Quality, Yield and Nutrient Uptake of Fenugreek as influenced by Integrated Nutrient Management

ABSTRACT

Organic Agriculture sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. The experiment was carried out at Agriculture experimental field, Nehru PG collage Lalitpur (U.P.) during 2014-15. Lalitpur district is a part of Bundelkhand plateau. Betwa River is the boundary between Jhansi and Lalitpur in the north. Most of the area is under the average elevation of 300m to 450m from the sea level, whereas some portion in south has an elevation above 450m. Its latitudinal extension is from $24^0$10'N to $25^0$15'N and longitudinal extension is from $78^0$10'E to $790^0$0'E.The experimental comprising four levels of Vermicompost, Farm Yard Manure and *Rhizobium* was conducted in the factorial randomized block design with 12 treatment combinations and three replications in 30 pots. Application of integrated nutrient management increased the seed & straw yield (q/ha) as compared to control. Seed and straw yield (kg/ha) of fenugreek crop was found, the maximum 300gm/pot of vermicompost (14.33 q/ha) and (92.67 q/ha) followed by FYM and Rhizobium. The Application of vermicompost (300gm/pot) resulted in significantly higher nitrogen phosphorus and potassium uptake than FYM, Rhizobium treatment and control.

Keywords: INM, Yield, Nutrient uptake, quality.

Introduction

Fenugreek (*Trigonella foenumgraecum* L.) locally known as Methi, is belongs to sub family papilionaceae of family leguminosae. Methi crop grow in Northern Indian states like Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Haryana, Maharashtra, Punjab etc. during winter season crop. Its seeds are a good source of protein, vitamins, alkaloid *trigonellin*, and essential oil and has immense medicinal value. The plant is aromatic herbaceous, annual herbs and a self pollinated one. The plants are weak spreading and moderately branched attaining a height of 15 to 45 cm. This data is 90 days after sowing. Each pods contains 10 -20 seeds. Over part of this plant is utilized as leafy vegetables, fodder and condiments.

Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them. Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities. Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment. The crop production continuous use of inorganic fertilizers leads to deterioration in soil chemical, physical, and biological properties & soil health. The negative impacts of chemical fertilizers, coupled with escalating prices, have led to growing interests in the use of organic

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fertilizers. Organic materials such as vermicompost, FYM and *Rhizobium* have supplies all major nutrients (N, P, K, Ca, Mg, S) necessary for plant growth, as well as a mixed fertilizer.

Moreover, their findings showed that optimum yield enhancement is achieved when the correct species of earthworms are inoculated. Vermicompost significantly stimulate the growth of a wide range of plant species including several horticultural crops such as tomato, pepper, garlic, aubergine, strawberry, sweet corn and green gram. This crop is used in 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 cannot sustain productivity of land under modern farming similarly, nutrient supply through organic manures of biofertilizers can hardly. Nutrient enrichment of soils by nitrogen fixing symbiotic bacteria present in legumes has been known for centuries. Scientific demonstration of this symbiosis was started in 19th century and it established the facts that bacteria present in nodules on legume roots are responsible for fixing atmospheric nitrogen. *Rhizobium* are well known group of bacteria that acts as the primary symbiotic fixer of Nitrogen. Fenugreek like other legumes is a good source of dietary protein for consumption by man and animals. From ancient times Greeks (and the Romans) used it as medicine, spice and cattle fodder and still known as Greek hay. *Rhizobium* present in it's root nodules, effect was not mate to stud the indigenous Rhizobia present in nodules of this plant. In the present study we have isolated a strain of Rhizobium from the root nodule. *Rhizobium* inoculation an N fertilization with nitrogen and molybdenum on the composition and quality of fenugreek seed.

The complex process by which the rhizobia produce nitrogen for the legume is called biological nitrogen fixation, or BNF. Only rhizobia that are specifically compatible with a particular species of legume can stimulate the formation of root nodules, a process called nodulation. This process has great economic benefit for legume production. As a result, rhizobial inoculants are produced commercially in many countries. Inoculants contain rhizobia isolated from plant nodules and grown (cultured) artificially in the laboratory. On the basis of above observation present research work to study the effect of integrated nutrient management on yield character of plant and study their effect on quality in Fenugreek.

Methods and Material;-

The performance of Vermicompost, Farm Yard Manure (FYM) and Rhizobium treatment were tested the pot experiment using Winter Season Fenugreek (Methi). The experimental comprising four levels of Vermicompost, Farm Yard Manure and *Rhizobium*, was conducted in the factorial randomized block design with three replications in 30 pots. The experiment was laid out in randomized block design. There were in all 12 treatment combinations and three replications. The allocation of the treatments in to the pots was done randomly in each replication.

The details are as below treatments: -

1. Control

2. Levels of Vermicompost - 4 (0, 100, 200, 300 gm)
3. Levels of FYM - 4 (0, 100, 200, 300 gm)
4. Levels of Rhizobium - 4 (0, 10, 20, 30 kg/ha)

Soil Properties & Characteristics-

The experiment was conducted on Black soil. Black soil is heavy soil and is distributed in upland and low lying areas of Lalitpur. It is clear from data the experiment field of Black soil was deficient in plant nutrients. Result of Physico-chemical analysis indicated that the soil was normal having no salinity, sodicity and alkalinity hazards (Table-1).

Table-1: Important characteristics of initial soil

Soil Characteristics		Black soil
A.	**Mechanical separates:**	
	Coarse sand (%)	10.00
	Fine sand (%)	20.00
	Silt (%)	30.00
	Clay (%)	40.00
B.	**Physico-chemical analysis**	
	pH (1:2.5)	7.35
	EC (1:2.5) ds m^{-1}	0.36
	Pore space	39.30 %
C.	**Available Nutrients and others**	
	Organic carbon (%)	0.52
	Available Nitrogen (Kg ha^{-1})	135.52
	Available Phosphorus (Kg ha^{-1})	8.97
	Available Potassium (Kg ha^{-1})	253.04

Plant analysis

The plant N content was determined by sulphuric acid digestion method, plant P and K content was determined by di acid digestion method. The total plant N, P and K content was determined by multiplying the nutrient content with dry matter yield.

i. Nitrogen Uptake (kg/ha)

$$= \frac{\text{N content in seed (\%)X seed yield}\left(\frac{\text{kg}}{\text{ha}}\right)\text{+N content in straw (\%)X straw yield}\left(\frac{\text{kg}}{\text{ha}}\right)}{100}$$

ii. Phosphorus Uptake (kg/ha)

$$= \frac{\text{P content in seed (\%)X seed yield} \left(\frac{kg}{ha}\right) + \text{P content in straw (\%)X straw yield} \left(\frac{kg}{ha}\right)}{100}$$

iii. Potassium Uptake (kg/ha)

$$= \frac{\text{Kcontent in seed (\%)X seed yield} \left(\frac{kg}{ha}\right) + \text{K content in straw (\%)X straw yield} \left(\frac{kg}{ha}\right)}{100}$$

Quality characteristics of seed Protein- The protein content in seed was obtained by following formula mentioned below-

Protein percentage = N x 6.25

Protein yield was calculated by using the following formula:

$$\text{Protein yield (kg/ha)} = \frac{\text{Protein content (\%)XSeed yield} \left(\frac{kg}{ha}\right)}{100}$$

Statistical analysis: -

The data obtained from various observations of crop growth and yield were subjected to statistical analysis using with the help of IRRISTAT for Windows version 4.0.2.0.

Result and Discussion

Yield

The data regarding of Seed and Straw Yield (q/ha) at vermicompost, FYM and Rhizobium were analyzed statistically and the results have been presented in table 2. Application of integrated nutrient management increased the seed yield (q/ha) as compared to control. Seed yield levels of 14.25, 14.27 and 14.33 in all levels of vermicompost followed by FYM (14.27, 14.25 and 14.27) and *Rhizobium* (13.07, 13.08 and 13.12) as compared to control (11.97, 11.92 and 11.95) during experimental year (Jat & Shaktawat 2001; Jat *et al*. 2006; Dotaniya 2015 and Dotaniya et al., 2017, 2018)

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Table 2: Effect of Integrated Nutrient Management on Seed Yield and Straw Yield.

Treatment	Seed Yield (q/ha)	Straw Yield (q/ha)
Vermicompost (0 gm)	11.97	84.05

Vermicompost (100gm)	14.25	92.43
Vermicompost (200gm)	14.27	92.57
Vermicompost (300gm	14.33	92.67
SE ±	0.04	0.06
CD at (5%)	0.14	0.20
FYM (0 gm)	11.92	84.10
FYM (100gm)	14.27	92.46
FYM (200gm)	14.25	92.50
FYM (300gm)	14.27	92.53
SE ±	0.04	0.02
CD at (5%)	0.14	0.081
Rhizobium (0 gm)	11.95	84.08
Rhizobium (10gm)	13.07	89.00
Rhizobium (20gm)	13.08	89.02
Rhizobium (30gm)	13.12	89.13
SE ±	0.03	0.11
CD at (5%)	0.98	0.38

Effects of integrated nutrient management have been found significant effect over to control. Seed yield (kg/ha) of fenugreek crop was found, the maximum 300gm/pot of vermicompost (14.33 q/ha) followed by FYM and Rhizobium. Effect of integrated nutrient management increased the straw yield (q/ha) as compared to control. Effects of integrated nutrient management have been found significant effect over to control. Straw yield (kg/ha) of fenugreek crop was found the maximum 300gm/pot of vermicompost (92.67 q/ha) followed by FYM and Rhizobium. The higher yield in integrated nutrient amended soil in compare to control was due to better soil properties, enhanced nutrient availability and batter uptake of nutrients. The straw yield also showed that the vegetative growth was high in integrated nutrient treatment when compared to control (Dubey *et al.* 2012; Dotaniya 2015 and Dotaniya et al., 2017, 2018; Naimuddin *et al.* 2014).

Nutrient Uptake

Total nitrogen uptake

Maximum nitrogen uptake was recorded with vermicompost (300g/pot) which recorded significantly higher nitrogen uptake (Table 3) than all other treatments of vermicompost and control. Application of FYM treatment was being at par with each other. FYM (300g/pot) was resulted in maximum total nitrogen uptake which was significantly higher than control. Application of *Rhizobium* was *at par* with each other and resulted in significantly higher nitrogen uptake than control (Dotaniya et al., 2017, 2018)

Total phosphorus uptake

Application of vermicompost (300g/pot) being *at par* with vermicompost (200g/pot) resulted in maximum total phosphorus uptake which was significantly higher than all other treatments. Application of FYM treatment (300g/pot) was resulted in significantly higher total phosphorus uptake than other treatments and control. Application of *Rhizobium* (30g/pot) being *at par* with *Rhizobium* (20g/pot) resulted in maximum total phosphorus uptake which was significantly higher than all other treatments and control (Table 3). It is expected that with the application of integrated nutrients 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 (Dotaniya 2015 and Dotaniya et al., 2017, 2018).

Total potassium uptake

Potassium uptake was recorded with vermicompost (300g/pot) which was significantly higher than vermicompost (200g/pot) and vermicompost (100g/pot) treatment and control. Application of FYM treatment (300g/pot) was resulted in significantly higher total potassium uptake than other treatments and control. *Rhizobium also* being resulted in significantly higher potassium uptake (30g/pot) produced significantly higher uptake than other *Rhizobium treatment* and control (Table 3). 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 (Dubey *et al*. 2012). 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 addition of vermicompost @ 300g/pot increased the nutrient content and uptake.

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Table 3: Effect of Integrated Nutrient Management on N, P and K Uptake by Crop.

Treatment	Total N uptake (kg/ha)	Total P uptake (kg/ha)	Total K uptake (kg/ha)
Vermicompost (0 gm)	93.28	10.50	81.74
Vermicompost (100gm)	120.16	15.61	97.70

Vermicompost (200gm)	123.86	15.82	98.04
Vermicompost (300gm	125.29	16.00	99.41
SE ±	0.66	0.09	0.26
CD at (5%)	2.29	0.315	0.9
FYM (0 gm)	92.56	10.31	81.15
FYM (100gm)	117.19	15.50	96.62
FYM (200gm)	118.17	15.65	96.94
FYM (300gm	119.89	15.88	98.42
SE ±	0.57	0.06	0.40
CD at (5%)	1.97	0.21	1.39
Rhizobium (0 gm)	92.51	10.54	80.12
Rhizobium (10gm)	106.83	14.55	88.68
Rhizobium (20gm)	107.59	14.67	89.52
Rhizobium (30gm	108.59	14.79	90.71
SE ±	0.86	0.07	0.21
CD at (5%)	2.96	0.226	0.74

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This might be due to (i) increased supply of all essential nutrient directly through organic to crop, (ii) indirectly through checking the losses of nutrient from soil solution and (iii) by increasing in the nutrient use efficiency. The *Rhizobium* inoculation increased the N and P content in seed 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 (Dotaniya et al., 2017, 2018; Kumar *et al*. 2007; Kumawat *et al*. 2013).

Quality analysis

The data regarding of Protein content (%) and Protein yield (kg/ha) at vermicompost, FYM and Rhizobium were analyzed statistically and the results have been presented in table 4. FYM produced significantly higher protein content than other treatments of FYM and control. *Rhizobium* 30g/pot produced significantly higher protein content and yield than other *Rhizobium* treatment and control. The supplementary application of vermicompost, FYM and *Rhizobium* increased nitrogen availability and nitrogen use efficiency thereby increasing protein synthesis (Kumawat *et al*. 2013 and Dotaniya 2015; Dubey *et al*. 2012). Since the protein yield are mainly the function of seed yield and their respective content in the seed.

Table 4: Effect of Integrated Nutrient Management on Protein content (%) and

Protein Yield (kg/ha).

Treatment	Protein Content (%)	Protein Yield (Kg/ha)
Vermicompost (0 gm)	14.92	178.50
Vermicompost (100gm)	18.65	265.73
Vermicompost (200gm)	19.25	274.64
Vermicompost (300gm	19.48	279.20
SE ±	0.19	2.88
CD at (5%)	0.66	9.97
FYM (0 gm)	14.73	175.52
FYM (100gm)	18.13	258.58
FYM (200gm)	18.29	260.65
FYM (300gm	18.88	269.28
SE ±	0.19	2.45
CD at (5%)	0.66	8.50
Rhizobium (0 gm)	14.81	177.01
Rhizobium (10gm)	17.19	224.57
Rhizobium (20gm)	17.38	227.33
Rhizobium (30gm	17.63	231.18
SE ±	0.19	2.45
CD at (5%)	0.64	8.48

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