

Effect of FYM and Phosphorus on the Performance of Fenugreek (*Trigonella foenum-graecum* L.) Irrigated with Saline Water

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Abstract

A pot experiment was conducted during *rabi* season of 2003 on loamy sand soil for evaluating the response of fenugreek to farm yard manure and phosphorus irrigated with saline water. The application of farm yard manure showed the significant increase in plant height, total number of nodules per plants, seed index, seed and straw yield, nitrogen, phosphorus, potassium, calcium and sodium uptake by seed and straw. The application of phosphorus increased the yield attributing parameters, yield, root nodules and uptake of N, P, K, Ca and Na. The increasing level of EC_{iw} decreased the plant height, total number of nodules per plant, seed index, seed and straw yield and nutrient uptake by seed and straw.

Key words : FYM, Phosphorus, Fenugreek, Saline water.

Fenugreek (*Trigonella foenum-graecum* L.) popularly known by its vernacular name “*methi*” is an important leguminous crop grown in *rabi* season. It occupies prime place amongst the seed spices grown in northern India particularly in Rajasthan. Fenugreek is supposed to be a multi purpose crop. Its green leaves and young pods are used as vegetable and seeds as condiment for human consumption and as forage and concentrate for cattle. It has immense medicinal utility as it prevents constipation, indigestion and stimulates the digesting process and the metabolism. India has attained the status of major producer and exporter of fenugreek. In Rajasthan, fenugreek occupies 32,857 ha area with annual production of 43,434 tonnes and the average productivity is 1,321 kg/ha (1). However, the average productivity in Rajasthan (1,008 kg/ha) is low as compared to national average of 1,298 kg/ha, despite higher genetic potential (1,560 kg/ha). Thus, there is an ample scope for increasing its productivity particularly in Rajasthan. Being an important cash crop and looking to its export in large scale, farmers include fenugreek in their cropping strategy particularly in the areas having saline soil or saline water as it performs better compared to other legumes like gram and pea due to fair tolerance to salinity (2). Its roots may also be considered as manufacturing to synthesize nitrogenous food for plants and maintain-

ing the soil fertility status of soils. FYM is rich in organic matter and is a good source of plant nutrients. Poor nutrient economy of light textured soils necessitates the need for supplementing fertilizers with FYM. Organic acids released from decomposing organic matter help to reduce pH in soils. The supply of phosphorus to legumes is more important than nitrogen. Phosphorus is necessary for growth of *Rhizobium* bacteria, responsible for nitrogen fixation through nodulation ; phosphorus application to legume not only benefits the current crop but also has favourable effects on succeeding non-legume crop. It also improves the crop quality. It is a part of ADP, ATP, nucleic acid, flavin nucleotides and thiamine phosphate. Though the effects of phosphorus and FYM application on fenugreek have been reported, but information on their interactive effect under saline condition is lacking. Therefore, the present investigation was undertaken to evaluate the effect of different levels of FYM, phosphorus and EC of irrigation water on yield attributes and yield and nutrient uptake by the fenugreek.

Methods

A pot experiment was conducted during *rabi* 2003 at S. K. N. College of Agriculture, Jobner (Rajasthan) to study the effect of FYM and phosphorus on the

performance of fenugreek irrigated with saline water. The experiment was laid out in completely randomized design with three replications by taking three levels of FYM (0, 5 and 10 t/ha), three levels of phosphorus (0, 20 and 40 kg P₂O₅/ha) and three levels of EC_{iw} (2, 4 and 6 dS/m) as variables. Jobner is located at 75.28° east longitude and 26.06° north latitude and altitude is 427 meters above mean sea level. This region falls under agro climatic zone III-A (semi-arid eastern plain) of Rajasthan. The climate of the region is typically semi-arid characterized by the aridity of atmosphere and salinity of rhizosphere with extremes of the temperature both during summer and winter. The annual rainfall of locality ranges between 400 to 500 mm, which is mostly received from July and September. Ten kg soil was filled in each cylindrical ceramic pot (20 cm in diameter and 28 cm in height). At the time of filling the pots, the broken pieces of stone were placed on the bottom hole to allow free drainage. Three different types of irrigation water based on treatment were used for irrigating the crop. The desired levels of salinity (i.e. 2, 4, 6 dS/m) were prepared by adding chloride and sulfate salts in irrigation water. FYM based on treatment was applied 21 days before sowing and thoroughly mixed. The basal dose of fertilizers was mixed in soil at sowing time. A uniform basal dose of N at 30 kg/ha and phosphorus based on treatment were applied through urea and SSP, respectively at the time of sowing. The fenugreek, seed of variety RMT-1 was treated with bavistin at 3 g/kg seed to control seed borne diseases. Ten treated seeds per pot were sown on 5 November, 2003 and after germination, only three plants per pot were maintained. Measured volume (1.25 liters) of water was applied to each pot according to plan of experiment. Besides one pre-sowing irrigation eight subsequent irrigations were given. The statistical analysis of the data on the final value of plant height, seed and straw yield, seed index, uptake of N, P, K, Ca and Na in seed and straw were done by statistical method of analysis of variance. To compare the treatment difference, the critical difference (CD) at 5% level of significance was calculated as per method described by Panse and Sukhatme (3) wherever *F* test came out significant.

Results and Discussion

Effect of FYM

Table 1 revealed that the increasing levels of

FYM increased the plant height, total number of root nodules per plant, seed index, seed and straw yield of fenugreek significantly. The application of 10 t/ha of FYM increased the plant height by 35.3%, total number of root nodules per plant by 38.6% seed index by 8.7%, seed yield by 38.9% and straw yield by 39.1% as compared to control (no FYM). The beneficial effect of FYM on yield attributes was probably due to enhanced supply of macro and micronutrients during growing season. It might have attributed to higher manufacturing of food and its subsequent partitioning in sink. The availability and optimum supply of nutrients favorably influenced the flowering and seed formation which ultimately increased the plant height, seed and straw yield. Similar results were also reported by Khiriyia et al. (4) in fenugreek. The another probable reason could be efficient and greater partitioning of metabolites and adequate transformation of nutrients to developing plant structures as a result, almost all yield attributes of crop resulted into significant improvement due to FYM application. These results corroborate with the findings of Ramamurthy et al. (5) in cowpea and Dubey and Gupta (6) in pigeonpea.

Table 1 also shows that the application of FYM at increasing rates increased the uptake of nutrients significantly. The application of 10 t FYM/ha increased the N, P, K, Ca, and Na uptake by seed to the extent of 57.9, 106.7, 81.5, 45.3 and 29.0% respectively as compared to control. The increase in N, P, K, Ca and Na uptake by straw with 10 t FYM/ha was observed to be 71.9, 147.2, 71.0, 64.1 and 31.2% higher than control. The crop manured with higher dose of FYM utilized more nitrogen as compared to lower doses resulting in increased nitrogen content in seed and straw. The increased photosynthetic efficiency thereby more dry matter production and nutrient concentration in plants seems to be major factor responsible for higher N uptake with the FYM application. Since uptake of nutrient is a function of their content and yield attributed to its higher nutrient content. This may be due to the improvement in available nutrients status and physico-chemical properties of soil encouraging proliferation of roots which in turn absorbed more water and nutrients from large area and also from greater depth. Moreover, FYM after decomposition releases macro and micro-nutrients which become available to the plants and enhance the pho-

Table 1. Effect of FYM, phosphorus and saline water on yield attributes, yield and nutrient uptake (mg/pot) of fenugreek.

| Treatments | Plant height (cm) | Total number of nodule per plant | Seed index (g) | Seed yield (g/pot) | Straw yield (g/pot) |
|-------------------------------|----------------------|---|----------------------|--------------------------|---------------------------|
| FYM Levels | | | | | |
| F ₀ | 36.13 | 5.90 | 1.14 | 8.52 | 19.97 |
| F ₅ | 42.80 | 7.66 | 1.20 | 10.36 | 24.31 |
| F ₁₀ | 48.90 | 8.18 | 1.24 | 11.84 | 27.78 |
| CD (<i>P</i> = 0.05) | 0.960 | 0.235 | 0.030 | 0.328 | 0.700 |
| Phosphorus Levels | | | | | |
| P ₀ | 36.07 | 5.86 | 1.13 | 8.12 | 19.40 |
| P ₂₀ | 42.87 | 7.60 | 1.20 | 10.47 | 24.55 |
| P ₄₀ | 48.89 | 8.28 | 1.25 | 12.14 | 28.11 |
| CD (<i>P</i> = 0.05) | 0.960 | 0.235 | 0.030 | 0.328 | 0.700 |
| EC_{iw} Levels | | | | | |
| S ₂ | 45.78 | 8.20 | 1.23 | 11.54 | 27.21 |
| S ₄ | 42.81 | 7.65 | 1.20 | 10.53 | 23.12 |
| S ₆ | 39.24 | 5.85 | 1.15 | 8.66 | 21.73 |
| CD (<i>P</i> = 0.05) | 0.960 | 0.235 | 0.030 | 0.328 | 0.700 |

Table 1. Continued.

| | Nitrogen | | Phosphorus | | Potassium | | Calcium | | Sodium | |
|-------------------------------|----------|--------|------------|-------|-----------|--------|---------|--------|--------|-------|
| | Seed | Straw | Seed | Straw | Seed | Straw | Seed | Straw | Seed | Straw |
| FYM Levels | | | | | | | | | | |
| F ₀ | 260.25 | 171.18 | 30.75 | 18.46 | 75.07 | 213.81 | 17.26 | 97.62 | 31.14 | 70.53 |
| F ₅ | 338.53 | 237.76 | 47.05 | 29.96 | 107.30 | 297.41 | 21.63 | 134.24 | 36.05 | 82.22 |
| F ₁₀ | 411.18 | 294.32 | 63.57 | 45.65 | 136.27 | 365.65 | 25.08 | 160.28 | 40.20 | 92.6 |
| CD (<i>P</i> = 0.05) | 17.109 | 11.394 | 2.486 | 1.585 | 6.161 | 13.763 | 0.969 | 7.978 | 1.950 | 4.535 |
| Phosphorus Levels | | | | | | | | | | |
| P ₀ | 244.94 | 155.41 | 30.07 | 20.13 | 74.17 | 211.73 | 16.62 | 103.65 | 28.89 | 67.05 |
| P ₂₀ | 342.12 | 240.86 | 46.31 | 33.10 | 109.79 | 297.99 | 21.75 | 133.58 | 36.53 | 83.36 |
| P ₄₀ | 422.89 | 306.99 | 65.00 | 40.84 | 134.70 | 367.15 | 25.60 | 154.91 | 41.96 | 94.89 |
| CD (<i>P</i> = 0.05) | 17.109 | 11.394 | 2.486 | 1.585 | 6.161 | 13.763 | 0.969 | 7.978 | 1.950 | 4.535 |
| EC_{iw} Levels | | | | | | | | | | |
| S ₂ | 361.61 | 290.61 | 56.71 | 38.34 | 131.65 | 364.41 | 23.19 | 136.91 | 38.81 | 88.61 |
| S ₄ | 349.92 | 245.80 | 48.44 | 29.90 | 110.49 | 283.62 | 21.99 | 128.82 | 36.73 | 78.82 |
| S ₆ | 298.41 | 161.85 | 36.22 | 25.82 | 76.50 | 228.84 | 18.79 | 120.41 | 31.85 | 77.88 |
| CD (<i>P</i> = 0.05) | 17.109 | 11.394 | 2.486 | 1.585 | 6.161 | 13.763 | 0.969 | 7.978 | 1.950 | 4.535 |

tosynthesis and synthesis of carbohydrates and their translocation to different plant parts resulting into higher growth and yield, that is why increased uptake was observed. Results of the present investigation are in line with those of Kundu et al. (7) in

soyabean and Dubey and Verma (8) in cowpea.

Effect of Phosphorus

Table 1 shows that the increasing levels of phosphorus increased significantly the plant height, total

number of nodules per plant, seed index, seed and straw yield of fenugreek. The application of 40 kg P_2O_5 /ha increased the plant height by 35.3%, total number of nodules per plant by 41.2%, seed index by 10.6%, seed yield by 49.5% and straw yield by 44.8% as compared to control (no phosphorus). The regulatory functions of phosphorus in photosynthesis and carbohydrate metabolism of leaves can be considered to be one of the major factors limiting plant growth particularly during the reproductive phase. The levels of phosphorus during this period regulate starch/sucrose ratio in the leaves and in reproductive organs, phosphorus also being an important structural component of wide variety of biochemical including nucleic acid, co-enzymes, nucleotides, phosphoproteins, phospholipids and sugar phosphate might have resulted increase in carbohydrate accumulation and their re-mobilization to reproductive parts of the crop plant being the closest sink and hence resulted in increased flowering, fruiting and grain formation. Significant increase in seed and straw yield was observed by the application of 40 kg P_2O_5 /ha (Table 1). The increase in seed yield under application of phosphorus might be due to the concomitant increase in number of pods per plants. This might be due to the reason that excess assimilates stored in the leaves and later translocation into seeds at the time senescing being the closest sink. This ultimately increased the seed yield. Further, significant increase in straw yield was also recorded with the application of 40 kg P_2O_5 /ha over control (Table 1). The increase in straw yield might be due to the results of overall increase in growth and development of plants. Similar results were also reported by Khiriya et al. (4) in fenugreek.

The N, P, K, Ca and Na uptake by seed and straw increased significantly with the increasing levels of phosphorus (Table 1). With the application of 40 kg P_2O_5 /ha increased the uptake of N, P, K, Ca and Na by seed and straw to the extent of 72.7 and 97.5, 116.2 and 102.9, 81.6 and 73.4, 54.0 and 49.5 and 45.2 and 41.5%, respectively as compared to control. Phosphorus in the soil improved the over all nutritional environment of the soil leading to higher uptake by the plant. Since the nutrient uptake is a function of their content in seed and straw, the increase in these parameters along with the increased concentration due to application of phosphorus leads to an increase

Table 2. Interactive effect of FYM and phosphorus on plant height (cm), seed and straw yield (g/pot) and N, P and K uptake (mg/pot).

| Treatments | P ₀ | P ₂₀ | P ₄₀ |
|--------------------------|----------------|-----------------|-----------------|
| Plant Height | | | |
| F ₀ | 30.58 | 36.35 | 41.45 |
| F ₅ | 36.23 | 43.06 | 49.10 |
| F ₁₀ | 41.39 | 49.19 | 56.10 |
| SE ± | 0.582 | | |
| CD (P = 0.05) | 1.662 | | |
| Seed Yield | | | |
| F ₀ | 6.75 | 8.70 | 10.10 |
| F ₅ | 8.21 | 10.6 | 12.29 |
| F ₁₀ | 9.38 | 12.10 | 14.04 |
| SE ± | 0.199 | | |
| CD (P = 0.05) | 0.569 | | |
| Straw Yield | | | |
| F ₀ | 16.13 | 20.41 | 23.37 |
| F ₅ | 19.63 | 24.84 | 28.45 |
| F ₁₀ | 22.44 | 28.39 | 32.51 |
| SE ± | 0.425 | | |
| CD (P = 0.05) | 1.212 | | |
| N Uptake by Seed | | | |
| F ₀ | 189.38 | 264.55 | 326.80 |
| F ₅ | 246.46 | 344.14 | 424.97 |
| F ₁₀ | 298.98 | 417.61 | 516.86 |
| SE ± | 10.378 | | |
| CD (P = 0.05) | 29.633 | | |
| N Uptake by Straw | | | |
| F ₀ | 113.51 | 175.92 | 224.09 |
| F ₅ | 157.67 | 244.35 | 311.24 |
| F ₁₀ | 195.05 | 302.23 | 385.62 |
| SE ± | 6.912 | | |
| CD (P = 0.05) | 19.735 | | |
| P Uptake by Seed | | | |
| F ₀ | 19.62 | 30.22 | 42.40 |
| F ₅ | 30.02 | 46.24 | 64.88 |
| F ₁₀ | 40.55 | 62.46 | 87.70 |
| SE ± | 1.508 | | |
| CD (P = 0.05) | 4.307 | | |
| P Uptake by Straw | | | |
| F ₀ | 11.85 | 19.48 | 24.03 |
| F ₅ | 19.23 | 31.62 | 39.00 |
| F ₁₀ | 29.30 | 48.18 | 59.45 |
| SE ± | 0.962 | | |
| CD (P = 0.05) | 2.746 | | |

Table 2. Continued.

| Treatments | P ₀ | P ₂₀ | P ₄₀ |
|--------------------------|----------------|-----------------|-----------------|
| K Uptake by Seed | | | |
| F ₀ | 52.45 | 75.50 | 95.22 |
| F ₅ | 74.97 | 110.80 | 136.12 |
| F ₁₀ | 95.02 | 141.03 | 172.73 |
| SE ± | 3.737 | | |
| CD (P = 0.05) | 10.671 | | |
| K Uptake by Straw | | | |
| F ₀ | 154.92 | 217.98 | 268.52 |
| F ₅ | 215.50 | 303.21 | 373.51 |
| F ₁₀ | 264.76 | 371.76 | 459.42 |
| SE ± | 8.349 | | |
| CD (P = 0.05) | 23.839 | | |

in uptake of nutrients. The results of present investigation are in conformity with Kumawat et al. (9)

Effect of Salinity of Irrigation Water

The increasing salinity of irrigation water decreased the yield and yield attributing characteristics of fenugreek significantly. Due to irrigation with the water of EC 6 dS/m decreased the plant height, total number of nodule per plant, seed index, seed and straw yield to the extent of 14.2, 28.6, 11.8, 24.9 and 20.1%, respectively, as compared to the normal water (EC 2 dS/m). The decrease in seed index may be due to the reason anthesis and seed filling stages are most sensitive stage to salinity stress in the soil. The seed remained shriveled if the crop experience salinity, nutritional and water stress at this stage. The reduction in seed index with increasing level of salinity of soil was reported by Pathan et al. (10). The reduction in yield due to high salinity of irrigation water may be due to higher accumulation of salts in the plant cell and the osmotic potential and pressure potential become limiting factor for plant growth. The adverse effects of salinity on metabolic and enzymatic activity of the plant leads to decrease in number of nodules, growth and finally the yield of the crop. The results are in conformity with the work of Pathan et al. (10).

The uptake of nutrients decreased significantly with the increasing salinity of irrigation water. With the application of S₆ water (EC 6 dS/m) decreased the

N, P, K, Ca and Na uptake by seed and straw of fenugreek to the extent of 15.4 and 42.5, 36.1 and 32.7, 14.8 and 37.2, 18.9 and 12.0 and 17.9 and 12.1%, respectively as compared to control (EC 2 dS/m). The nutrient uptake is the function of concentration of these nutrients and the yield of the crop. The crop yield reduced significantly due to increasing salinity of irrigation water and hence a perceptible reduction was observed in uptake of nutrients. Sodium dominant salinity resulted in the lower uptake of potassium due to antagonism between sodium and potassium. The increased concentration of Na in soil solution causes more absorption of sodium by plants and decreases the uptake of potassium as sodium competes with potassium on absorbing sites. The results find support from the work of Pathan et al. (10).

Interactive Effects of FYM and Phosphorus

Irrespective of the level of phosphorus the increasing level of FYM (upto 10 t FYM/ha) increased significantly the plant height, number of root nodules per plant, seed index, seed and straw yield and N, P and K uptake by seed and straw of fenugreek (Table 2). Similarly irrespective of the level of FYM, the increasing level of phosphorus (upto 40 kg P₂O₅/ha) increased significantly the yield attributing characteristics, yield and N, P and K uptake by seed and straw of fenugreek. Further the synergistic effect of FYM and phosphorus interaction on these parameters was highest at F₁₀P₄₀, while the lowest was observed at F₀P₀. The traceable improvement in yield attributing characters, yield and N, P, and K uptake may be due to additive effect of FYM and phosphorus.

On the basis of results it is concluded that the increasing salinity reduced the yield attributing characters, yield and nutrient uptake of fenugreek. A perceptible improvement in the yield and uptake of nutrients by fenugreek is possible with the application of FYM at 10 t/ha and 40 kg P₂O₅/ha under saline environment.

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