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Response of *Trigonella foenum-graecum* to organic manures and *Rhizobium* inoculation in a Typic Haplustept

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Abstract

Field experiments carried out to study the effect of organic manures and *Rhizobium* on performance of fenugreek (*Trigonella foenum-graecum*) revealed that germination was hastened by the application of organic manures [Vermicompost (VC), Sheep manure (SM) and Farmyard manure (FYM)] and seed inoculation with *Rhizobium*. Plant height and number of branches were higher with FYM. However, there was no significant variation in days to flower initiation and complete flowering. Yield and yield attributes i.e. number of pods plant^{-1}, number of seeds pod^{-1} and seed test weight were maximum with FYM. Application of manures and *Rhizobium* inoculation enhanced the seed yield. Per cent seed yield increase with *Rhizobium* inoculation, sheep manure, vermi-compost and FYM was 11.45, 22.91, 20.83 and 35.41, respectively. Harvest Index and protein content were highest with FYM.

Keywords: fenugreek, FYM, *Rhizobium*, sheep manure, *Trigonella foenum-graecum*, vermicompost

Fenugreek (*Trigonella foenum-graecum* L.) is belonging to subfamily *Papilionaceae* of the family *Leguminosae/ Fabaceae* (Suleiman *et al.* 2008) and good soil renovator and is widely used as a green manure (Abdelgani *et al*. 1999). *Rhizobium* are well known group of bacteria that act as the symbiotic fixer of N. This symbiosis reduces the requirement for N fertilizers during the growth of leguminous crops (Ali *et al*. 2012). Use of organic manures along with fertilizers have not only helped in maintaining the physico-chemical characteristics of soil, but has also increased the crop yields (Singh & Dubey 1987). Besides improving soil quality, organic manures are a potential source of micronutrients and improve structure, increase water holding capacity and improve buffering capacity of soils (Baldock & Skjemstad 1999). Organic manuring has also been found to stimulate microbial and enzyme activitites in soil (Rathore *et al.* 2009). However, Information available on organic fenugreek production is very limited. Therefore, the present investigation was carried out with three types of organic manures (Vermicompost -VC, Sheep manure -SM and FYM including *Rhizobium* inoculation in fenugreek.

The experiment was carried out during *rabi* seasons of 2010–11 and 2011–12 at the research farm of National Research Centre on Seed Spices, Tabiji, Ajmer, Rajasthan, India. This lies

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in between 74° 35′ 39" E to 74° 36′ 01" longitude and 26° 22′ 12" to 26° 22′ 31" N latitude at an altitude of 460.17 m above MSL. This zone is semi-arid eastern plain and receives a rainfall 500–600 mm annually. Summer and winter temperatures are not as extreme as in the arid west regions but the summer temperature may reach around 42–45°C and in the winter it may go down to 2.0°C. The soil of experimental field was fine loamy sand, mixed calcareous, hyperthermic, Typic Haplustept. The soil was more than 100 cm deep, brown to dark brown in colour, slightly to moderately alkaline and slightly calcareous. The texture of experimental soil was analyzed by the International Pipette method (Piper 1966). Soil samples were analyzed for available N (Subbiah & Asija 1956), 0.5 M $NaHCO_3$ extractable P (Olsen *et al.* 1954) and 1N NH_4OAc extractable K (Jackson 1973). The analyses revealed that the soil was lower in N (116.7 kg ha^{-1}) and P (6.2 kg ha^{-1}) and medium in K (135.1 kg ha^{-1}). Soil organic carbon (SOC) was estimated by wet digestion method as described by Walkley & Black (1935). Initial SOC content was 0.23%. The per cent N, P and K in FYM was 1.34, 0.39 and 1.65, respectively; in SM it was 1.0, 0.27 and 0.85, respectively and in VC it was 0.86, 0.24 and 0.80, respectively. The micronutrient content (ppm) of manures is given in Table 1.

The experiment was laid out in a Randomized Block Design (RBD) having five treatments i.e. VC @ 10 t ha^{-1}, SM @ 10 t ha^{-1}, FYM @ 10 t ha^{-1}, seed inoculation with *Rhizobium* @ 10 g kg^{-1} of seed and control (without manure and *Rhizobium*) with four replications. The fenugreek variety RMt-305 was used. Seeds were sown during second week of November by maintaining spacing of 30 cm × 10 cm. Growth and yield parameters were recorded during the crop cycle. Irrigation and inter-cultural operations were done as and when required. Crop was harvested during March. The harvested crop was threshed and yield parameters were recorded. Data generated were pooled and analyzed using MSTATC software.

Results revealed that organic manuring and seed inoculation with *Rhizobium* hastened germination of fenugreek (Table 2). However, seed germination was earliest with FYM. This might be due to organic acids produced by the

Table 1. Micronutrient content (mg kg^{-1}) in manures used in the study

Micronutrients	Farmyard manure	Sheep manure	Vermicompost
Zinc	99.4 (± 1.6)	50.9 (± 5.1)	54.9 (± 13.7)
Iron	551.6 (± 21.7)	475.2 (± 21.6)	419.9 (± 9.2)
Manganese	148.7 (± 79.3)	176.3 (± 10.8)	209.9 (± 8.3)
Copper	66.2 (± 7.0)	41.5 (± 5.1)	44.9 (± 1.9)

The value given in parentheses is standard deviation

Table 2. Effect of organic manures and *Rhizobium* inoculation on seed germination and growth parameters in fenugreek (Mean of two years)

Treatment	Days to Germination	Plant height (cm)				No of branches	
		30 DAS	60 DAS	90 DAS	At harvest	Primary	Secondary
Control	3.8	4.7	21.1	35.1	48.0	6.5	17.7
VC-5	3.3	5.2	24.2	39.1	51.7	6.9	19.9
SM-10	3.5	5.0	23.4	38.4	50.0	6.8	19.4
FYM-10	3.0	5.3	24.6	39.3	51.7	6.9	20.0
Rhizobium	3.5	4.9	22.4	37.4	50.0	6.7	18.9
SEm±	0.2	0.2	0.5	1.0	1.2	0.2	1.0
CD (P<0.05)	0.6	NS	1.6	2.9	3.6	NS	2.2

VC=Vermicompost; SM=Sheep Manure; DAS=Days of sowing

manure leading to early germination. Polysaccharides promote better soil structure through their ability to bind inorganic soil particles into stable aggregates. Research indicated that the heavier polysaccharide molecules may be more important in promoting aggregate stability and water infiltration than the lighter molecules (Elliot & Lynch 1984). Some sugars may stimulate seed germination and root elongation (Bot & Benites 2005). The manure also invariably encourages arbuscular mycorrhizal fungal colonization in fenugreek (Tarafdar *et al*. 2011). Better seed germination rate of sunflower was observed when manure was added as compared to the control (Jalaluddin & Hamid 2011). At 30 days after sowing (DAS), there was no significant variation in plant height. However, at 60, 90 DAS and at harvest, the tallest plants were found with FYM which was at par with other manures and *Rhizobium* inoculation. There was no significant difference in number of primary branches. Moreover, secondary branches were significantly higher with *Rhizobium* and manures as compared to control. This clearly indicated that there is a need for adding organic manures to the soil. These results are in agreement with the findings of Maheshbabu *et al.* (2008) in soybean. No significant differences between treatments were registered in days to flower initiation and days to complete flowering (Table 3). Marked effect of organic treatments was observed on pods per plant as compared to control. Higher number of pods per plant was recorded with FYM over other manures and *Rhizobium* inoculation. Maximum number of seeds per pod was recorded with FYM, which was at par with *Rhizobium* inoculation, VC and SM. It was apparent that use of *Rhizobium* and manures, supplied nutrients and plant growth promoting substances leading to improvement in the yield attributes. These results are in conformity with the findings of Bhunia *et al*. (2006). There was no significant variation among the treatments with respect to seed test weight.

Seed yield was significantly higher with manures and *Rhizobium* inoculation as compared to control (Table 4). Moreover, seed yield with FYM was higher over the other manures and *Rhizobium* inoculation. Seed yield increase (%) with the application of *Rhizobium*, VC, SM and FYM over the control was 11.45, 22.91, 20.83 and 35.41, respectively. This may be due to better supply of nutrients by the manures which led to higher growth and ultimately higher yield. The organic manures also improve the availability of nutrients and balanced supply of N throughout the life cycle of crop thereby reducing leaf senescence and increased assimilate demand, which resulted in higher number of pods, test weight and yield of fenugreek (Choudhary *et al.* 2011). The favourable effect of *Rhizobium* in enhancing the yield and nutrient uptake in fenugreek was also reported by Purbey & Sen (2007) and manures by Khiriya & Singh (2003) and Aishwath *et al.* (2011). Harvest index was higher with all the

Table 3. Effect of organic manures and *Rhizobium* inoculation on yield parameters of fenugreek (Mean of two years)

Treatment	Days to flowering initiation	Days to complete flowering	No of pods plant^{-1}	No of seeds pod^{-1}	Test weight (g)
Control	45.8	51.6	48.1	13.7	15.8
VC	44.8	50.5	56.2	15.7	16.9
SM	45.5	51.6	57.2	15.4	16.8
FYM	44.8	50.6	62.4	16.1	17.4
Rhizobium	45.8	51.6	49.9	15.4	16.4
SEm±	0.8	1.1	1.7	0.6	0.6
CD (P<0.05)	NS	NS	5.1	1.3	1.4

VC=Vermicompost; SM=Sheep Manure

Table 4. Effect of organic manures and *Rhizobium* on yield, harvest index and protein content (Mean of two years)

Treatment	Yield (q ha^{-1})		Harvest index	Protein content (%)	
	Seed	Straw	(%)	Seed	Straw
Control	9.6	27.3	26.1	25.1	12.3
VC	11.8	28.3	29.5	27.6	12.7
SM	11.6	28.0	29.4	28.3	13.3
FYM	13.0	28.4	31.4	29.5	13.1
Rhizobium	10.7	27.6	27.9	27.0	13.0
SEm±	0.4	1.1	0.6	0.5	0.8
CD (P<0.05)	0.9	NS	1.8	1.2	NS

VC=Vermicompost; SM=Sheep Manure

manures. However, it was highest with FYM. This is because the nutritional quality of FYM was better than other manures, which provided balanced nutrition to fenugreek. Zafar *et al.* (2003) also reported highest harvest index with balanced nutrition in lentil. Protein content in seed was enhanced either by use of *Rhizobium* or application of organic manures. Maximum protein content was found with FYM application. However, protein content in straw was at par in all the treatments. N is an integral part of protein supplied by these manures and *Rhizobium* inoculation. This could probably be attributed to the increase in N_2-fixing efficiency of inoculated plants where more N was fixed and translocated to the seed. Combined effect of *Rhizobium* and manures was more pronounced on fenugreek as recorded by Saeed & Elsheikh (1995). Abdelgani *et al.* (1999) reported positive impact of *Rhizobium* inoculation on seed quality of fenugreek with respect to protein content, non-soakers, hydration coefficient, moisture content, ash content, fat content and crude fiber. Higher protein content was also recorded with integrated use of manures and fertilizers in fenugreek by Choudhary *et al.* (2011). Overall, application of organic manures and *Rhizobium* inoculation improved the seed germination, growth, yield and quality of fenugreek. Among the manures used, application of FYM was found to be superior over SM and VC.

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