

Mohit Lal
Ph.D., Scholar, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Parades, India

Corresponding Author:
Satish Kumar Gautam
Ph.D., Scholar, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Parades, India

Assessment of Correlation coefficients analysis in fenugreek (*Trigonella foenum-graecum* L.)

Satish Kumar Gautam, CN Ram, GC Yadav and Mohit Lal

Abstract
The present investigation entitled "Studies on combining ability, heterosis and gene action in fenugreek (*Trigonella foenum-graecum* L.) for yield and quality attributing traits" at Main Experiment Station (MES) of the Department of Vegetable Science A.N.D. University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during *rabi* season of 2019-20 (Y_1) and 2020-21(Y_2). The experiment was conducted in a Randomized Complete Block Design (R.B.D.) with three replications on 54 genotypes (40 F_1 + 10 line + 4 testers). Observations were recorded for 11 characters *viz*., days to 50% flowering, plant height (cm), number of branches per plant, days to maturity, pods length (cm), biological yield per plant (g), harvest-index (%), number of pods per plant, number of seeds per pods, 1000-seed weight (g) and seed yield per plant (g). The findings of the present investigation revealed that phenotypic and genotypic correlation coefficients analysis for yield and quality economic traits.

Keywords: Fenugreek, *Trigonella foenum-graecum* L., phenotypic and genotypic correlation coefficients

Introduction
Fenugreek (*Trigonella foenum- graecum*) belongs to family Fabaceae, 2n=16. It is seed spice as well as leafy vegetable. It has been originated in Egypt. Fenugreek can be grown in the tropical and in temperate regions. It is grown from sea level up to an altitude of 2000 m. There are two species of the genus *Trigonella*, which are of economic importance, *viz., Trigonella foenumgraecum* or the commonly called "methi" and *Trigonella corniculata* or the "kasthuri methi." Fenugreek is an annual herb, 30 to 90 cm tall and has light green leaves which are pinnately trifoliate. The flowers are papillonaceaus and white or yellow in colour and produces stander, beaked pods of approximately 10-15 cm long and each pod contains 10-20 small hard yellowish brown seed possessing smooth and oblong, about 3 mm long, each grooved across one corner, giving them a hooked appearance. India is also known as land of spices. India is one of the dominant producers and exporters of fenugreek. The value-added products of fenugreek such as its seeds, powder and oleoresins are exported to Europe, North America, South Africa and other Asian countries (Anonymous, 2019-20). In India, it occupies an area of about 127 thousand hectare with 184 mt productions with share of 2.4 percent. Fenugreek is mainly grown in the states of Rajasthan, Gujarat, Punjab, Haryana, U.P., M.P. Maharashtra and Tamil Nadu. Rajasthan alone contributes nearly 60 per cent of total area and 80 per cent of total production of the crop in the country. The present investigation was to evaluate the germplasm and unveil the phenotypic and genotypic correlation coefficients studies for yield and yield attributing traits as such information forms the basis for designing breeding strategies to improve the yield potential.

Material and Methods
The experiment was conducted on fenugreek (*Trigonella foenum-graecum* L.) at Main Experiment Station (Vegetable Research Farm), ANDUA&T Kumarganj Ayodhya (U.P.) India, during *rabi* season of 2019-20 (Y_1) and 2020-21(Y_2). The experiment was conducted in a Randomized Complete Block Design (R.B.D.) with three replications and 54 genotypes (40 F_1 + 10 line + 4 testers). The crop was planted in row length spaced 30 cm. apart where, 10 cm. plant to plant spacing was maintained. The experimental plant material for present investigation was comprised of 40 hybrid developed by crossing 10 line (NDM-3, NDM-4, NDM-8, NDM-10, NDM-5, NDM-63, NDM-14, NDM-23, and NDM-19 with 4 testers PEB, NDM-2, Hisar Sonali (check) and NDM-1.The observations were recorded on five plants randomly selected from each genotype in each replication on eleven characters, *viz*., days to

50% flowering, plant height (cm), number of branches per plant, days to maturity, pods length (cm), biological yield per plant (g), harvest-index (%), number of pods per plant, number of seeds per pods, 1000-seed weight (g) and seed yield per plant (g). The data were recorded from 40 F_1's and 10 parental lines with 4 testers on eleven characters were subjected to phenotypic and genotypic correlation coefficients Al- Ji bouri *et al.* (1958) [1].

Result and Discussion

In Y_1 phenotypic level (Table -1) seed yield per plant exhibited positively significant correlation with harvest index, test weight positively correlation with plant height while, test weight showed negatively significant correlation with days to maturity. days to maturity exhibited negatively significant correlation with number of branches per plant and plant height. Harvest index exhibited negatively significant correlation with biological yield. However, plant height, number of branches per plant, pods length, biological yield, number of pods per plant and number of seed per pods. showed no significant correlation (positive or negative) with any of characters.

In Y_2 phenotypic level (Table -2) seed yield per plant exhibited positively significant correlation with harvest index. While, test weight showed negatively significant correlation with number of pods per plant, harvest index showed negatively significant correlation with biological yield, exhibited positively significant correlation with number of branches per plant. while, pods length showed negatively significant correlation with number of branches per plant and days to maturity showed negatively significant correlation with plant height. However, days to 50% flowering, plant height, number of branches per plant, number of seed per pods and number of pods per plant and showed no significant correlation (positive or negative) with any of characters.

In pooled phenotypic level (Table -3) seed yield per plant exhibited positively significant correlation with harvest index and pods length while, test weight showed negatively significant correlation with number of pods per plant, days to maturity and positively significant correlated with plant height. number of seed per pod exhibited positively significant correlation with pod length, number of seed per pod showed negatively significant correlation with days to maturity. Number of pods per plant exhibited positively significant correlation with biological yield and pod length. Harvest index showed negatively significant correlation with biological yield and biological yield exhibited positively significant correlation with number of branches per plant and plant height days to maturity showed negatively significant correlation with plant height and number of branches per plant. However, days to 50% flowering, plant height, number of branches per plant, and pods length showed no significant correlation (positive or negative) with any of characters. Similar results had also been reported by Singh (2000) [14] and Kumari *et al.* (2013) [9].

Table 1: Estimates of phenotypic correlation coefficient among different characters in fenugreek. (Y_1=2019-20)

S. No	Characters	Days to 50% flowering	Plant height (cm)	No. of branches per plant	Days to maturity	Pods length (cm)	Biological yield	Harvest index	No. of pods per plant	No. of seed per pods	Test weight (g)	Seed yield per plant (g)
1	Days to 50% flowering	1.000	-0.115	0.094	-0.036	0.088	-0.055	0.080	-0.031	0.036	-0.046	0.061
2	Plant height (cm)		1.000	0.013	-0.194*	0.097	0.062	-0.018	-0.129	0.029	0.179*	-0.001
3	No. of branches per plant			1.000	-0.258**	-0.091	0.114	-0.025	0.075	-0.005	-0.096	0.012
4	Days to maturity				1.000	0.000	-0.029	-0.016	-0.062	-0.097	-0.169*	-0.025
5	Pods length (cm)					1.000	0.026	0.113	0.113	0.111	0.013	0.128
6	Biological yield						1.000	-0.332**	0.144	-0.008	0.057	0.019
7	Harvest index							1.000	-0.010	-0.060	-0.029	0.936**
8	No. of pods per plant								1.000	0.050	-0.137	0.042
9	No. of seed per pods									1.000	0.019	-0.066
10	Test weight (g)										1.000	-0.009
11	Seed yield per plant (g)											1.000

*,** Significant at 5% and 1% probability levels, respectively.

Table 2: Estimates of phenotypic correlation coefficient among different characters in fenugreek. (Y_2=2020-21)

S. No	Characters	Days to 50% flowering	Plant height (cm)	No. of branches per plant	Days to maturity	Pod length (cm)	Biological yield	Harvest index	No. of pods per plant	No. of seed per pods	Test weight (g)	Seed yield per plant (g)
1	Days to 50% flowering	1.000	-0.084	0.011	-0.046	-0.128	-0.003	0.105	0.022	0.015	-0.023	0.108
2	Plant height (cm)		1.000	0.001	-0.289**	0.018	0.133	-0.139	-0.105	-0.067	0.075	-0.102
3	No. of branches per plant			1.000	-0.093	-0.175*	0.195*	-0.005	0.105	0.060	-0.134	0.058
4	Days to maturity				1.000	-0.011	-0.106	-0.033	0.084	-0.138	-0.071	-0.069
5	Pods length (cm)					1.000	-0.032	0.043	0.084	0.083	0.082	0.032
6	Biological yield						1.000	-0.288**	0.076	-0.034	0.004	0.037
7	Harvest index							1.000	0.000	0.041	-0.054	0.946**
8	No. of pods per plant								1.000	-0.065	-0.238**	0.027
9	No. of seed per pods									1.000	0.018	0.031
10	Test weight (g)										1.000	-0.051
11	Seed yield per plant (g)											1.000

*,** Significant at 5% and 1% probability levels, respectively.

Table 3: Estimates of phenotypic correlation coefficient among different characters in fenugreek. (pooled)

S. No	Characters	Days to 50% flowering	Plant height (cm)	No. of branches per plant	Days to maturity	Pod length (cm)	Biological yield	Harvest index	No. of pods per plant	No. of seed per pods	Test weight (g)	Seed yield per plant (g)
1	Days to 50% flowering	1.000	-0.103	0.051	-0.035	-0.013	-0.039	0.089	-0.014	0.027	-0.039	0.078
2	Plant height (cm)		1.000	0.021	-0.259**	0.094	0.130*	-0.065	-0.094	0.009	0.152**	-0.024
3	No. of branches per plant			1.000	-0.190**	-0.106	0.165**	-0.019	0.093	0.044	-0.102	0.037
4	Days to maturity				1.000	-0.032	-0.092	-0.031	-0.012	-0.137*	-0.142*	-0.064
5	Pods length (cm)					1.000	0.043	0.093	0.119*	0.119*	0.055	0.111*
6	Biological yield						1.000	-0.290**	0.137*	0.007	0.053	0.059
7	Harvest index							1.000	0.002	-0.003	-0.030	0.938**
8	No. of pods per plant								1.000	0.026	-0.164**	0.051
9	No. of seed per pods									1.000	0.032	-0.001
10	Test weight (g)										1.000	-0.011
11	Seed yield per plant (g)											1.000

*,** Significant at 5% and 1% probability levels, respectively

In Y_1 genotypic level (Table - 4) seed yield per plant exhibited positively significant correlation with harvest index, followed by correlation with number pods per plant, biological yield and pods length exhibited test weight positively correlation with plant height followed by harvest index and pods length cm exhibited number of seed pods significant positively correlation with pods length followed by number of branches per plant and harvest index. Exhibited number of pods per plant positively significant correlation with biological yield followed by harvest index and number of branches per plant exhibited harvest index positively correlation with pods length cm showed biological yield positively correlation with number of branches per plant showed pod length positively correlation with number of branches per plant followed by plant height, while test weight showed negatively significant correlation with number of pod per plant followed by biological yield, number of branches per plant and days to maturity. Showed number of seed per pods negatively significant correlation with days to maturity exhibited number of pods per plant negatively significant correlation with pod length followed by plant height, showed harvest index negatively significant correlation with number of branches per plant. showed days to maturity negatively significant correlation with number of branches per plant followed by however days to 50% flowering, plant height and number of branches per plant showed no significant correlation (positive or negative) with any of characters.

In Y_2 genotypic level (Table -5) seed yield per plant exhibited positively significant correlation with harvest index, followed by correlation with number pods per plant, biological yield and days to 50% flowering. While negatively significant correlation with plant height exhibited test weight positively correlation with pod length followed by number of seed per pods, plant height and harvest index showed test weight negatively significant correlation with number of pods per plant followed by biological yield and days to maturity. exhibited number of seed pods significant positively correlation with harvest index while negatively significant correlation with biological yield followed by days to maturity, showed number of pods per plant positively significant correlation with harvest index followed by biological yield, number of branches per plant and days to maturity. exhibited harvest index positively correlation with plant height followed by days to 50% flowering. showed biological yield positively significant correlation with number of branches per plant followed by plant height while negatively significant correlation with pods length followed by days to maturity. showed pods length negatively significant correlation with number of branches per plant followed by days to 50% flowering, showed days to maturity negatively significant correlation with plant height. However days to 50% flowering, plant height and number of branches per plant showed no significant correlation (positive or negative) with any of characters.

In pooled genotypic level (Table -6) yield per plant exhibited positively significant correlation with harvest index, followed by correlation with pods length, biological yield, number of pods per plant and days to maturity. While negatively significant correlation with days to 50% flowering exhibited test weight positively correlation with plant height followed by harvest index and number of seed per pods showed test weight negatively significant correlation with number of pods per plant followed by biological yield, number of branches per plant and days to 50% flowering. exhibited number of seed pods significant positively correlation with pods length followed by days to 50% flowering and harvest index. while, negatively significant correlation with biological yield followed by days to maturity and number pods per plant. showed number of pods per plant positively significant correlation with biological yield followed by number of branches per plant and days to maturity. while, negatively signification correlation with plant height. exhibited harvest index positively correlation with pods length followed by days to maturity. while negatively significant correlation with days to 50% flowering followed by number of branches per plant. showed biological yield positively significant correlation with number of branches per plant while negatively significant correlation with pods length followed by days to 50% flowering. showed pods length negatively significant correlation with plant height while negatively significant correlation with number of branches per plant followed by days to 50% flowering showed days to maturity negatively significant correlation with number of branches per plant followed by plant. showed number of branches significant correlation However days to 50% flowering and plant height showed no significant correlation (positive or negative) with any of characters similar results had also been reported by Dash and Kole (2000) [4], Verma and Korla (2003) [16] and Benerjee and Kole (2004) [2].

Table 4: Estimates of genotypic correlation coefficients among different characters in fenugreek (Y_1=2019-20)

S. No	Characters	Days to 50% flowering	Plant height (cm)	No. of branches per plant	Days to maturity	Pods length (cm)	Biological yield	Harvest index	No. of pods per plant	No. of seed per pods	Test weight (g)	Seed yield per plant (g)
1	Days to 50% flowering	1.000	-0.098	0.099	-0.041	0.099	-0.120	0.118	-0.051	0.054	-0.125	0.060
2	Plant height (cm)		1.000	0.035	-0.230**	0.180*	0.142	-0.102	-0.162*	0.031	0.338**	-0.052
3	No. of branches per plant			1.000	-0.411**	-0.379**	0.201*	-0.189*	0.384**	0.157*	-0.257**	-0.107
4	Days to maturity				1.000	-0.121	0.086	-0.113	-0.087	-0.309**	-0.219**	-0.074
5	Pods length (cm)					1.000	-0.026	0.426**	-0.224**	0.208**	0.206**	0.383**
6	Biological yield						1.000	0.059	0.554**	-0.154	-0.558**	0.393**
7	Harvest index							1.000	0.376**	0.189*	0.308**	0.941**
8	No. of pods per plant								1.000	-0.128	-0.578**	0.537**
9	No. of seed per pods									1.000	0.087	0.112
10	Test weight (g)										1.000	0.104
11	Seed yield per plant (g)											1.000

*,** Significant at 5% and 1% probability levels, respectively.

Table 5: Estimates of genotypic correlation coefficients among different characters in fenugreek (Y_2=2020-21)

S. No	Characters	Days to 50% flowering	Plant height (cm)	No. of branches per plant	Days to maturity	Pods length (cm)	Biological yield	Harvest index	No. of pods per plant	No. of seed per pods	Test weight (g)	Seed yield per plant (g)
1	Days to 50% flowering	1.000	-0.059	0.008	-0.068	-0.283**	0.109	0.206**	-0.017	0.019	-0.148	0.225**
2	Plant height (cm)		1.000	0.022	-0.338**	-0.052	0.253**	-0.314**	-0.156*	-0.068	0.230**	-0.234**
3	No. of branches per plant			1.000	-0.151	-0.472**	0.508**	-0.014	0.178*	0.018	-0.341**	0.119
4	Days to maturity				1.000	-0.126	-0.237**	-0.015	0.155*	-0.325**	-0.103	-0.081
5	Pods length (cm)					1.000	-0.355**	0.131	-0.068	0.058	0.295**	0.020
6	Biological yield						1.000	-0.001	0.196*	-0.345**	-0.292**	0.269**
7	Harvest index							1.000	0.289**	0.206**	0.161*	0.963**
8	No. of pods per plant								1.000	-0.148	-0.408**	0.330**
9	No. of seed per pods									1.000	0.247**	0.094
10	Test weight (g)										1.000	0.076
11	Seed yield per plant (g)											1.000

*,** Significant at 5% and 1% probability levels, respectively.

Table 6: Estimates of genotypic correlation coefficients among different characters in fenugreek (pooled)

S. No	Characters	Days to 50% flowering	Plant height (cm)	No. of branches per plant	Days to maturity	Pod length (cm)	Biological yield	Harvest index	No. of pods per plant	No. of seed per pods	Test weight (g)	Seed yield per plant (g)
1	Days to 50% flowering	1.000	0.027	0.096	-0.036	-0.179**	-0.166**	-0.286**	0.044	0.258**	-0.146*	-0.323**
2	Plant height (cm)		1.000	-0.108*	-0.292**	0.166**	-0.067	-0.076	-0.176**	0.111*	0.320**	-0.093
3	No. of branches per plant			1.000	-0.400**	-0.350**	0.492**	-0.150*	0.651**	-0.083	-0.484**	0.004
4	Days to maturity				1.000	-0.039	0.057	0.176**	0.185**	-0.365**	0.064	0.188**
5	Pods length (cm)					1.000	-0.214**	0.385**	0.015	0.450**	-0.055	0.295**
6	Biological yield						1.000	-0.004	0.721**	-0.343**	-0.760**	0.294**
7	Harvest index							1.000	0.041	0.255**	0.280**	0.955**
8	No. of pods per plant								1.000	-0.343**	-0.666**	0.253**
9	No. of seed per pods									1.000	0.233**	0.130*
10	Test weight (g)										1.000	0.048
11	Seed yield per plant (g)											1.000

*,** Significant at 5% and 1% probability levels, respectively.

Conclusion

In Y_1 phenotypic level seed yield per plant exhibited positively significant correlation with harvest index. In Y_2 phenotypic level seed yield per plant exhibited positively significant correlation with harvest index and in pooled phenotypic level seed yield per plant exhibited positively significant correlation with harvest index and pod length.

In Y_1 genotypic level seed yield per plant exhibited positively significant correlation with harvest index, followed by correlation with number pods per plant, biological yield and pods length. In Y_2 genotypic level seed yield per plant exhibited positively significant correlation with harvest index, followed by correlation with number pods per plant, biological yield and days to 50% flowering, while negatively significant correlation with plant height. in pooled genotypic level seed yield per plant exhibited positively significant correlation with harvest index, followed by correlation with pods length, biological yield, number of pods per plant and days to maturity, while negatively significant correlation with days to 50% flowering.

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