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Effect of nitrogen and phosphorus on the productivity of fenugreek (*Trigonella foenum-graecum* L.) in South-West Punjab

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Abstract
A field experiment entitled "Effect of different levels of nitrogen and phosphorus on growth and yield of fenugreek (*Trigonella foenum-graecum* L.) in South West Punjab" was conducted during *rabi* season of 2017-18 at experimental field, Guru Kashi University, Talwandi Sabo, Punjab. The experiment was laid out in split plot design with two levels of nitrogen (15 and 30 kg N/ha) in main plots and five levels of phosphorus (0, 10, 20, 30 and 40 kg P_2O_5/ha) in sub plots, replicated thrice. The results indicated that highest plant height, number of branches, number of pods per plant, number of seeds per pod, pod length, seed yield, straw yield and biological yield were found in 30 kg N/ha and 40 kg P/ha. The application of 30 kg N/ha gave significantly higher (1441 kg/ha) seed yield as compare to 15 kg N/ha treatment. Increasing levels of phosphorus up to 40 kg/ha phosphorus (P_2O_5) significantly increased the seed yield of fenugreek over 0, 10, 20 and 30 kg P_2O_5/ha. There was 39.1, 21.2, 12.5 and 5.7% increase in seed yield due to application of 40 kg P_2O_5/ha over 0, 10, 20 and 30 kg P_2O_5/ha, respectively. Thus it can be concluded that nitrogen application at 30 kg/ha and phosphorus @ 40 kg/ha were found more effective than rest of the treatments.

Keywords: Fenugreek, growth, nitrogen, phosphorus and yield

Introduction
Fenugreek (*Trigonella foenum-graecum* L.) belonging to the family leguminosae popularly known by its vernacular name "Methi", is an annual, dicotyledonous and important seed condiment crop grown in northern India during *rabi* season. Fenugreek is a multipurpose crop whose every part is consumed in one or the other forms. Its fresh tender leaves and pods are consumed as fried vegetable being rich in iron, calcium, protein and vitamins. Its chopped leaves are mixed in flour to prepare "parotha", the grain are used to form a concentrate feed for animals.

Fenugreek has immense medicinal utility. It prevents constipation, removes indigestion and stimulates the digestive process. Fenugreek seeds have shown to have hypoglycemic and anti cholesterolemic action and used for treatment of dysentery, diarrhea, rickets, aphrodisiac and diabetes. It is also used to prepare carminative tonic. Its seeds are bitter in taste due to presence of alkaloid "trigonellin" trigocoumarin, trimethyl coumarin and nicotinic acid mucilage is prominent constituent of seed. Fenugreek seeds are known to possess demulcent, diuretic, carminative, astringent and anti-diabetic properties. These properties are attributed to the presence of trigonelline, choline and diosgnin, being a legume, its roots are endowed as for fixing nitrogen for plants. Improvement in productivity of fenugreek is not only necessary to realize more profit but it is also necessary to make the crop competitive with other winter crops. The prime factor limiting the productivity of fenugreek is inadequate and unbalanced supply of nutrients. The gap between the nutrient demand and supply cannot be bridged by individual fertilizer alone, can be filled only through appropriate combination of mineral fertilizers like nitrogen and phosphorus.

Nitrogen and phosphorus status in soils of this region are low (125 and 14 kg/ha, respectively). Nitrogen being the structural part of plant body helps in synthesis of protein and important for photosynthetic activities in the plants. Fenugreek responds well to nitrogen fertilization even up to 40 kg/ha depending upon initial soil fertility status and moisture availability during the crop season. Further, a major part of fertilizer N applied is lost as NH_3 through volatilization. The soils of this region being poor in texture and organic matter content, will require split application of nitrogen rather than single application for better absorption. The response to phosphorus is determined by soil phosphorus status, moisture availability and yield level attained. Phosphorus initially important for root development and after words fruiting and synthesis of oil in oilseed crops helps to increase yields of crops.

Therefore, keeping all above facts in mind, the present investigation entitled "Effect of different levels of nitrogen and phosphorus on growth and yield of Fenugreek (*Trigonella foenum graecum* L.)" was conducted.

Materials and methods

The present investigation "Effect of different levels of nitrogen and phosphorus on growth and yield of fenugreek (*Trigonella foenum graecum* L.)" was conducted at experimental farm of University College of Agriculture, Guru Kashi University Talwandi Sabo, Bathinda during rabi season 2017-18. Talwandi Sabo is located at 29º57 N latitude and 75º7 E longitudes and altitude (213 m above sea levels). The tract is characterized by semi humid climate. Maximum temperature is about 45-47ºc is not uncommon during summer, while freezing temperature accompanied by frost occurrence may be witnessed in the month of December and January. The mean annual rainfall fluctuates around 150 mm, major part of which is during the month of July to November with a few shower of cyclonic rains during winter and spring month. The soil of experimental field was sandy loam in texture. The soil was alkaline (pH 8.5) and with normal electrical conductivity (0.37 dSm^{-1}). The soil was low in organic carbon content (0.36%) and available nitrogen (135.0 kg/ha), medium in available phosphorus (15.9 kg/ha) and available potassium (239.4 kg/ha). The experiment was laid out in split plot design with two levels of nitrogen (15 and 30 kg N/ha) in main plots and five levels of phosphorus (0, 10, 20, 30 and 40 kg P_2O_5/ha) in sub plots, replicated thrice. All the observations on growth and yield of fenugreek were recorded after harvesting of the crop.

The collected data were statistically analyzed by using Fisher's ANOVA technique and least significant difference (LSD) test at 5% probability level was used to compare differences among treatment means.

Results and Discussion

Growth attributes

Plant height was significantly influenced by levels of nitrogen in fenugreek (Table 1). Application of 30 kg N/ha significantly increased the plant height at harvest (70.31 cm) over 15 kg N/ha. The magnitude of increase in plant height at harvest was 2.9% over 15 kg N/ha. The data further revealed that increasing levels of phosphorus up to 40 kg P_2O_5/ha significantly increase the plant height of fenugreek at harvest over 0, 10, 20 and 30 kg P_2O_5/ha. There was 10.7, 5.5, 2.6 and 0.9% increase in plant height due to application of 40 kg P_2O_5/ha over 0, 10, 20 and 30 kg P_2O_5/ha, respectively. Similar increase in plant height with an increase in nitrogen doses was also reported by Kumar *et al.* (2016) [7].

Table 1: Effect of different levels of nitrogen and phosphorus on growth parameters of fenugreek.

Treatment	Plant height (cm)	Number of branches/plant
Nitrogen level (kg/ha)		
15	68.4	3.91
30	70.3	4.04
LSD (P=0.05)	0.7	0.08
P_2O_5 level (kg/ha)		
0	65.0	3.63
10	68.2	3.88
20	70.1	4.04
30	70.9	4.13
40	72.4	4.21
LSD (P=0.05)	0.5	0.06

Number of branches per plant was significantly influenced by both the levels of nitrogen in fenugreek. Application of 30 kg N/ha significantly increased the branches per plant at 45 DAS (4.04) over 15 kg N/ha. There was 3.2% increase in branches per plant at 45 DAS over 15 kg N/ha. Further data revealed that increasing levels of phosphorus up to 40 kg P_2O_5/ha significantly increase the branches per plant of fenugreek at 45 DAS over 0, 10, 20 and 30 kg P_2O_5/ha. There was 16.0, 8.5, 4.2 and 1.9% increase in branches per plant due to application of 40 kg P_2O_5/ha over 0, 10, 20 and 30 kg P_2O_5/ha, respectively. The results are in accordance with the findings reported by Jagdale and Dalve, (2010) [3] and Shivran *et al.* (2016) [8] in fenugreek.

Yield attributes

Number of pods per plant: Application of 30 kg N/ha significantly increased the number of pods per plant (44.64) over 15 kg N/ha (43.22) (Table 2). The percent increase in pods per plant due to 30 kg N/ha was 3.3 percent over 15 kg N/ha. Increasing levels of phosphorus up to 40 kg phosphorus (P_2O_5) significantly increase the number of pods per plant of fenugreek over 0, 10, 20 and 30 kg P_2O_5/ha. There was 16.7, 9.5, 5.1 and 2.5 percent increase in number of pods per plant due to application of 40 kg P_2O_5/ha over 0, 10, 20 and 30 kg P_2O_5/ha, respectively. The increase in pods per plant might be due to fertilizer application in terms of nitrogen and phosphorus stimulating cell division, elongation and ultimately promoted the vegetative growth and pod formation. The favorable effect of phosphorus up to 40 and 60 kg/ha on number of pods per plant also reported by Jagdale and Dalve, (2011) [4] and Kumar *et al.* (2016) [7].

Number of seeds/pod: Application of 30 kg N/ha significantly increased the seeds per pod (16.53) over 15 kg N/ha (16.01) (Table 2). The percent increase in seeds per pod was 3.2 percent over 15 kg N/ha. Increasing levels of phosphorus up to 40 kg phosphorus (P_2O_5) significantly increase the number of seeds per pod of fenugreek over 0, 10, 20 and 30 kg P_2O_5/ha. The per cent increase in pods per plant due to application of 40 kg P_2O_5/ha was to the tune of 16.5, 9.6, 5.3 and 2.7 per cent over 0, 10, 20 and 30 kg P_2O_5/ha, respectively. Similar results were also obtained by Datta and Hore (2017) [2].

Pod length: Application of 30 kg N/ha significantly increased the pod length (14.29 cm) over 15 kg N/ha (13.77) (Table 2). The percent increase in pod length due to 30 kg N/ha was 3.8 percent over 15 kg N/ha. Increasing levels of phosphorus up to 40 kg phosphorus (P_2O_5) significantly increase the pod length of fenugreek over 0, 10, 20 and 30 kg P_2O_5/ha. The

percent increase in pod length due to application of 40 kg P_2O_5/ha was to the tune of 17.0, 10.1, 5.9 and 2.8 percent over 0, 10, 20 and 30 kg P_2O_5/ha, respectively. The improvement in yield attributing characters due to supply of nitrogen and phosphorus was also recorded by Aishwath *et al.* (2010) [1] in fenugreek.

Table 2: Effect of different levels of nitrogen and phosphorus on yield attributing characteristics of fenugreek.

Treatment	No. of pods/ plant	No. of seeds/pod	Pod length (cm)
Nitrogen level (kg/ha)			
15	43.2	16.0	13.8
30	44.6	16.5	14.3
LSD (P=0.05)	1.2	0.4	0.4
P_2O_5 level (kg/ha)			
0	40.1	14.8	12.8
10	42.7	15.8	13.6
20	44.5	16.5	14.2
30	45.7	16.9	14.6
40	46.8	17.3	15.0
LSD (P=0.05)	0.84	0.3	0.3

Productivity of fenugreek

The application of nitrogen at the rate of 30 kg/ha gave significantly higher (1441 kg/ha) seed yield as compare to 15 kg N/ha (Table 3). The percent increase in seed yield due to 30 kg N/ha was 15.7 percent over 15 kg N/ha. Further data revealed that increasing levels of phosphorus up to 40 kg/ha phosphorus (P_2O_5) significantly increase the seed yield of fenugreek over 0, 10, 20 and 30 kg P_2O_5/ha. There was 39.1, 21.2, 12.5 and 5.7% increase in seed yield due to application of 40 kg P_2O_5/ha over 0, 10, 20 and 30 kg P_2O_5/ha, respectively. Similar results were also obtained by Datta and Hore (2017) [2].

Table 3: Effect of different levels of nitrogen and phosphorus on productivity of fenugreek

Treatment	Seed yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
Nitrogen level (kg/ha)				
15	1245	2757	4002	31.11
30	1441	3143	4584	31.44
LSD (P=0.05)	115	269	382	NS
P_2O_5 level (kg/ha)				
0	1102	2428	3530	31.21
10	1265	2767	4032	31.41
20	1363	2982	4345	31.36
30	1450	3190	4640	31.23
40	1533	3383	4916	31.17
LSD (P=0.05)	81	190	270	NS

Highest straw yield (3143 kg/ha) was recorded with application of nitrogen at 30 kg/ha and minimum straw yield (2757 kg/ha was recorded in N at 15 kg/ha (Table 3). The percent increase in straw yield due to 30 kg N/ha was 14.0% over 15 kg N/ha. Further data revealed that increasing levels of phosphorus up to 40 kg phosphorus (P_2O_5) significantly increase the straw yield of fenugreek over 0, 10, 20 and 30 kg P_2O_5/ha. The percent increase in straw yield due to application of 40 kg P_2O_5/ha was to the tune of 39.3, 22.3, 13.4 and 6.1% over 0, 10, 20 and 30 kg P_2O_5/ha, respectively. Some researcher reported that an increase in the straw yield of fenugreek was obtained with P doses of 40 kg/ha Khiriya *et al*. (2003) [5].

The application of nitrogen at the rate of 30 kg/ha gave significant and highest biological yield (4584 kg/ha) as compare to 15 kg N/ha (4002 kg/ha) (Table 3). The per cent increase in biological yield due to 30 kg/ha was 14.6 percent over 15 kg N/ha. Further data revealed that increasing levels of phosphorus up to 40 kg phosphorus (P_2O_5) significantly increase the seed yield of fenugreek over 0, 10, 20 and 30 kg P_2O_5/ha. The percent increase in biological yield due to application of 40 kg P_2O_5/ha was to the tune of 39.3, 21.9, 13.2 and 6.1% over 0, 10, 20 and 30 kg P_2O_5/ha, respectively.

The application of different doses of nitrogen and phosphorus (P_2O_5) was found non-significant on harvest index of fenugreek. Since, harvest index is a function of economic and biological yield representing vegetative and reproduction growth of crop. The results of the present investigation corroborate the findings of Shivran *et al.* (2016) [8] and Kumar *et al*. (2016) [7].

Conclusion

Application of nitrogen @ 30 kg/ha treatment recorded significantly higher growth and seed yield of fenugreek than other treatments. Application of phosphorus (P_2O_5) @ 40 kg/ha resulted in significantly higher growth and seed yield of fenugreek than other treatments. Application of nitrogen @ 30 kg/ha and phosphorus (P_2O_5) @ 40 kg/ha recorded significantly higher growth as well as seed yield of fenugreek than other treatment combinations.

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