*Journal of Crop and Weed, 13(3):55-60 (2017)*

# Effect of nitrogen, phosphorus and potassium on growth and yield of fenugreek (*Trigonella foenum-graecum* L.)

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*Received : 12-10-2017 ; Revised : 18-11-2017 ; Accepted : 20-11-2017*

**ABSTRACT**

*The experiment was carried out at the Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal during the year 2013-14 and 2014-15. The variety 'Hissar Sonali' was taken under the study. Three levels of each nitrogen (40, 60 and 80 kg ha$^{-1}$), phosphorus (60, 80 and 100 kg ha$^{-1}$) and two levels of potassium (20 and 40 kg ha$^{-1}$) were included in the investigation. There were altogether 18 treatments. The experiment was laid out in factorial randomized block design with three replications. Among different treatment combination maximum plant height was observed with $N_{60}P_{100}K_{40}$ (108.17 cm) at 105 DAS. Plants grown under $N_{60}P_{80}K_{40}$ combination, exhibited maximum number of primary branch (8.72) per plant. The minimum days required for 50 per cent pod formation was noticed in $N_{40}P_{60}K_{40}$ (68.12 days). The yield attributing parameters like maximum number of pods plant$^{-1}$ (76.48) and seed yield plant$^{-1}$ (14.36 g) were observed in $N_{60}P_{80}K_{40}$ combination. Maximum projected yield (17.20 q ha$^{-1}$) was recorded in $N_{60}P_{80}K_{40}$ followed by $N_{40}P_{80}K_{40}$ (16.31 q ha$^{-1}$) and $N_{60}P_{100}K_{40}$ (15.80 q ha$^{-1}$) as compared to lowest yield of 11.70 q ha$^{-1}$ under $N_{40}P_{60}K_{20}$ combination. In majority of parameters, the increasing trend was noticed with medium level of nitrogen ($N_{60}$) and phosphorus ($P_{80}$) but positive response was observed with higher level of potassium. From yield maximization point of view, the most effective treatment was NPK @ 60:80:40 kg ha$^{-1}$ followed by NPK @ 40:80:40 kg ha$^{-1}$ and NPK @ 60:100:40 kg ha$^{-1}$ under alluvial plains of West Bengal.*

***Keywords*** : Fenugreek, nitrogen, phosphorous, potassium

Fenugreek (*Trigonella foenum-graecum* L.) is an important minor spice grown for its seed and leaves. Seeds are used as a condiments for flavoring of foods and leaves as vegetables. Fenugreek seeds and leaves are rich in mineral, protein and carbohydrates. Fenugreek is supposed to be a multipurpose crop. It has been used in folk medicine for centuries for a wide range of disease. It is used for treatment of flatulence, dysentery, diarrhoea, enlargement of liver and spleen, rickets, diabetes and many other (Dutta *et al.*, 2011). Fenugreek is also a good soil renovator and has widely been used as a green manure in agricultural production. India has attained the status of major producer and exporter of fenugreek. Fenugreek being a legume crop, is a heavy feeder of P, though it make use of atmospheric nitrogen through symbiotic fixation to meet a major part of its nitrogen needs. It responds well to both nitrogen and phosphorous application (Pareek and Gupta, 1981). However, information is lacking under new alluvial zone of West Bengal. An effort was, therefore, made to find out the optimum rate of N, P and K for maximization of yield.

## MATERIALS AND METHODS

The experiment was carried out at the HRS, Mondouri, BCKV, Mohanpur, Nadia, West Bengal during the year 2013-14 and 2014-15. The variety 'Hissar Sonali' was taken under the study. The soil at the experimental field was Gangetic alluvial with sandy clay loam texture, good water holding capacity, well drained with moderate soil fertility status and soil pH of 6.9. The organic carbon, total nitrogen, available phosphorus and potassium contents are 0.63, 0.084 per cent, 18.07 kg ha$^{-1}$ and 194.80 kg ha$^{-1}$, respectively. The seeds were sown during 1st week of November in 2.0 x 1.5 m plot at 30 x 10 cm spacing during both the years. Standard package and practices were followed during the growing period of this crop.

Three levels of each nitrogen (40, 60 and 80 kg ha$^{-1}$), phosphorus (60, 80 and 100 kg ha$^{-1}$) and two levels of potassium (20 and 40 kg ha$^{-1}$) were included in this investigation. The doses of fertilizer were adjusted with the application of urea, single super phosphate and muriate of potash. There were altogether 18 treatments. The experiment was laid out in factorial randomized black design with three replications. All experimental plots received a uniform dose of FYM at 15 tonnes ha$^{-1}$. FYM, ½ dose of nitrogen, full dose of phosphorus and full dose of potash were applied as basal and the remaining ½ dose of nitrogen was applied 30 days after sowing (DAS) as topdressing. Harvesting was done during end of March.

The observations were recorded on five randomly selected plants from each plot on different growth and yield parameters. Plant height was recorded at 105 day after sowing. The projected yield per hectare was calculated on plot yield basis after deducting 25 per cent area utilized for channel, ridges *etc*. Data recorded on different parameters of fenugreek for both the years were pooled together and analyzed statistically to express the result.

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**Table 1: Individual effect of NPK on growth parameters of fenugreek**

| Treatments | Plant height (cm) | | | No. of primary branches plant$^{-1}$ | | | Days to pod formation | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled |
| **Nitrogen (kg ha$^{-1}$)** | | | | | | | | | |
| $N_{40}$ | 86.93 | 90.18 | 88.55 | 6.25 | 6.18 | 6.22 | 71.79 | 75.15 | 73.47 |
| $N_{60}$ | 93.21 | 94.56 | 93.88 | 7.02 | 6.91 | 6.97 | 82.82 | 78.33 | 80.58 |
| $N_{100}$ | 95.72 | 96.40 | 96.06 | 6.94 | 7.04 | 6.99 | 75.81 | 80.73 | 78.27 |
| **SEm (±)** | **0.197** | **0.366** | **0.150** | **0.165** | **0.165** | **0.091** | **0.218** | **0.221** | **0.167** |
| **LSD (0.05)** | **0.568** | **1.053** | **0.433** | **0.475** | **0.475** | **0.263** | **0.627** | **0.635** | **0.465** |
| **Phosphorus (kg ha$^{-1}$)** | | | | | | | | | |
| $P_{60}$ | 85.06 | 87.95 | 86.51 | 6.16 | 5.01 | 6.02 | 72.36 | 73.57 | 72.96 |
| $P_{80}$ | 92.27 | 97.16 | 94.72 | 7.24 | 7.35 | **7.29** | 78.09 | 81.63 | 79.86 |
| $P_{100}$ | 98.52 | 96.02 | 97.27 | 6.81 | 6.90 | 6.85 | 79.99 | 79.00 | 79.50 |
| **SEm (±)** | **0.197** | **0.366** | **0.150** | **0.165** | **0.165** | **0.091** | **0.218** | **0.221** | **0.167** |
| **LSD (0.05)** | **0.568** | **1.053** | **0.433** | **0.475** | **0.475** | **0.263** | **0.627** | **0.635** | **0.465** |
| **Potassium (kg ha$^{-1}$)** | | | | | | | | | |
| $K_{20}$ | 88.50 | 89.31 | 88.91 | 5.97 | 5.88 | 5.93 | 77.31 | 79.55 | 78.43 |
| $K_{40}$ | 95.40 | 98.11 | 96.75 | 7.48 | 7.54 | 7.51 | 76.30 | 76.59 | 76.43 |
| **SEm (±)** | **0.161** | **0.299** | **0.123** | **0.135** | **0.135** | **0.074** | **0.178** | **0.180** | **0.132** |
| **LSD (0.05)** | **0.464** | **0.860** | **0.354** | **0.388** | **0.388** | **0.214** | **0.512** | **0.519** | **0.380** |

## RESULTS AND DISCUSSION

Observations on different growth and yield parameters were presented in table 1 and 2. The significant variations were noticed in both individual effect and in interaction effect. Increasing height with the increasing level of all three nutrients were also observed. The height increased from 88.55 to 96.06 cm with $N_{40}$ to $N_{80}$, from 86.51 to 97.27 cm with $P_{60}$ to $P_{100}$ and 88.91 to 96.75 cm with $K_{20}$ to $K_{40}$, respectively. As per interaction maximum plant height (108.17 cm) was recorded in $N_{60}P_{100}K_{40}$ followed by $N_{80}P_{80}K_{40}$ (103.17 cm), $N_{60}P_{80}K_{40}$ (102.88 cm) and $N_{80}P_{80}K_{20}$ (101.36 cm) but they were *at par*. The lowest plant height (78.14 cm) was found at $N_{40}P_{60}K_{20}$ combination. Plant height increased with increasing nitrogen doses. A positive response to nitrogen application was also reported by Tuncturk *et al*. (2011) and Mehta *et al*. (2012). This might be due to early and abundant availability of nitrogen leading to better nutritional environment in the root zone for growth and development of plant. The findings of this investigation are in close conformity with those of Halesh *et al*. (2000) and Mavai *et al*. (2000) who also recorded higher plant heights in fenugreek from higher phosphorus doses (75 and 90 kg P ha$^{-1}$ respectively). In different studies related to phosphorus doses in fenugreek, Jat (2004) and reported that highest values in different parameters of fenugreek were obtained from 120 kg P ha$^{-1}$. Phosphorus plays an important role in root development and proliferation as well as it also improves root nodule formation and biological N fixation by supplying assimilates to the roots. Increased availability of phosphorus owing to its application in the soil, improved nutrient availability. The applied phosphorus increased nitrogenase activity of roots, which enhanced the root nodulation and created congenial environment for plant rhizosphere that resulted increasing physiological growth parameters. Increase in plant height due to application of 30 to 90 Kg $P_2O_5$ ha$^{-1}$ in fenugreek has been reported by Tuncturk (2011).

There was a significant difference among the different levels of nitrogen in respect of number of primary branches plant$^{-1}$. Increasing trend was noticed with increasing level of nitrogen. The maximum response of phosphorus was noticed with its medium level (7.29 branches plant$^{-1}$) but higher dose of potassium gave maximum number of primary branches (7.51 plant$^{-1}$). Similar results have also been reported by Tuncturk *et al*. (2011). Among the interactions, maximum number of primary branches (8.72) was noticed with $N_{60}P_{80}K_{40}$ followed by $N_{60}P_{100}K_{40}$ (8.45), $N_{40}P_{100}K_{40}$ (8.35) as compared to minimum number of branches (4.90) under $N_{40}P_{100}K_{20}$ combination.

In both nitrogen and phosphorus, increasing the level from $N_{40}$ to $N_{60}$ and $P_{60}$ to $P_{80}$ caused delayed pod formation from 73.47 to 80.58 days and 72.96 to 79.86 days respectively but further increase to highest level *i.e*., $N_{80}$ and $P_{100}$ did not delayed the pod formation markedly. The opposite trend was noticed in case of

**Table 2: Interaction effect of NPK on growth parameter of fenugreek**

| Treatments | Plant height (cm) | | | No. of primary branches plant$^{-1}$ | | | Days to pod formation | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled |
| $N_{40}P_{60}K_{20}$ | 73.41 | 82.87 | 78.14 | 4.92 | 5.40 | 5.16 | 68.28 | 74.42 | 71.35 |
| $N_{40}P_{80}K_{20}$ | 82.94 | 89.60 | 86.27 | 5.08 | 5.52 | 5.30 | 73.15 | 79.19 | 76.17 |
| $N_{40}P_{100}K_{20}$ | 91.72 | 94.38 | 93.05 | 5.16 | 4.68 | 1.90 | 78.32 | 69.78 | 74.05 |
| $N_{60}P_{60}K_{20}$ | 81.56 | 87.08 | 84.32 | 5.82 | 5.48 | 5.65 | 74.26 | 78.18 | 76.22 |
| $N_{60}P_{80}K_{20}$ | 86.04 | 81.12 | 83.58 | 7.05 | 6.63 | 6.84 | 81.35 | 85.57 | 83.46 |
| $N_{60}P_{100}K_{20}$ | 94.36 | 84.12 | 89.24 | 5.42 | 5.04 | 5.23 | 87.93 | 82.21 | 85.07 |
| $N_{80}P_{60}K_{20}$ | 90.75 | 86.29 | 88.52 | 6.96 | 5.64 | 6.30 | 74.63 | 79.87 | 77.25 |
| $N_{80}P_{80}K_{20}$ | 98.30 | 104.42 | 101.36 | 6.82 | 7.48 | 7.15 | 78.72 | 82.62 | 80.67 |
| $N_{80}P_{100}K_{20}$ | 97.47 | 93.97 | 95.72 | 6.75 | 7.09 | 6.92 | 80.19 | 84.07 | 82.13 |
| $N_{40}P_{60}K_{40}$ | 86.12 | 82.82 | 84.50 | 5.38 | 5.92 | 5.65 | 72.46 | 63.78 | 68.12 |
| $N_{40}P_{80}K_{40}$ | 89.45 | 93.07 | 91.26 | 8.42 | 7.46 | 7.94 | 68.35 | 78.77 | 73.56 |
| $N_{40}P_{100}K_{40}$ | 97.88 | 98.36 | 98.12 | 8.56 | 8.14 | 8.35 | 71.20 | 84.96 | 78.08 |
| $N_{60}P_{60}K_{40}$ | 93.16 | 97.48 | 95.32 | 7.23 | 6.59 | 6.91 | 77.34 | 71.68 | 74.56 |
| $N_{60}P_{80}K_{40}$ | 98.45 | 106.91 | 102.68 | 8.48 | 8.96 | 8.72 | 86.60 | 79.26 | 82.93 |
| $N_{60}P_{100}K_{40}$ | 105.69 | 110.65 | 108.17 | 8.12 | 8.78 | 8.45 | 89.46 | 73.06 | 81.26 |
| $N_{80}P_{60}K_{40}$ | 85.32 | 91.20 | 88.26 | 6.67 | 6.83 | 6.50 | 68.16 | 73.48 | 70.82 |
| $N_{80}P_{80}K_{40}$ | 98.46 | 107.88 | 103.17 | 7.61 | 8.07 | 7.84 | 80.35 | 84.37 | 82.36 |
| $N_{80}P_{100}K_{40}$ | 104.05 | 94.65 | 99.35 | 6.85 | 7.67 | 7.26 | 72.82 | 79.94 | 76.38 |
| **N x P** | | | | | | | | | |
| **SEm (±)** | **0.341** | **0.633** | **0.261** | **0.189** | **0.286** | **0.158** | **0.377** | **0.382** | **0.280** |
| **LSD (0.05)** | **0.984** | **1.824** | **0.751** | **0.544** | **N.S.** | **N.S.** | **1.086** | **1.101** | **0.806** |
| **P x K** | | | | | | | | | |
| **SEm (±)** | **0.279** | **0.517** | **0.213** | **0.154** | **0.233** | **0.129** | **0.308** | **0.312** | **0.228** |
| **LSD (0.05)** | **0.803** | **1.489** | **0.613** | **0.444** | **0.672** | **0.371** | **N.S.** | **0.899** | **0.658** |
| **N x K** | | | | | | | | | |
| **SEm (±)** | **0.279** | **0.517** | **0.213** | **0.154** | **0.233** | **0.129** | **0.308** | **0.312** | **0.228** |
| **LSD (0.05)** | **0.803** | **1.489** | **0.613** | **0.444** | **0.672** | **0.371** | **0.887** | **N.S.** | **0.658** |
| **N x P x K** | | | | | | | | | |
| **SEm (±)** | **0.483** | **0.896** | **0.368** | **0.267** | **0.404** | **0.223** | **0.533** | **0.540** | **0.396** |
| **LSD (0.05)** | **1.391** | **2.580** | **1.062** | **0.769** | **N.S.** | **0.643** | **N.S.** | **N.S.** | **N.S.** |

potassium *i.e.*, increase of dose from $K_{20}$ to $K_{40}$ enhanced the pod formation by two days (78.43 to 76.43 days). Like flower formation, delayed in pod formation in case of nitrogen and phosphorus may be due to the better plant growth. Among the interactions, earliest pod formation in 50 per cent plant population took place with $N_{40}P_{60}K_{40}$ (68.12 days) followed by $N_{80}P_{60}K_{40}$(70.82 days) and $N_{40}P_{60}K_{20}$ (71.35 days) as compared to most delayed pod formation in plants under combination of $N_{60}P_{100}K_{20}$ (85.07 days) followed by $N_{60}P_{80}K_{20}$ (83.46 days) and $N_{60}P_{80}K_{40}$ (82.93 days).

Investigations concerning to the number of pods formed plant$^{-1}$ showed significant variations among the different levels and interactions. It is an important parameter concerning to the yield. Increased in the level of nitrogen and phosphorus up to medium dose increased the number of pods plant$^{-1}$ but further increase was not found beneficial. Pod number increased from 61.24 to 66.40 and 61.58 to 67.47 with the increase of level from $N_{40}$ to $N_{60}$ and $P_{60}$ to $P_{80}$ respectively. Further increase to $N_{80}$ and $P_{100}$ caused reduction in pod number to 66.29 and 64.88 respectively Nitrogen application at this level may stimulating cell division, elongation and ultimately promoted the vegetative growth and pod formation. Higher and lower dose of phosphorus than 80 kg ha$^{-1}$ did not favour to obtain the potential number of pods plant$^{-1}$ which may be due to promotion in extensive root development and nodulation (Detroja *et al*., 1996). Increase in dose of potassium from K20 to $K_{40}$ caused increase in pod number from 63.13 to 66.15. This night be due to increase in photosynthetic activities and maintenance of the proper water balanced in plants. Similar results was also obtained by Jain *et al*. (1987). These findings are also in the good conformity with the Sharma (2000) and Halesh *et al*. (2000) who obtained highest number of pod plant$^{-1}$ with 60 kg ha$^{-1}$. The favourable effect of phosphorus up to 60 kg ha$^{-1}$ on number of pods plant$^{-1}$ also reported by Pareek and Gupta, (1981) and Data and Verma (2001). Among the

**Table 3: Individual effect of NPK on number of pod plant$^{-1}$ and seed yield of fenugreek**

| Treatments | Number of pod plant$^{-1}$ | | | Seed yield plant$^{-1}$ (g) | | | Projected yield (q ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled |
| **Nitrogen (kg ha$^{-1}$)** | | | | | | | | | |
| $N_{40}$ | 61.25 | 61.23 | 61.24 | 11.66 | 11.88 | 11.77 | 13.37 | 13.84 | 13.61 |
| $N_{60}$ | 67.71 | 65.08 | 66.40 | 11.59 | 13.22 | 12.40 | 13.58 | 15.63 | 14.61 |
| $N_{100}$ | 67.02 | 65.56 | 66.29 | 10.65 | 11.86 | 11.25 | 11.85 | 13.59 | 12.72 |
| **SEm (±)** | **0.398** | **0.375** | **0.263** | **0.303** | **0.208** | **0.167** | **0.122** | **0.143** | **0.098** |
| **LSD (0.05)** | **0.145** | **1.081** | **0.758** | **0.873** | **0.599** | **0.482** | **0.350** | **0.412** | **0.283** |
| **Phosphorus (kg ha$^{-1}$)** | | | | | | | | | |
| $P_{60}$ | 62.85 | 60.32 | 61.58 | 9.60 | 11.56 | 10.58 | 11.25 | 13.14 | 12.19 |
| $P_{80}$ | 68.22 | 66.71 | 67.47 | 12.16 | 13.05 | 12.60 | 13.68 | 15.45 | 14.57 |
| $P_{100}$ | 64.91 | 64.85 | 64.88 | 12.15 | 12.35 | 12.25 | 13.88 | 14.46 | 14.17 |
| **S. Em (±)** | **0.398** | **0.375** | **0.263** | **0.303** | **0.208** | **0.167** | **0.122** | **0.143** | **0.098** |
| **LSD (0.05)** | **0.145** | **1.081** | **0.758** | **0.873** | **0.599** | **0.482** | **0.350** | **0.412** | **0.283** |
| **Potassium (kg ha$^{-1}$)** | | | | | | | | | |
| $K_{20}$ | 62.74 | 63.53 | 63.13 | 10.58 | 11.36 | 10.97 | 12.32 | 13.44 | 12.88 |
| $K_{40}$ | 67.91 | 64.39 | 66.15 | 12.02 | 13.28 | 12.65 | 13.55 | 15.27 | 14.41 |
| **SEm (±)** | **0.325** | **0.306** | **0.215** | **0.247** | **0.170** | **0.137** | **0.099** | **0.117** | **0.080** |
| **LSD (0.05)** | **0.935** | **N.S.** | **0.619** | **0.713** | **0.489** | **0.394** | **0.284** | **0.336** | **0.231** |

interaction maximum pod number was recorded with $N_{60}P_{80}K_{40}$ (76.48) followed by $N_{60}P_{80}K_{20}$ (69.34) and $N_{60}P_{100}K_{40}$ (69.26) as compared to minimum number of pod with $N_{80}P_{60}K_{20}$ (53.38).

The positive response of nitrogen and phosphorus upto medium level was observed in seed yield plant$^{-1}$. In respect of potassium, the higher dose gave the seed yield of 12.65 g plant$^{-1}$ as compared to 10.97 g plant$^{-1}$ at 20 kg ha$^{-1}$. Similar result in respect of effect of nitrogen was also observed by Sharangi *et al*. (2005) who obtained maximum seed yield with 60 kg N ha$^{-1}$. Some researcher reported that an increase in the seed yield of fenugreek was obtained with P doses of 40 and kg ha$^{-1}$ (Khiriya *et al*., 2001, 2003 and Sheoran *et al*., 2003). Among the interactions, maximum seed yield of 14.36 g was recorded with $N_{60}P_{80}K_{40}$ followed by $N_{40}P_{80}K_{40}$ (13.86 g), $N_{60}P_{100}K_{40}$ (13.45 g) as compared to lowest yield from $N_{60}P_{60}K_{20}$ (9.15 g) combination.

In sole effect the maximum yield of 14.60 q ha$^{-1}$ was recorded with N at the rate of 60 kg ha$^{-1}$. In respect of phosphorus and potassium the maximum yield of 14.56 q ha$^{-1}$ and 14.41 q ha$^{-1}$ were observed with 80 kg P and 40 kg K ha$^{-1}$ respectively. Among the interactions, the maximum projected yield was recorded with $N60P_{80}K_{40}$ (17.20 q ha$^{-1}$) followed by $N_{40}P_{80}K_{40}$ (16.31 q ha$^{-1}$) and $N_{60}P_{100}K_{40}$ (15.80 q ha$^{-1}$) as compared to lowest yield of 11.70 q ha$^{-1}$ under $N_{40}P_{60}K_{20}$ combination. The medium level of both nitrogen and phosphorus with higher level of potassium was more effective for maximization of yield. Both nitrogen and phosphorus applied beyond the lower dose delayed mainly because of better performance of growth parameters like plant height and number of branching which might have passed through long span resulted to delay in flowering (Data and Verma, 2001). Application of phosphorus beyond 80 kg ha$^{-1}$ did not show any positive response in respect of yield and yield attributing character. This finding are also in good agreement with Data and Verma (2001) who did not get any positive response of application of phosphors beyond 120 kg ha$^{-1}$. The better yield and yield attributes with phosphorus fertilization might be due to its key role in root development, energy translocation and metabolic process of plant, through which increased translocation of photosynthates towards sink development might have occurred.

Increased seed yield was due to increased number of pods plant$^{-1}$ was produced at medium level of nitrogen and phosphorus. These results are in conformity with the findings of Baboo and Sharma (1995). The maximum plant height (108.17 cm) was observed with medium level of nitrogen (60 kg ha$^{-1}$) with highest level of phosphorus (100 kg ha$^{-1}$) at 105 days after sowing. A positive response to phosphorus application may be due to favourable effect of phosphorus on nitrogen transformation leading to accumulation and metabolism of carbohydrates in plants Baboo (1997) reported higher ratio of phosphorus application increased height of the plant. similarly positive response of nitrogen, phosphorus

**Table 4: Interaction effect of NPK on number of pod plant$^{-1}$ and seed yield of fenugreek**

| Treatments | Number of pod plant$^{-1}$ | | | Seed yield plant$^{-1}$ (g) | | | Projected yield (q ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled |
| $N_{40}P_{60}K_{20}$ | 53.24 | 61.72 | 57.48 | 8.46 | 10.52 | 9.49 | 10.45 | 12.95 | 11.70 |
| $N_{40}P_{80}K_{20}$ | 58.38 | 62.34 | 60.36 | 11.05 | 11.71 | 11.38 | 12.46 | 13.74 | 13.10 |
| $N_{40}P_{100}K_{20}$ | 66.94 | 57.16 | 62.05 | 12.26 | 11.62 | 11.94 | 14.55 | 13.05 | 13.80 |
| $N_{60}P_{60}K_{20}$ | 59.32 | 56.78 | 58.05 | 8.63 | 9.67 | 9.15 | 10.18 | 10.98 | 10.58 |
| $N_{60}P_{80}K_{20}$ | 72.45 | 66.23 | 69.34 | 12.32 | 13.04 | 12.68 | 13.95 | 15.37 | 14.66 |
| $N_{60}P_{100}K_{20}$ | 63.35 | 72.17 | 67.76 | 11.74 | 14.18 | 12.96 | 14.07 | 16.53 | 15.30 |
| $N_{80}P_{60}K_{20}$ | 55.82 | 50.94 | 53.38 | 8.72 | 9.76 | 9.24 | 10.46 | 11.14 | 10.80 |
| $N_{80}P_{80}K_{20}$ | 58.14 | 62.98 | 60.56 | 11.16 | 12.08 | 11.62 | 13.10 | 14.56 | 13.83 |
| $N_{80}P_{100}K_{20}$ | 53.26 | 59.28 | 56.27 | 10.85 | 9.65 | 10.25 | 11.76 | 12.54 | 12.15 |
| $N_{40}P_{60}K_{40}$ | 59.84 | 62.52 | 61.18 | 10.72 | 11.92 | 11.32 | 12.30 | 14.04 | 13.17 |
| $N_{40}P_{80}K_{40}$ | 71.21 | 65.43 | 68.32 | 14.07 | 13.65 | 13.86 | 17.17 | 15.45 | |
| $N_{40}P_{100}K_{40}$ | 60.15 | 56.17 | 58.16 | 13.42 | 11.88 | 12.65 | 15.87 | 13.75 | 14.81 |
| $N_{60}P_{60}K_{40}$ | 67.09 | 59.95 | 63.52 | 11.28 | 12.36 | 11.82 | 13.04 | 15.12 | 14.08 |
| $N_{60}P_{80}K_{40}$ | 72.28 | 80.68 | 76.48 | 13.92 | 14.80 | 14.36 | 16.07 | 18.33 | 17.20 |
| $N_{60}P_{100}K_{40}$ | 66.59 | 71.93 | 69.26 | 11.65 | 15.25 | 13.45 | 14.17 | 17.43 | 15.80 |
| $N_{80}P_{60}K_{40}$ | 58.52 | 53.98 | 56.25 | 9.78 | 12.14 | 10.96 | 11.08 | 14.62 | 12.85 |
| $N_{80}P_{80}K_{40}$ | 60.13 | 64.59 | 62.36 | 10.43 | 13.01 | 11.72 | 11.86 | 15.24 | 13.55 |
| $N_{80}P_{100}K_{40}$ | 57.15 | 60.47 | 58.81 | 12.95 | 11.51 | 11.23 | 12.84 | 13.46 | 13.15 |
| **N x P** | | | | | | | | | |
| **SEm (±)** | **0.689** | **0.650** | **0.456** | **0.525** | **0.360** | **0.290** | **0.211** | **0.247** | **0.170** |
| **LSD (0.05)** | **1.984** | **1.872** | **1.312** | **N.S.** | **1.038** | **0.835** | **0.607** | **0.713** | **0.491** |
| **P x K** | | | | | | | | | |
| **SEm (±)** | **0.562** | **0.531** | **0.372** | **0.428** | **0.294** | **0.237** | **0.172** | **0.202** | **0.139** |
| **LSD (0.05)** | **1.620** | **1.529** | **1.071** | **N.S.** | **0.847** | **0.682** | **0.495** | **N.S.** | **0.401** |
| **N x K** | | | | | | | | | |
| **SEm (±)** | **0.562** | **0.531** | **0.372** | **0.428** | **0.294** | **0.237** | **0.172** | **0.202** | **0.139** |
| **LSD (0.05)** | **1.620** | **N.S.** | **1.071** | **N.S.** | **0.847** | **0.682** | **N.S.** | **0.582** | **0.401** |
| **N x P x K** | | | | | | | | | |
| **SEm (±)** | **0.974** | **0.919** | **0.644** | **0.742** | **0.509** | **0.410** | **0.298** | **0.350** | **0.241** |
| **LSD (0.05)** | **2.805** | **2.648** | **1.856** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **1.008** | **0.694** |

and potassium upto 50 kg ha$^{-1}$, 90 kg ha$^{-1}$ and 60 kg ha$^{-1}$ were on number of branches plant$^{-1}$ were reported by Thapa and Maity, (2004), Tuncturk (2011) and Data and Verma (2001) respectively.

The interaction effects due to N and P application were beneficial for yield and yield attributes. The increase in seed yield was associated with a similar increase in yield attributes. Detroja *et al*. (1996) have also shown that seed yield in fenugreek was positively correlated with the plant height, number of branches plant$^{-1}$, number pods plant$^{-1}$, number of seed pod$^{-1}$ and test weight. These findings lead us to believe that fenugreek makes a moderate demand on nitrogen and phosphate. Detroja *et al*. (1996) also did not get any positive response beyond 30 kg N ha$^{-1}$ and 60 kg P ha$^{-1}$.

Application of 80 kg $P_2O_5$ ha$^{-1}$ resulted in higher plant height, number of branches plant$^{-1}$ and other yield attributes over 60 kg $P_2O_5$. The applied phosphorus probably increased the nitrogenase activity of roots which enhanced root nodulation and created a congenial environment in the rhizosphere that resulted in increasing physiological growth parameters. Increase in growth parameters due to application of 60 kg and 90 kg $P_2O_5$ ha$^{-1}$ have also been reported by Bhunia *et al*. (2006) and Tuncturk (2011). From yield maximization point of view the most effective treatment was $N_{60}P_{80}K_{40}$ (17.20 q ha$^{-1}$) followed by $N_{40}P_{80}K_{40}$ (16.31 q ha$^{-1}$) and $N_{60}P_{100}K_{40}$ (15.80 q ha$^{-1}$) under alluvial plains of West Bengal for fenugreek production.

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