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Studies on Path Coefficient Analysis and Correlation to Evaluate the Relationships between Yield and Its Components in Fenugreek (*Trigonella foenum-graecum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was carried out for correlation and path coefficient analysis in Fenugreek (*Trigonella foenum-graecum* L.) The correlation of different traits with seed yield was examined both at phenotypic and genotypic levels and the study showed that genotypic correlation coefficient

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values were higher than the phenotypic values. This indicated that how much of phenotypic correlation coefficient are influenced by environment. The seed yield per plant was positive and significant with biological yield per plant, test weight and number of branches per plant at genotypic and phenotypic levels. The maximum direct positive effect on seed yield per plant was observed in biological yield per plant, harvest index, days to 50 per cent flowering, number of seed per pod, number of branches per plant and number of pods per plant. In the present investigation, genotypes *viz*., AFG-4 and RMT-303 were superior for seed yield per plant along with other traits like biological yield, test weight and number of pods per plant. These diverse genotypes can be used in future breeding programme of fenugreek.

Keywords: Correlation analysis; path coefficient analysis; fenugreek; seed yield.

1. INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.; 2n=16) belongs to the family Fabaceae and is a multiuse and commercially important spice crop grown for its seeds, tender shoots and fresh leaves. It is an annual and self-pollinated seed spice that originated from Western Asia and South East Europe. The genus Trigonella consists of 50 species, most of which have an oriental origin in the Iranian/Indian region; 11 species occur in India, out of which *Trigonella foenum-graecum* L. (fenugreek) and *Trigonella corniculata* L. (kasurimethi /champa methi) are commercially cultivated in India [1].

Fenugreek seeds and herbs are well known for their distinct aroma and slightly bitter taste. In the recent past, the use of fenugreek has been well recognized and demand is increasing due to its multifarious uses as food, spice, forage, medicinal plant, cosmetics and a source for natural diosgenin and galactomannan in the pharmaceutical and steroid industries [2-4]. Dried seeds are used in many Indian dishes such as pickles and curries to bring special flavor and aroma. Chopped leaves are used as a flavoring agent, sprouts as salad and pot herbs as decoration. The Diosgenin content found in the leaves is of great medicinal value and is being used in contraceptive pills. Normally fenugreek seeds contain 0.4-1.26 percent of diosgenin. The seeds also contain saponins and fibers. Apart from its use as a seed spice, several medicinal uses of fenugreek have been also reported. From ancient times, it has been used to cure flatulence, dysentery, diarrhea, dyspepsia with lack of apatite and severe cough. Fibers present in the seed help lower blood sugar and thus helps in curing diabetes. It is also helpful in gastric problems, effective in regulating the digestive system and provides relief in joint pain of old age people. Seed is also used as a concentrated mixture to feed cattle which increases milk flow. Seeds of fenugreek contain 48% carbohydrates, 25.5% protein, 20% mucilaginous matter, 7.9% fat and 4.8% saponins. Apart from these properties, fenugreek seeds are rich in riboflavin (Vit B_2), niacin (Vit B_5), thiamin (B_1), folic acid, vitamin A, B_6 (pyridoxine), and vitamin C. Important mineral nutrients such as copper, potassium, calcium, iron, selenium, zinc, manganese and magnesium are also present in sufficient amount. Seeds taste a little bitter due to the presence of an alkaloid, called, —*Trigonellin*.

Though seed spices are being used for a long time and their importance is known from even ancient times but still there is a lack of effort for the improvement of the genetic potential of these crops. The germplasm is used as the most valuable reservoir to provide variability for various traits that are a prerequisite for a successful breeding programme. Yield is a complex quantitative character highly influenced by environmental conditions, resulting in difficulty to determine whether the observed variability is heritable or not, for this, heritability is a suitable measure to estimate the heritable genetic portion of the total variability. The estimation of heritability along with genetic advances is generally more useful to provide a clear prediction of the breeding value. Correlation reveals only the direction and magnitude of association between any two traits however the path coefficient analysis partition the correlation into direct and indirect effects of various components on yield and serves as a powerful tool in the selection procedure accordingly.

2. MATERIALS AND METHODS

The present investigation on fenugreek for correlation and path analysis was conducted at 12 genotypes, raised in randomized block design with three replications during the *Rabi* season

Table 1. Genotypic correlation coefficient among different traits in fenugreek genotypes

Chr	DF50	DM	PH	NBP	NSP	NPP	PL	TW	HI	BY	SYP
DF50	1 **	0.7613 **	0.5801 *	-0.2604	-0.6749 *	-0.5709	-0.5192	-0.3847	-0.6202 *	-0.1851	-0.5845 *
DM		1 **	0.8582 **	-0.2681	-0.5696	-0.2809	-0.5966 *	-0.5574	-0.0675	-0.2849	-0.3341
PH			1 **	-0.2944	-0.4476	-0.2462	-0.7958 **	-0.6771 *	0.4489	-0.5894 *	-0.3876
NBP				1 **	0.5799 *	0.6973 *	0.7069 *	0.7689 **	0.0109	0.5245	0.6023 *
NSP					1 **	0.7192 **	0.484	0.6772 *	0.1649	0.2031	0.3186
NPP						1 **	0.3653	0.594 *	0.5692	0.1413	0.5014
PL							1 **	0.7081 **	-0.2408	0.5932 *	0.5216
TW								1 **	-0.3548	0.7632 **	0.6374 *
HI									1 **	-0.4859	0.0373
BY										1 **	0.8557 **
SYP											1 **

Table 2. Phenotypic correlation coefficient among different traits in fenugreek genotypes

Chr	DF50	DM	PH	NBP	NSP	NPP	PL	TW	HI	BY	SYP
DF50	1 **	0.6583 **	0.547 **	-0.2792	-0.6293 **	-0.4563**	-0.4033 *	-0.3723 *	-0.2667	-0.2265	-0.5058 **
DM		1 **	0.7275 **	-0.2081	-0.5435 **	-0.3086	-0.5107**	-0.4937 **	0.0022	-0.2101	-0.2526
PH			1 **	-0.2064	-0.4115 *	-0.1154	-0.6289**	-0.6116 **	0.2207	-0.3553 *	-0.2641
NBP				1 **	0.4802 **	0.6219 **	0.5887 **	0.6689 **	-0.1012	0.4493 **	0.4722 **
NSP					1 **	0.6004 **	0.3939 *	0.6576 **	0.1905	0.084	0.2605
NPP						1 **	0.385 *	0.4989 **	0.2669	0.2103	0.4638 **
PL							1 **	0.5997 **	-0.15	0.4353 **	0.4015 *
TW								1 **	-0.1696	0.5198 **	0.5018 **
HI									1 **	-0.582 **	0.0888
BY										1 **	0.7528 **
SYP											1 **

Table 3. Estimates of genotypic path coefficient for yield and its attributing traits in fenugreek genotypes

Chr	DF50	DM	PH	NBP	NSP	NPP	PL	TW	HI	BY	Correlation with SYP
DF50	0.16493	-0.00096	-0.07733	-0.00584	-0.10615	-0.04595	0.00940	0.13046	-0.40522	-0.24788	-0.5845 *
DM	0.12556	-0.00126	-0.11441	-0.00601	-0.08959	-0.02261	0.01080	0.18901	-0.04411	-0.38152	-0.3341
PH	0.09568	-0.00108	-0.13331	-0.00660	-0.07040	-0.01982	0.01440	0.22959	0.29329	-0.78934	-0.3876
NBP	-0.04295	0.00034	0.03924	0.02242	0.09120	0.05613	-0.01280	-0.26074	0.00710	0.70237	0.6023 *
NSP	-0.11132	0.00072	0.05967	0.01300	0.15728	0.05789	-0.00876	-0.22963	0.10771	0.27200	0.3186
NPP	-0.09415	0.00035	0.03282	0.01564	0.11311	0.08049	-0.00661	-0.20143	0.37192	0.18929	0.5014
PL	-0.08563	0.00075	0.10609	0.01585	0.07613	0.02941	-0.01810	-0.24011	-0.15732	0.79449	0.5216
TW	-0.06345	0.00070	0.09026	0.01724	0.10651	0.04781	-0.01282	-0.33910	-0.23185	1.02212	0.6374 *
HI	-0.10229	0.00008	-0.05984	0.00024	0.02593	0.04582	0.00436	0.12033	0.65340	-0.65075	0.0373
BY	-0.03053	0.00036	0.07857	0.01176	0.03194	0.01138	-0.01074	-0.25880	-0.31749	1.33924	0.8557 **

Table 4. Estimates of phenotypic path coefficient for yield and its attributing traits in fenugreek genotypes

Chr	DF50	DM	PH	NBP	NSP	NPP	PL	TW	HI	BY	SYP
DF50	-0.05342	0.01738	-0.00800	-0.00808	0.00990	0.00845	0.01315	-0.00700	-0.20820	-0.26997	-0.5058 **
DM	-0.03516	0.02640	-0.01065	-0.00602	0.00855	0.00571	0.01665	-0.00929	0.00172	-0.25042	-0.2526
PH	-0.02922	0.01920	-0.01463	-0.00597	0.00648	0.00214	0.02051	-0.01150	0.17229	-0.42349	-0.2641
NBP	0.01491	-0.00549	0.00302	0.02894	-0.00755	-0.01152	-0.01919	0.01257	-0.07893	0.53553	0.4722 **
NSP	0.03361	-0.01435	0.00602	0.01389	-0.01574	-0.01112	-0.01285	0.01237	0.14864	0.10012	0.2605
NPP	0.02437	-0.00815	0.00169	0.01800	-0.00945	-0.01852	-0.01256	0.00938	0.20836	0.25066	0.4638 **
PL	0.02154	-0.01348	0.00920	0.01703	-0.00620	-0.00713	-0.03261	0.01128	-0.11718	0.51885	0.4015 *
TW	0.01989	-0.01304	0.00895	0.01934	-0.01035	-0.00924	-0.01955	0.01881	-0.13248	0.61957	0.5018 **
HI	0.01425	0.00006	-0.00323	-0.00293	-0.00300	-0.00494	0.00489	-0.00319	0.78059	-0.69370	0.0888
BY	0.01210	-0.00555	0.00520	0.01300	-0.00132	-0.00389	-0.01420	0.00978	-0.45435	1.19193	0.7528 **

2023-2024. Observations were recorded on plot as well as single plant basis. Observations on plot basis were recorded for days to 50 per cent flowering, days to maturity, which observations based on single plant were recorded for plant height (cm), number of branches per plant, number of pods per plant, number of seed per pod, pod length, test weight (g), biological yield per plant (g), harvest index and seed yield per plant. For recording single plant observations five competitive plants were randomly selected from each plot. Average of these five plants with respect to plant height (cm), number of branches per plant, number of pods per plant, number of seed per pod, pod length, test weight (g), biological yield per plant (g), harvest index and seed yield per plant.was used for statistical analysis. The genotypic co-variance was calculated as per Johnson et.al., [5]. To estimate a cause and effect relationship the partitioning of genotypic and phenotypic correlation coefficient was done into direct and indirect effects by path analysis as suggested by Dewey and Lu [6] and developed by Wright [7].

3. RESULTS AND DISCUSSION

3.1 Correlation Coefficient

The study of correlation coefficient indicated the degree of association between the dependent variable i.e. yield and its contributing component traits. In the present study, thirteen characters were studied to find out the genotypic and phenotypic correlations with seed yield. It was found that the value of the genotypic correlation coefficient was higher than the phenotypic correlation coefficient value for all the characters under study. This indicated how much of the phenotypic correlation coefficient is influenced by the environment. The seed yield per plant had a positive and significant association with biological yield per plant, test weight and number of branches per plant. Whereas, negative and significant correlation expressed with days to 50 per cent flowering. These results were found in agreement with an earlier report by Chandra et al. [8] Ayanoglu et al. [9]. Kole and Mishra [10] Sharma & Sastry [11] Singh & Pramila [12], Kole and saha [13], Pushpa et al. [14] Yadav et al. [15] Patil [16] Gurjar et al. [17] Wojo et al. [18] Mamatha et al. [19] Kumar et al. [20] and Singh et al. [21].

3.2 Path Analysis

The results of path coefficient based on genotypic coefficient taking seed yield per plant as dependent variable indicated that the characters biological yield per plant, harvest index, days to 50 per cent flowering, number of seed per pod, number of branches per plant and number of pods per plant showed positive direct effect on seed yield per plant while traits like test weight, plant height, pod length and days to maturity exhibited negative direct effect on seed yield per plant. Similar finding also reported by Chandra and Sastry [8] Balai et al [4], Sharma and Sastry [11] Singh and Pramila [22] Prajapati et al. [23], Dashora et al. [24], Fikreselassie et al. [25], Yadav et al. [15] Pathak et al. [26], Kumari et al. [27], Lodhi et al. [28], Singh et al. [22] and Kumar et al. [27], Acharya et al. [29].

4. CONCLUSION

In the present investigation, genotypes *viz*., AFG-4 and RMT-303 were superior not only for seed yield per plant but also related traits like biological yield, test weight and number of pods per plant. These diverse genotypes can be used in future breeding programme of fenugreek. The germplasm is used as the most valuable reservoir to provide variability for various traits that are a prerequisite for a successful breeding programme. Yield is a complex quantitative character highly influenced by environmental conditions, resulting in difficulty to determine whether the observed variability is heritable or not, for this, heritability is a suitable measure to estimate the heritable genetic portion of the total variability.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies, such as Large Language Models (ChatGPT, COPILOT, etc) and text- to- image generators have been during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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