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Research Article

EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON NUTRIENT UPTAKE, PROTEIN CONTENT AND YIELD OF FENUGREEK

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ABSTRACT
A field experiment was conducted on sandy loam soil at Medicinal Plants Research and Development Centre, of G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand) during *Rabi* season 2007-08 to evaluate the response of integrated nutrient management on nutrient uptake, protein content and seed yield of fenugreek (*Trigonella foenum-graecum* L.).The experiment was conducted in the randomized block design with three replications.Ten treatments consisting of control (T_1) , vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}(T_2), vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1}(T_3), vermicompost 5 t alongwith *Rhizobium* + 20 kg N ha^{-1}(T_4), *Rhizobium* alongwith vermicompost 5 t ha^{-1} (T_5), *Rhizobium* alongwith vermicompost 10 t ha^{-1}(T_6), vermicompost 5 t ha^{-1}(T_7), vermicompost 10 t ha^{-1}(T_8) , 40 kg N ha^{-1}(T_9) and *Rhizobium* inoculation (T_{10}) were tested. Nitrogen content and uptake was observed significantly higher with the application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}.The maximum phosphorus content was observed with the application of *Rhizobium* alongwith vermicompost 10 t ha^{-1}. Whereas, uptake of phosphorus was maximum with vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}. Potassium content (seed and straw) and uptake increased with application of *Rhizobium* alongwith vermicompost 10 t ha^{-1}. Protein content and yield increased with integrated nutrient management. Application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} resulted in the highest protein content (21.75%) and yield (449.57 kg ha^{-1}). Application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} resulted in the highest seed yield (70.69 per cent increase over control). The maximum straw yield (25.01 per cent increase over control) was recorded with application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}.

Key Words: *Condiment, Spice, Integrated Nutrient Management, Nutrient uptake, Protein, Fenugreek.*

INTRODUCTION
Fenugreek (*Trigonella foenum-graecum* L.) locally known as 'methi' belonging to the family-Leguminosae and Sub family-Papilionacea is widely used as spice and condiment to add flavour in various foods (Dwivedi et.al. ,2006) . Fenugreek is cultivated as leafy vegetable, condiment and medicine. India is one of the major producers and exporters of fenugreek. Commercially it is grown on a large scale in Rajesthan, Gujrat, Madhya Pradesh, Uttar Pradesh and Uttarakhand. In India The area under fenugreek is about 40,000 ha. with an annual production of 25,000 tonnes and annual earning of more than Rs. 35 lakh (Purohit and Vyas,2004). Its seeds are used as condiment and vegetable for human consumption and as a concentrate for cattle feed. Its fresh and tender leaves are rich in iron, calcium, protein, vitamins and essential amino acids. Besides, it has medicinal value, as it prevents constipation, removes indigestion, stimulates digestive process and metabolism, in general. Seeds are used for the treatment of diabetes, dysentery, diarrhoea and rickets. Diosgenin which is extracted from the seeds is used in synthesis of sex hormones. Its roots are endowed with mini factory to synthesize nitrogen for plant. Thus, its cultivation enriches the soil in nitrogen.
Biofertilizers play an important role in increasing availability of nitrogen and phosphorus. Therefore, introduction of efficient strain of *Rhizobium* in the soil is helpful in boosting up production and enhancing nitrogen fixation. Chemical fertilizers alone can not sustain productivity of land under modern farming. Similarly, nutrient supply through organic manures or biofertiliazers can hardly

fulfil the need of a crop. Application of organic manure in conjunction with inorganic fertilizer in an integrated manner, appears to be the best alternative. Integrating chemical fertilizer with organic manures has been found to be quite promising not only in maintaining higher productivity but also in providing great stability in crop production (Nambiar et al., 1989) . Farm yard manure or vermicompost when integrated with reduced doses of inorganic fertilizers result in improved soil fertility, growth and yield of plant (Subbian, and Palaniappan, 1992).

Chemical fertilizers have deleterious effect on soil fertility leading to unsustainable yields; while integratetion of chemical fertilizers with organic manures and bio-fertilizers would be able to maintain soil fertility and sustain crop productivity (Jeyabal *et al.*, 2000).Nutrient supply plays an important role in the crop production but under intensive cultivation use of chemical fertilizers alone for long period could result in deterioration of soil fertility and quality of produce. The use of organic manure in combination with inorganic fertilizers has been recommended for balancing soil fertility by several workers .In view of better quality, higher demand and more economic returns of fenugreek grown by adopting INM as evident from the above cited literature, the present study was carried out to find out the response of integrated nutrient management on nutrient uptake, protein content and seed yield of fenugreek (*Trigonella foenum-graecum* L.).

MATERIALS AND METHODS

Field study: A field experiment was conducted during rabi season 2007-08 on sandy loam soil (Table 1) at Medicinal Plants Research and Development Centre of Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, U.S. Nagar (Uttarakhand) in Bhabar and Tarai Agroclimatic zone, about 30 km southward of foot hills of shivalik range of Himalayas at 29°N latitude, 79.29°E longitude and at an altitude of 243.8 meter above the mean sea level under sub-humid subtropical climatic conditions. The total rainfall during the crop season (second week of November to third week of April) was 27.4 mm received in three months, January, March and April. There were three rainy days during the crop period. The maximum amount of rainfall (14.4 mm) was received in month of April. The maximum relative humidity (RH) ranged from 68 to 97 percent and minimum RH ranged from 20 to 89 percent. During the total growth period, the weekly mean maximum temperature ranged between 18.1°C to 37.3°C. Similarly the weekly mean minimum temperature ranged from 2.6°C to 17.3°C. Mean sunshine hours ranged from 3.5 hrs to 10.5 hrs.

Ten treatments tested on the fenugreek var: Pusa Early Bunching consisted of control (T_1) , vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}(T_2), vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1}(T_3), vermicompost 5 t alongwith *Rhizobium* + 20 kg N ha^{-1}(T_4), *Rhizobium* alongwith vermicompost 5 t ha^{-1} (T_5), *Rhizobium* alongwith vermicompost 10 t ha^{-1}(T_6), vermicompost 5 t ha^{-1}(T_7), vermicompost 10 t ha^{-1}(T_8) , 40 kg N ha^{-1}(T_9) and *Rhizobium* inoculation (T_{10}). The treatments were laid out in RBD with three replications, each treatment having a gross plot size of 3.0 × 4.0 m^2 and net plot size of 2.0 × 3.0 m^2. The seed was inoculated with *Rhizobium* (15 ml kg^{-1}) as per the treatment and sown @ 20 kg ha^{-1} in hand hoe opened furrows 30 cm apart at 3 cm depth. A uniform dose of 40 kg P_2O_5 ha^{-1} in the form of single super phosphate (SSP) was applied to all the treatments before sowing of the crop. Vermicompost (Table 1) required for the experiment was collected from the Instructional Dairy Farm, Pantnagar.

Table 1: Chemical Composition of vermicompost used in treatments

S. No.	Characters	Value (%)	Method
1.	Nitrogen (%)	2.88	Modified micro-Kjeldahl method
2.	Phosphorus (%)	0.97	Wet digestion molybdo phosphoric acid method
3.	Potassium (%)	1.41	Flame emission spectro photometery method

Plant analysis: (Nutrient analysis of plant): The plant sample (seed and straw) of fenugreek were collected from each plot and were dried for 48 hrs in hot air oven at 65 ± 5°C.These dried samples were partitioned into grain and straw. Finally ground samples were passed though 0.5 mm mesh sieve and were used for chemical determination of nitrogen, phosphorus and potassium concentration as described by Jackson (1973).

Table:2 Plant nutrients analyzed and their respective methods

Plant nutrients	Method used
Nitrogen concentration	Modified micro-kjeldahl method
Phosphorus concentration	Wet digestion molybdo phosphoric acid method
Potassium concentration	Flame emission spectro photometery method

Uptake of NPK: The total respective nutrient uptake by fenugreek from each treatment was calculated as follows:

i. Nitrogen uptake (kg ha^{-1})

$$= \frac{\text{N content in seed (\%)} \times \text{seed yield (kg ha}^{-1}\text{)} + \text{N content in straw (\%)} \times \text{straw yield (kg ha}^{-1}\text{)}}{100}$$

ii. Phosphorus uptake (Kg ha^{-1})

$$= \frac{\text{P content in seed (\%)} \times \text{seed yield (kg ha}^{-1}\text{)} + \text{P content in straw (\%)} \times \text{straw yield (kg ha}^{-1}\text{)}}{100}$$

iii. Potassium uptake (kg ha^{-1})

$$= \frac{\text{K content in seed (\%)} \times \text{seed yield (kg ha}^{-1}\text{)} + \text{K content in straw (\%)} \times \text{straw yield (kg ha}^{-1}\text{)}}{100}$$

Quality characteristics of seeds(Protein) : The protein content in seed was obtained by multiplying the nitrogen content of seed by 6.25 [1]. Protein yield was calculated by using the following formula:

$$\text{Protein yield (kg ha}^{-1}\text{)} = \frac{\text{Protein content (\%)} \times \text{Seed yield Kg ha}^{-1}}{100}$$

Statistical analysis : The experimental data obtained were analyzed by using analysis of variance (ANOVA) technique for each character as prescribed for a randomized block design layout. The interpretation of data was done on the basis of 'F' test. The critical differences(CD) at 5% level of probability were calculated for testing the significant of difference between two treatment means and are presented in tables of experimental results with standard error of means (SEm ±) as described by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Nutrient Uptake

Nitrogen content in seed : Application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} resulted in significantly higher nitrogen content than *Rhizobium* alongwith vermicompost 5 t ha^{-1}, vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control. *Rhizobium* alongwith vermicompost 10 t ha^{-1} being *at par* with *Rhizobium* alongwith with vermicompost 5 t ha^{-1} resulted in significantly higher nitrogen content than *Rhizobium* treatment and control. Vermicompost 10 t ha^{-1} being *at par* with vermicompost 5 t ha^{-1} produced significantly higher nitrogen content than control. 40 kg N ha^{-1} produced significantly higher nitrogen content than *Rhizobium* alongwith vermicompost 5 t ha^{-1}, vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control (Table 3).

Nitrogen content in straw : Application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} being *at par* with vermicompost 5 t alongwith *Rhizobium* 30 kg N ha^{-1} resulted in maximum nitrogen content which was significantly higher than all other treatments. *Rhizobium* alongwith vermicompost 10 t ha^{-1} resulted in significantly higher nitrogen content than *Rhizobium* alongwith vermicompost 5 t ha^{-1}, vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control. 40 kg N ha^{-1} produced significantly higher nitrogen content than all other treatments except vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} and vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1}(Table 3).

Total nitrogen uptake by plant (seed + straw): Maximum nitrogen uptake was recorded with vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} which was *at par* with vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1} and 40 kg N ha^{-1} which recorded significantly higher nitrogen uptake than all other treatments. *Rhizobium* alongwith vermicompost 10 t ha^{-1} was *at par* with *Rhizobium* alongwith vermicompost 5 t ha^{-1} and resulted in significantly higher nitrogen uptake than vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control. Vermicompost 10 t ha^{-1} produced significantly higher nitrogen uptake than vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control. Significantly higher nitrogen uptake was observed under 40 kg N ha^{-1} treatment than all other treatments except vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} and vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1} (Table 3).

Integrated application of inorganic and organic sources of nutrients significantly increased the nitrogen, phosphorus and potassium content and their uptake by fenugreek crop. The successive increase in fertilizer levels and addition of vermicompost @ 5 t ha^{-1} increased the nutrient content and uptake.

This might be due to (i) increased supply of all essential nutrient directly through organic and inorganic source to crop, (ii) indirectly through checking the losses of nutrient from soil solution and (iii)by increasing in the nutrient use efficiency.

The maximum nitrogen content in seed and straw, their uptake by crop was recorded with the application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}). Increase in nitrogen content and uptake with nitrogen application *Rhizobium* alongwith vermicompost and *Rhizobium* might be due to positive influence of starter dose N on symbiotic nitrogen fixation and nodulation in plant. Dashora (1980) reported that application of 20 kg N ha^{-1} significantly increased nitrogen content of seed and straw and total uptake. Similar results were also reported by Singh (1991) and Chandra (2000). The *Rhizobium* inoculation increased the N and P content in grain and straw and total uptake N and P. This was probably due to more nitrogen fixation by the bacteria resulting better utilization of all the nutrients by crop thus resulting in more N and P content in seed and straw, these findings are in agreement with those of Dravid (1991) and Kumawat (1991).

Phosphorus content in seed : The maximum phosphorus content in seed was recorded with *Rhizobium* alongwith vermicompost 10 t ha^{-1} which was significantly higher than all other treatments. Vermicompost 10 t ha^{-1} produced significantly higher phosphorus content than all other treatments except *Rhizobium* alongwith vermicompost 10 t ha^{-1}.Vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} being *at par* with vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1} resulted in significantly higher phosphorus content than all other treatments except *Rhizobium* alongwith vermicompost 10 t ha^{-1} and vermicompost 10 t ha^{-1}. 40 kg N ha^{-1} produced significantly higher phosphorus content than *Rhizobium* treatment and control (Table 4).

Phosphorus content in straw: Application of *Rhizobium* alongwith vermicompost 10 t ha^{-1} and vermicompost 10 t ha^{-1} were *at par* with each and resulted in significantly higher phosphorus content than all other treatments. Combination of vermicompost, *Rhizobium* and nitrogen recorded significantly higher phosphorus content than control.Application of 40 kg N ha^{-1} also produced significantly higher phosphorus content than control(Table 4).

Total phosphorus uptake by plant (seed + straw): Application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} being *at par* with vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1}, *Rhizobium* alongwith with vermicompost 10 t ha^{-1}, vermicompost 10 t ha^{-1} and 40 kg N ha^{-1} resulted in maximum total phosphorus uptake which was significantly higher than all other treatments. *Rhizobium* alongwith with vermicompost 10 t ha^{-1} was *at par* with vermicompost 10 t ha^{-1} and resulted in significantly higher total phosphorus uptake than *Rhizobium* alongwith vermicompost 5 t ha^{-1}, vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control. Vermicompost 10 t ha^{-1} produced significantly higher total P uptake than vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control. 40 kg N ha^{-1} produced significantly higher total uptake than vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control (Table 4).

It is expected that with the application of vermicompost there was increase in the availability of phosphorus to plant and because of this, the content of phosphorus in plant also increased, increase in phosphorus content in plant is also expected due to better buffering capacity of vermicompost for incipient moisture stress and improving phosphorus availability to plant. Shelke (2001) observed higher phosphorus content when brinjal crop was treated with organic manures and inorganic fertilizer compared to control or crop receiving only inorganic fertilizer.

Potassium content in seed *:* Application of *Rhizobium* alongwith vermicompost 10 t ha^{-1} was observed to be *at par* with vermicompost 10 t ha^{-1} and resulted in significantly higher potassium content than all other treatments. Vermicompost 10 t ha^{-1} produced significantly higher potassium content than all other treatments except *Rhizobium* alongwith vermicompost 10 t ha^{-1}.Vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1} was *at par* with vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} produced significantly higher potassium content than 40 kg N ha^{-1}, *Rhizobium* treatment and control. 40 kg N ha^{-1} produced significantly higher potassium content than *Rhizobium* treatment and control.

Potassium content in straw *: Rhizobium* alongwith vermicompost 10 t ha^{-1} and vermicompost 10 t ha^{-1} being *at par* with each other recorded significantly higher potassium content than all other treatments. Vermicompost 10 t ha^{-1} produced significantly higher potassium content than all other treatments except *Rhizobium* alongwith vermicompost 10 t ha^{-1} produced significantly higher potassium content than all other treatments except *Rhizobium* alongwith vermicompost 10 t ha^{-1}.Application of vermicompost 5 t alongwith *Rhizobium* + 20 kg N ha^{-1} was not significantly different from vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1} and vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} and all these treatment resulted in significantly higher potassium content than other treatments except *Rhizobium* alongwith vermicompost 10 t ha^{-1} and vermicompost 10 t ha^{-1}. 40 kg N ha^{-1} produced significantly higher K content than *Rhizobium* treatment and control (Table 5).

Total potassium uptake by plant (seed + straw)*:* Potassium uptake was recorded with vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} which was significantly higher than *Rhizobium* alongwith vermicompost 5 t ha^{-1}, vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control and remaining treatments were *at par* with vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}. *Rhizobium* alongwith vermicompost 10 t ha^{-1} being *at par* with vermicompost 10 t ha^{-1} resulted in significantly higher potassium uptake 40 kg N ha^{-1} produced significantly higher uptake than *Rhizobium* treatment and control (Table 5).

Pattern of K uptake by fenugreek plant was slow in early stage of crop and increased with taken gradually with the growth and development of crop. Uptake of potassium is mainly positive and therefore with increase in crop growth there has been improvement in potassium uptake by fenugreek. Similar findings have been reported by Khiriya and Singh (2003) and Singh (1991).

Quality analysis(Protein)*:* Application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} being *at par* with vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1} and 40 kg N ha^{-1} resulted in significantly higher protein content than all other treatments (Table 6).*Rhizobium* alongwith vermicompost 10 t ha^{-1} produced significantly higher protein content than *Rhizobium* alongwith vermicompost 10 t ha^{-1}, vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control. Vermicompost 10 t ha^{-1} produced significantly higher protein content than *Rhizobium* alongwith vermicompost 5 t ha^{-1}, vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control. 40 kg N ha^{-1} resulted in significantly higher protein content than all other treatments except vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} and vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1} treatments except vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} and vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1} .Application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}, vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1} and 40 kg N ha^{-1} being *at par* with each other recorded significantly higher protein yield than all other treatments (Table 6). *Rhizobium* alongwith vermicompost 10 t ha^{-1} resulted in significantly higher protein yield than *Rhizobium* treatment and control. Vermicompost 10 t ha^{-1} was *at par* with vermicompost 5 t ha^{-1} and produced significantly higher protein yield than control. 40 kg N ha^{-1} produced significantly higher protein yield than all other treatments except combination of vermicompost, *Rhizobium* and nitrogen.

Nitrogen alone or in combination with organic nutrients increased protein content due to nitrogen. Because nitrogen is a basic constituent of protein and with increase in the rate of nitrogen application, nitrogen availability increased which resulted in increased protein content in seed. The results are in conformity with Nagre(1991).The supplementary application of vermicompost and *Rhizobium* increased nitrogen availability and nitrogen use efficiency thereby increasing protein synthesis. Similar findings were of Jasrotics (1999) and Kumawat(1994). Since the protein yield are mainly the function of seed yield and their respective content in the seed.

Seed yield: Vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}, vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1}, vermicompost 5 t alongwith *Rhizobium* + 20 kg N ha^{-1} and 40 kg N ha^{-1} being *at par* with each other resulted in significantly higher seed yield than other treatments. *Rhizobium* alongwith with vermicompost 10 t ha^{-1} and *Rhizobium* alongwith vermicompost 5 t ha^{-1} being *at par* with each other produced significantly higher seed yield than control. 40 kg N ha^{-1} produced significantly higher seed yield than *Rhizobium* alongwith vermicompost 5 t ha^{-1}, vermicompost 5 t ha^{-1}, vermicompost 10 t ha^{-1}, *Rhizobium* treatment and control. Per cent increase in seed yield of fenugreek with vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}, vermicompost 5 t alongwith with *Rhizobium* + 30 kg N ha^{-1}, vermicompost 5 t alongwith *Rhizobium* + 20 kg N ha^{-1} and 40 kg N ha^{-1} over control was 70.69, 61.02, 43.10 and 55.49, respectively (Table 7).

Straw yield: Application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} resulted in maximum straw yield which was significantly higher than *Rhizobium* treatment and control while other treatments being *at par*.*Rhizobium* alongwith vermicompost 10 t ha^{-1} being *at par* with *Rhizobium* alongwith vermicompost 5 t ha^{-1} resulted in significantly higher straw yield than *Rhizobium* treatment and control. Vermicompost 10 t ha^{-1} being *at par* with vermicompost 5 t ha^{-1} produced significantly higher straw yield than control. 40 kg N ha^{-1} produced significantly higher straw yield than vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control (Table 7).

Total biological yield: Application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}. Vermicompost 5 t alongwith *Rhizobium* + 30 kg N ha^{-1}, vermicompost 5 t alongwith *Rhizobium* + 20 kg N ha^{-1} and 40 kg N ha^{-1} being *at par* with each other resulted in significantly higher total biological yield than other treatments (Table 7).*Rhizobium* alongwith vermicompost 10 t ha^{-1} being *at par* with *Rhizobium* alongwith vermicompost 5 t ha^{-1} produced significantly higher total biological yield than vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control. Vermicompost 10 t ha^{-1} being *at par* with vermicompost 5 t ha^{-1} produced significantly higher total biological yield than *Rhizobium* treatment and control. 40 kg N ha^{-1} produced significantly higher total biological yield than vermicompost 5 t ha^{-1}, *Rhizobium* treatment and control.

Although, all yield attributes are decided by genetic makeup of that particular crop and variety, but the agronomic manipulation also effect them to a great extent. The reproductive growth depends on vegetative growth which increase leaf area and supply photosynthates for the formation of branches and other yield attributes. Therefore, biophysiochemical properties of soil plant system will influence buildup of yield attributes and the seed yield .

In the present study, it was observed that significant increase in seed yield was recorded due to use of integrated nutrients. The highest yield was obtained with application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}. As it has been indicated that yield is a function of yield attributes, it is evident from the Table 9 & 10 that the yield attributes increased with integrated nutrient management. Thus, increase in seed yield was due to increase in these attributes and more so due to significant increase in the number of branches and pods per plant observation on the basic capital of the plant (dry matter) revealed that this also increased with integrated nutrient management which no doubt provided basic source for yield attributes and seed yield is the china of soruce sink relationship. Jat and Ahlawat (2006) reported that the highest number of branches per plant, pods per plant, seeds per pod and seed yield of fenugreek were recorded with vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}. Similar finding have also been reported by Choudhary (1999) and Kumawat (
1997) .For performing necessary physiological function to buildup different yield attributes these nutrients, inorganic and organic which have been integrated in present study on integrated nutrient management were possibly responsible for synthesizing necessary enzymes, proteins, energy (ATP and NADP), chlorophyll and other for the translocation of photosynthates and perhaps only because

of these factors application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} increased the number of yield attributes and seed yield.

The study revealed that Response of integrated nutrient management on nutrient uptake, protein content and seed yield of fenugreek (*Trigonella foenum-graecum* L.) On the basis of experimental results, it is clearly observed nitrogen content and uptake was observed significantly higher with the application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}. The maximum phosphorus content was observed with the application of *Rhizobium* alongwith vermicompost 10 t ha^{-1}. Whereas, uptake of phosphorus was maximum with vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1}.Potassium content (seed and straw) and uptake increased with application of *Rhizobium* alongwith vermicompost 10 t ha^{-1}.Protein content and yield was increase with integrated nutrient management. Application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} resulted in highest protein content (21.75%) and yield (449.57 kg ha^{-1}). Application vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} resulting in highest seed yield has resulted in 70.69 per cent increase over control. The maximum straw yield was recorded with application of vermicompost 5 t alongwith *Rhizobium* + 40 kg N ha^{-1} and 25.01 per cent increase over control. 40 kg N ha^{-1} could be suggested for obtaining higher seed and biological yield from fenugreek. However, considering residual effect of organic manures on succeeding crop as well as soil health, application of fertilizer with vermicompost and *Rhizobium* could be the second best alternative.

Table 3: Effect of integrated nutrient management on N content and total N uptake by plant

No.	**Treatment**	**N content (%)**		**Total N uptake (kg ha^{-1})**
		Seed	**Straw**	
1.	Control	2.41	0.783	95.93
2.	Vermicompost 5 t alongwith Rhizobium + 40 kg N ha^{-1}	3.48	0.918	169.1
3.	Vermicompost 5 t alongwith Rhizobium + 30 kg N ha^{-1}	3.45	0.915	163.28
4.	Vermicompost 5 t alongwith Rhizobium + 20 kg N ha^{-1}	3.34	0.886	150.82
5.	Rhizobium alongwith vermicompost 5 t ha^{-1}	3.07	0.848	132.51
6.	Rhizobium alongwith vermicompost 10 t ha^{-1}	3.20	0.865	136.22
7.	Vermicompost 5 t ha^{-1}	3.02	0.845	124.57
8.	Vermicompost 10 t ha^{-1}	3.17	0.863	136.11
9.	40 kg N ha^{-1}	3.47	0.913	164.17
10.	Rhizobium inoculation	2.81	0.800	108.42
11.	SEM ±	1.21	0.001	3.75
12.	CD at (5%)	0.36	0.004	11.14
13.	CV (%)	6.65	2.293	4.71

Table 4: Effect of integrated nutrient management on P content and total P uptake by plant

Sl.No.	Treatment	P content (%)		Total P uptake (kg ha^{-1})
		Seed	Straw	
1.	Control	0.404	0.102	13.55
2.	Vermicompost 5 t alongwith Rhizobium + 40 kg N ha^{-1}	0.437	0.107	20.42
3.	Vermicompost 5 t alongwith Rhizobium + 30 kg N ha^{-1}	0.436	0.107	19.95
4.	Vermicompost 5 t alongwith Rhizobium + 20 kg N ha^{-1}	0.433	0.106	18.73
5.	Rhizobium alongwith vermicompost 5 t ha^{-1}	0.430	0.108	17.29
6.	Rhizobium alongwith vermicompost 10 t ha^{-1}	0.493	0.119	19.99
7.	Vermicompost 5 t ha^{-1}	0.426	0.107	15.88
8.	Vermicompost 10 t ha^{-1}	0.489	0.118	18.89
9.	40 kg N ha^{-1}	0.422	0.106	18.92
10.	Rhizobium inoculation	0.417	0.105	14.84
11.	SEM ±	0.001	0.001	0.549
12.	CD at (5%)	0.003	0.003	1.633
13.	CV (%)	4.38	3.54	5.33

Table 5: Effect of integrated nutrient management on K content and total K uptake by plant

No.	Treatment	K content (%)		Total K uptake (kg ha^{-1})
		Seed	Straw	
1.	Control	0.659	0.890	83.54
2.	Vermicompost 5 t alongwith Rhizobium + 40 kg N ha^{-1}	0.867	0.923	115.87
3.	Vermicompost 5 t alongwith Rhizobium + 30 kg N ha^{-1}	0.868	0.925	115.29
4.	Vermicompost 5 t alongwith Rhizobium + 20 kg N ha^{-1}	0.866	0.926	112.167
5.	Rhizobium alongwith vermicompost 5 t ha^{-1}	0.871	0.924	106.24
6.	Rhizobium alongwith vermicompost 10 t ha^{-1}	0.918	0.953	112.62
7.	Vermicompost 5 t ha^{-1}	0.873	0.925	99.21
8.	Vermicompost 10 t ha^{-1}	0.915	0.951	109.18
9.	40 kg N ha^{-1}	0.689	0.909	107.56
10.	Rhizobium inoculation	0.661	0.897	88.75
11.	SEM ±	0.001	0.002	3.237
12.	CD at (5%)	0.004	0.005	9.62
13.	CV (%)	3.27	4.34	5.34

Table 6: Effect of integrated nutrient management on protein content (%) and yield (kg ha^{-1})

No.	Treatment	Protein content (%)	Protein yield (kg ha^{-1})
1.	Control	15.08	182.65
2.	Vermicompost 5 t alongwith Rhizobium + 40 kg N ha^{-1}	21.75	449.57
3.	Vermicompost 5 t alongwith Rhizobium + 30 kg N ha^{-1}	21.56	420.42
4.	Vermicompost 5 t alongwith Rhizobium + 20 kg N ha^{-1}	20.88	361.42
5.	Rhizobium alongwith vermicompost 5 t ha^{-1}	19.19	290.15
6.	Rhizobium alongwith vermicompost 10 t ha^{-1}	20.00	313.2
7.	Vermicompost 5 t ha^{-1}	18.87	265.31
8.	Vermicompost 10 t ha^{-1}	19.81	294.38
9.	40 kg N ha^{-1}	21.68	408.23
10.	Rhizobium inoculation	17.56	231.09
11.	SEM ±	0.059	23.85
12.	CD at (5%)	0.20	70.87
13.	CV (%)	6.52	12.81

Table 7: Integrated nutrient management on biological yield, seed yield and straw yield (q ha^{-1})

Sl.No.	Treatment	Biological yield (q ha^{-1})	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})
1.	Control	96.98	12.11	84.88
2.	Vermicompost 5 t alongwith Rhizobium + 40 kg N ha^{-1}	126.77	20.67	106.13
3.	Vermicompost 5 t alongwith Rhizobium + 30 kg N ha^{-1}	125.63	19.50	106.11
4.	Vermicompost 5 t alongwith Rhizobium + 20 kg N ha^{-1}	122.33	17.33	105.00
5.	Rhizobium alongwith vermicompost 5 t ha^{-1}	115.77	15.12	100.66
6.	Rhizobium alongwith vermicompost 10 t ha^{-1}	118.70	15.66	103.04
7.	Vermicompost 5 t ha^{-1}	106.27	14.05	92.23
8.	Vermicompost 10 t ha^{-1}	115.38	14.86	100.51
9.	40 kg N ha^{-1}	123.01	18.83	104.18
10.	Rhizobium inoculation	102.50	13.16	89.34
11.	SEM ±	3.54	1.17	3.82
12.	CD at (5%)	10.53	3.47	11.36
13.	CV (%)	5.32	12.56	6.68

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