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Response of fenugreek (*Trigonella foenum-graecum*) to different levels of nitrogen and *Rhizobium*

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ABSTRACT

An experiment was carried out during 2007-08 and 2008-09 to study the effect of biofertilizer and nitrogen levels on growth, yield and quality of fenugreek (Trigonella foenum-graecum) in an Entisol of Horticultural Research Station, Mondouri, BCKV, West Bengal. Fenugreek (Rmt-1) seeds were treated with Rhizobium and sown with different levels of inorganic nitrogen and full dose of P and K including FYM @ 5 ton/ha. The results revealed that growth parameters viz., plant height and number of branches were significantly better in 15 to 20 per cent substitution of fertilizer nitrogen with biofertilizer. Seed yield was also highest (12.8 q / ha) in 15% substitution of inorganic nitrogen with Rhizobium followed by 20% and 25% N substitution. The essential oil content, however, did not show any variation among treatments. The findings indicated that there is a scope of replacement of 25 % inorganic fertilizer nitrogen in fenugreek through biofertilizer and sustaining the soil.

Key words: Fenugreek, growth, nitrogen, response, *Rhizobium* and yield

Fenugreek (*Trigonella foenum-graecum*), belonging to family Leguminosae, is an important minor spice grown for its seeds and leaves. Seeds are used as a condiment for flavouring of foods and leaves as vegetable. It has also got medicinal value, hence used for treatment of flatulence, dysentery, diarrhoea, enlargement of liver and spleen, rickets, diabetes, and many others. It is said to be a native of India, though it is grown in the tropical countries throughout the world. The major fenugreek producing states in India are Rajasthan, Madhya Pradesh, Gujarat, Uttar Pradesh, and Tamil Nadu.

The substantial increase in crop production was achieved through green revolution with high input fertilizers and plant protection chemicals. But it has now been realized that this increase in production was achieved at the cost of soil health. Further use of high dose of fertilizers and chemicals may bring about an irreversible damage of soil health and environment. Singh (1998) emphasized the need for incorporation of biofertilizers in the fertilizer programme to meet about one third of plant nutrient needs. Biofertilizers are environment friendly, less expensive, and hence lead to sustainable crop production. Besides, they produce hormones, vitamins and other growth factors required for plant growth. Fenugreek, being a legume crop, responds to inoculation with *Rhizobium* to meet the partial requirement of nitrogen. Global nitrogen fixation through microorganisms-legume association have been estimated to be 175 million tonnes per year and this accounted for about 40 per cent of total nitrogen fixed year^{-1} (Burns and Hardy, 1975). However, very few reports are available regarding the effect of biofertilizers on fenugreek. This experiment was, therefore, designed with the objective of studying the effect of partial replacement of fertilizer nitrogen with biofertilizer on yield and quality of fenugreek.

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MATERIALS AND METHODS

The investigation was carried out at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal during the period from November to March, 2007-08 and 2008-09. The soil was texturally sandy loam, low in organic carbon (4.1 g kg^{-1}) and total nitrogen (0.05%), medium in available phosphorus (21.1kg ha^{-1}), available potassium (178.8 kg ha^{-1}) and pH of 6.9. The experiment was laid out in randomized block design with six treatments and four replications .The variety of fenugreek used was Rmt-1. The treatments were:T_1- $N_{70\%}$ $P_{100\%}K_{100\%}$+ FYM+ *Rhizobium*, T_2- $N_{75\%}$ $P_{100\%}$ $K_{100\%}$+ FYM+ *Rhizobium*, T_3- $N_{80\%}$ $P_{100\%}$ $K_{100\%}$+ FYM+ *Rhizobium*, T_4- $N_{85\%}$ $P_{100\%}$ $K_{100\%}$+ FYM+ *Rhizobium*, T_5- recommended NPK+FYM, T_6-reccommendd NPK (control). The recommended dose of N: P: K was 40:40:20 kg ha^{-1}. Farm yard manure was applied at the rate 5t ha^{-1}. Regarding application of inorganic fertilizers, half amount of nitrogen and entire requirement of phosphorous and potash were applied during land preparation just before sowing, through urea, single super phosphate and muriate of potash, respectively, and remaining half amount of nitrogen was applied 30 days after sowing. The biofertilizer i.e *Rhizobium* (200g) was mixed with 400ml of water for preparing slurry and it was poured over the seeds and mixed well. The treated seeds were dried under shade, preferably in a cool place and sown in the next day. The seeds were dried sown at 30 cm x 15 cm spacing i.e., 50 plants plot^{-1} (1.5 m ×1.0 m). Observations were recorded on different parameters, *viz.*, plant height (cm), number of branches/plant, number of pods plant^{-1}, length of pod (cm), number of seeds pod^{-1}, 1000 seed weight (g), seed yield ha^{-1} (q), straw yield (quintal), and essential oil content (%). The statistical analysis of the experimental data was done according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Plant height recorded no significant difference on replacement up to 20% chemical nitrogen fertilizer, with biofertilizer *Rhizobium*. But *Rhizobium* application along with 85% nitrogen produced the maximum height (74.5cm) and T_6 (Control) recorded the least (Table 1). The integrated approach of fertilizer nitrogen and seed inoculation with *Rhizobium* increased plant height as it increased the internodal length. Similar result was observed by Chaudhary (1999).

The maximum number of branches (5.73) plant^{-1} was noted in T_4 ($N_{85\%}$ $P_{100\%}$ $K_{100\%}$+ FYM+ *Rhizobium*) although it was at par with the treatment T_3 having 20% N substitution with biofertilizer, but both these treatments were significantly superior to other treatments. (Table 1).The number of branches increased with increasing doses of nitrogen along with *Rhizobium* treatment. Inoculation with *Rhizobium* might have increased the nitrogen availability to plant by increasing the amount of nitrogen fixation. This finding is in agreement with several early workers (Chaudhary, 1999; Yadav and Kumawat, 2003; Jat *et al.*, 2006).

Table 1: Effect of biofertilizer and inorganic nitrogen on growth and yield attributes of fenugreek

Treatment	Plant height (cm)	Branches plant^{-1}	Pods plant^{-1}	Pod Length (cm)	Seeds pod^{-1}
T_1	68.2	4.80	36.2	8.32	18.4
T_2	71.0	5.06	39.4	9.65	18.7
T_3	74.2	5.60	40.3	8.61	19.0
T_4	74.5	5.73	41.4	8.60	19.1
T_5	73.4	5.20	40.2	8.57	18.9
T_6	62.2	4.43	30.7	7.16	16.3
SEm(±)	**0.40**	**0.11**	**0.66**	**0.53**	**0.24**
LSD(0.05)	**1.38**	**0.35**	**2.09**	**NS**	**0.765**

The number of pods produced per plant by 100% NPK was statistically at par with 15 to 25 % substitution of fertilizer N with *Rhizobium* and FYM. The lowest value (30.7) of this parameter was recorded in T_6 (Control) while the maximum (41.4) was obtained in T_4 ($N_{85\%}$ $P_{100\%}$ $K_{100\%}$+ FYM+ *Rhizobium*) (Table 1). The result is in support of the findings of Chaudhary (1999), Yadav and Kumawat (2003).

There was no significant variation noted among different treatments in respect of pod length and number of seeds per pod. This is in agreement with the findings of Yadav and Kumawat (2003).

It was noted that the treatment T_5 (with full NPK) did not show any significant difference with the treatments T_4 ($N_{85\%}$ $P_{100\%}$ $K_{100\%}$+ FYM+*Rhizobium*) and T_3 ($N_{80\%}$ $P_{100\%}$ $K_{100\%}$+ FYM+ *Rhizobium*) on 1000 seed weight (Table 2). However, the treatments T_3 and T_4 were significantly better than other treatments of varying N substitutions and the control. The maximum weight (12.1g) of 1000 seeds was observed in T_4 and the lowest (9.96g) was observed in T_6 (control). The higher dose of nitrogen had a beneficial effect and the same trend was noted by Chaudhary (1999).

Biofertilizer with varying levels of inorganic fertilizer N has shown marked effect on seed yield. Seed yield was found highest (12.8q) in T_4 ($N_{85\%}$ $P_{100\%}$ $K_{100\%}$+ FYM+ *Rhizobium*) and it was at par with fertilizer nitrogen substitution up to 25% by biofertilizer. The seed yield /ha declined with reduced rate of nitrogen. The minimum seed yield of T_6 (Control) produced minimum seeds (7.38q ha^{-1}) (Table 2) was recorded in the control.

The data on straw yield (Table 2), revealed that full NPK or 15 to 20 % substitution of fertilizer nitrogen with biofertilizers were at par but these treatments along with maximum substitution (25%) of nitrogen were all significantly better than the control.

Table 2: Effect of biofertilizer and inorganic nitrogen seed quality of fenugreek

Treatment	Seed weight (g^{-1000})	Seed yield (qha^{-1})	Straw yield (q ha^{-1})	Essential oil (%)
T_1	10.8	11.0	18.2	1.92
T_2	11.4	12.4	21.3	2.05
T_3	12.1	12.5	23.5	2.42
T_4	12.1	12.8	25.9	2.57
T_5	11.8	11.4	24.3	2.43
T_6	9.96	7.38	17.3	1.66
SEm(±)	**0.108**	**0.154**	**0.775**	**0.066**
LSD(0.05)	**0.340**	**0.485**	**2.444**	**2.085**

A lower substitution of nitrogen with *Rhizobium* inoculation enhanced vegetative growth similar to full dose of fertilizer nitrogen. But higher substitution of nitrogen reduced the straw yield. Similar result was also observed by Chaudhary (1999), Yadav and Kumawat (2003) and Jat *et al.* (2006). With regard to oil content in seeds, there was no significant difference observed between the treatments. However, maximum essential oil (2.57%) could be obtained through T_4 ($N_{85\%}$ $P_{100\%}$ $K_{100\%}$+ FYM+ *Rhizobium*) (Table 2).

Hence, it has been found that in the Gangetic alluvial plain of West Bengal, the maximum seed yield in fenugreek is obtained by applying up to 75% of recommended dose of inorganic nitrogen in the form of urea and 25% of nitrogen supplemented with biofertilizer *i.e.*, *Rhizobium*. The experimental results clearly indicated that there is a chance of saving 25% inorganic nitrogen with the addition of biofertilizer in fenugreek. It is therefore concluded that the concept of effective use of biofertilizer supplemented with related inorganic nutrients has played a vital role in increasing and sustaining the agricultural production.

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