

EFFECT OF VERMICOMPOST AND SULPHUR ON GROWTH, YIELD AND NUTRIENT UPTAKE OF FENUGREEK (*TRIGONELLA FOENUM- GRAECUM L.*)

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ABSTRACT

A field experiment was conducted during *Rabi* season of 2011-2012 at Jobner (Rajasthan) to study the effect of vermicompost and sulphur on growth, yield and nutrient uptake of fenugreek. The experiment consisting of sixteen treatment combinations with four levels of vermicompost (0, 2, 4, and 6 t ha⁻¹) and four levels of sulphur (0, 20, 40, and 60 kg ha⁻¹) was laid in randomized block design with three replications. Application of vermicompost up to 4 t ha⁻¹ significantly increased plant height (34.05, 50.2 and 58.9 cm), branches/plant (3.69, 5.73 and 8.06) at 60, 90 DAS and at harvest, total (26.22) and effective root nodules (14.95), leghaemoglobin content in root nodules (1.94 mg g⁻¹), seed (15.26 q ha⁻¹) and straw yields (39.02 q ha⁻¹), net returns (34235 Rs ha⁻¹) total uptake of N (4.49 kg ha⁻¹), P (0.699 kg ha⁻¹), K (3.29 kg ha⁻¹) and S (0.494 kg ha⁻¹) over lower levels. However, available nitrogen (140.71 kg ha⁻¹) status of soil after crop harvest was significantly increased with vermicompost up to 6 t ha⁻¹ vermicompost 4 t ha⁻¹ increased seed yield by 25.00 and 9.45 percent and net returns by 12.60 and 3.95 percent over control and 2 t ha⁻¹ vermicompost, respectively. Results further indicated that application of sulphur up to 40 kg ha⁻¹ resulted in significantly higher plant height (34.06, 50.2 and 59.0 cm) and branches/plant (3.53, 5.67 and 8.00) at 60, 90 DAS and at harvest, total (27.06) and effective root nodules (15.00), leghaemoglobin content in root nodules (1.91 mg g⁻¹), seed (15.05 q ha⁻¹) and straw yields (38.80 q ha⁻¹), net returns (35311 Rs ha⁻¹), total uptake of N (4.48 kg ha⁻¹), P (.683 kg ha⁻¹), K (3.29 kg ha⁻¹) and S (0.497 Kg ha⁻¹) and available Nitrogen (140.97 kg ha⁻¹) content in soil after crop harvest over lower levels of sulphur application. The application of 40 kg ha⁻¹ sulphur increased seed yield by 29.10 and 11.55 percent and net returns by 36.55 and 12.40 percent, respectively, over control and 60 kg S ha⁻¹.

INTRODUCTION

Fenugreek is considered as spice as well as legume crop and is an important vegetable and condiment crop grown in Northern India during *Rabi* season for leaves, shoot and seed. India, rightly known as land of spices is the largest producer, consumer and exporter of spices in the world. Its fresh tender leaves are also taken as vegetable which are rich in iron, calcium, vitamins and essential amino acids, like lysine, leucine and phenylalanine. The seeds are used in treatment of flatulence, dysentery, diarrhoea, dyspepsia, chronic cough, dropsy, enlargement of liver and spleen, rickets, gout, diabetes and arthritis. Diosgenin, the main sapogenin, is an estrogen precursor, and may help in managing menopause. Its concentration varies from 0.86 to 2.2% in seeds (Sanvaire and Baccon, 1976). The seed is bitter in taste due to presence of alkaloid known as "Trigonelline" which is considered as basic material for the synthesis of cellulose, hemicellulose and amino acids. The seeds contain protein (27.7 - 38.6 per cent), alkaloid trigonellin (0.12 - 0.38 per cent), choline (<0.02 per cent), fatty oil (6.8 per cent) and vitamins. Unlike other legumes, fenugreek is fairly tolerant to salinity (Habib *et al.*, 1971). Vermicompost has been advocated as good organic manure for use in the field crops. Use of vermicompost as a organic fertilizer and substitute for chemical fertilizer is advised by pioneers of organic farming. Earthworm processed organic

waste often referred to as vermicompost are finely divided peat like material with high porosity, aeration, drain ability and water holding capacity. Vermicompost contains nutrients in the readily available form to the plants such as nitrate, exchangeable P, K, Ca and Mg (Edwards and Burrows, 1988). It also contains biologically active substance such as plant growth regulators (Tomatic *et al.*, 1987). The application of vermicompost not only add plant nutrients and growth regulators to the soil but also add to physical, chemical and biological properties of the soil. Its other effects are reduced soil erosion, deodorification of obnoxious smell, destruction of pathogens and detoxification of soil pollutant. Sulphur is also one of the important essential plant nutrients and reported to be deficient in soils of Rajasthan. It helps in chlorophyll formation and also a constituent of amino acids like cystine, cysteine and methionine. Sulphur is also responsible for synthesis of certain vitamins (biotin and thiamine), proteins, fats and metabolism of carbohydrates. It has also been reported to promote nodulation in legumes resulting in to higher production (Tondon, 1991). The present study was, for such motives, undertaken with the objective to find out and determine the effect of vermicompost and sulphur on growth attributes, root nodules, leghaemoglobin content, seeds and straw yields, net returns and nutrient uptake of fenugreek.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Farm, S. K. N. College of Agriculture, Jobner, Rajasthan during *Rabi* season of 2011-2012. The soil was loamy sand in texture, alkaline in reaction (pH 8.4), high in electrical conductivity (5.8 dSm⁻¹), low in organic carbon (0.16%), available nitrogen (115.10 kg ha⁻¹), available phosphorus (13.25 kg ha⁻¹) and medium in available potassium (142.18 kg ha⁻¹). The experiment was laid out in randomized block design with three replications. There were sixteen treatment combinations consisting of four levels of vermicompost (0, 2, 4 and 6 t ha⁻¹) and four levels of sulphur (0, 20, 40 and 60 kg ha⁻¹). The vermicompost with mean composition of N 1.67, P₂O₅ 2.07, K₂O 0.89% and elemental sulphur were applied one week before sowing and incorporated in soil as per treatments. An acid extract of seed and stover samples was used for the determination of N, P, K, S and leghaemoglobin as per the method given by (Snell and Snell 1949) (Jackson 1973) (Tabatabai and Bremmer, 1970) and (Appleby *et al.*, 1986) and (Bergersen 1982). The nutrient content was expressed as per cent and its uptake in kg ha⁻¹ was calculated by using the standard formula. The fenugreek variety RMT-1 was sown on 17 November, 2011 with 20 kg ha⁻¹ seed in 30 cm widely spaced rows and harvested on April 06, 2012. Other agronomic practices were followed as per standard recommendation.

RESULTS AND DISCUSSION

Vermicompost

The application of vermicompost significantly increased the growth attributes, root nodules, leghaemoglobin content in root nodules, yields and nutrient uptake of fenugreek (Table 1 and 2). Vermicompost @ 4 t ha⁻¹ significantly increased plant height (34.05, 50.2 and 58.9 cm) and number of branches/plant (3.69, 5.73 and 8.06) at 60, 90 DAS and at harvest over 0 and 2 t ha⁻¹ vermicompost and reminded at par with vermicompost 6 t ha⁻¹. The improved growth might be due to better soil physical condition, prolonged availability of macro and micro nutrients to crop during entire growing season. The beneficial effect of vermicompost on these parameters might be due to its contribution in supplying additional plant nutrients and increasing availability of native soil nutrients with increased microbial activity. These results are in close agreement with that of (Khiriya *et al.*, 2001) and (Jat *et al.*, 2006).

Application of vermicompost 4 t ha⁻¹ being at par with 6 t ha⁻¹, significantly increased the number of effective root nodules (14.95) and leghaemoglobin content in root nodules (1.94 mg g⁻¹) as compared to 0 and 2 t ha⁻¹ vermicompost. However number of total root nodules significantly increased with vermicompost 4 t ha⁻¹ over control. The application of vermicompost might have enhanced the population of desired microbes in the root zone during the early stage of infection. Higher population of the desired organisms will always have greater possibilities of infection and consequently formation of more healthy and effective root nodules having higher amount of leghaemoglobin. (Sharma and Bhandari, 2002) also reported similar results of increased root nodules and

leghaemoglobin content with application of vermicompost.

Increasing application of vermicompost up to 4 t ha⁻¹ significantly increased seed and straw yields to the tune of 29.10 and 24.03 percent over control and 15.73 and 15.09 per cent over 2 t ha⁻¹, respectively (Table 2). However further increases in vermicompost at 6 t ha⁻¹ could not bring significant improvement over 4 t ha⁻¹. The significant increase in seed (15.26 q ha⁻¹) and straw yields (39.02 q ha⁻¹) under the influence of vermicompost was largely a function of improved growth and yield attributes. These findings are in close conformity with those of (Thanunathan *et al.*, 2002). The positive response of vermicompost may probably be due to enhanced supply of macro as well as micro nutrients which led to high assimilation of food and its subsequent partitioning in sink. It improved yield components due to vegetative and reproductive growth led to higher seed yield. (Chaturvedi and Chandel, 2005) and (Suman *et al.*, 2007). which consequently increased seed and straw yields. The net returns were also significantly increased with 4 t ha⁻¹ vermicompost over 0 and 2 t ha⁻¹ which was higher by 12.60 and 8.32 per cent, respectively.

Further results indicated that vermicompost 4 t ha⁻¹ significantly increased the total uptake of N (4.49 kg ha⁻¹), P (0.699 kg ha⁻¹), K (3.29 kg ha⁻¹) and S (0.494 kg ha⁻¹) of fenugreek compared to control and 2 t ha⁻¹ vermicompost but remained at par with vermicompost 6 t ha⁻¹. The increased uptake of N, P, K and S seems to be due to the fact that uptake of nutrients is a product of biomass and nutrient content. The results obtained in the present investigation are in close conformity with those of (Pandya and Singh, 1998). Similar results were also found in available nitrogen content of soil after harvest of crop (Table 2). It may be ascribed to the beneficial role of vermicompost in mineralization of native as well as its own nutrient content by creating favorable conditions for microbial as well as chemical activities which enhanced the available nutrient pool of the soil. These results are in close conformity with those of (Nethra *et al.*, 1999).

Sulphur

The increasing levels of sulphur significantly influenced the growth attributes, root nodules, leghaemoglobin content in root nodules, yields and nutrient uptake of fenugreek (Tables 1 and 2). Progressive increase in sulphur levels at 40 kg ha⁻¹ recorded significantly higher plant height (34.06, 50.2 and 59.0 cm) and branches/plant (3.53, 5.67 and 8.00) at 60, 90 DAS and at harvest over control and 20 kg ha⁻¹ but remained at par with 60 kg ha⁻¹. The increase in these yield attributing characters might be due to the important role of sulphur in energy transformation, activation of number of enzymes and also in carbohydrate metabolism. Supply of sulphur in adequate and appropriate amount helps in flower primordial initiation for its reproductive part, The favorable influence of applied sulphur on these growth parameters may be ascribed to catalytic or stimulatory effect of sulphur on most of the physiological and metabolic processes of the plant at successive growth stages due to adequate availability, mobilization and influx into the plant tissue owing to increased sulphur application. Sulphur also plays an important role in lowering the soil pH where most of the nutrients in soil remains in range of availability. Thus the addition of sulphur improved the

Table 1: Growth parameters, root nodules and leghaemoglobin content in root nodules of fenugreek under different levels of vermicompost and sulphur

Treatment	Plant height (cm)			Number of branches/plant			Number of total root nodules	Number of effective root nodules	Leghaemoglobin content in root nodules (mg/g)
	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest			
Vermicompost (t ha ⁻¹)									
0	28.3	45.2	53.1	2.35	4.75	6.43	18.86	9.89	1.07
2	31.5	47.9	56.2	3.15	5.40	7.44	25.49	12.66	1.69
4	34.5	50.2	58.9	3.69	5.73	8.06	26.22	14.95	1.94
6	36.6	52.1	59.7	3.77	5.81	8.21	27.48	15.87	2.00
SEm ±	0.9	0.7	0.9	0.05	0.09	0.16	0.47	0.33	0.06
CD (p = 0.05)	2.6	2.1	2.7	0.14	0.26	0.45	1.35	0.96	0.18
Sulphur (kg ha ⁻¹)									
0	28.7	45.1	53.2	2.68	4.93	6.53	19.34	9.79	1.13
20	31.7	47.8	56.1	3.21	5.36	7.49	24.16	12.76	1.62
40	34.6	50.2	59.0	3.53	5.67	8.00	27.06	15.00	1.91
60	36.0	52.1	59.5	3.55	5.74	8.13	27.49	15.82	2.04
SEm ±	0.9	0.7	0.9	0.05	0.09	0.16	0.47	0.33	0.06
CD (p = 0.05)	2.6	2.1	2.7	0.14	0.26	0.45	1.35	0.96	0.18

Table 2: Seed and straw yields, net returns, total nutrient uptake and available nitrogen in soil after harvest of fenugreek under different levels of vermicompost and sulphur

Treatment	Seed yield (q/ha)	Straw yield (q/ha)	Net returns (Rs/ha)	Total nutrient uptake (kg ha ⁻¹)				Available nitrogen (kg ha ⁻¹)
				N	P	K	S	
Vermicompost (t ha ⁻¹)								
0	11.82	31.46	30403	3.79	0.569	2.53	0.442	121.27
2	13.68	36.21	32933	4.20	0.646	2.99	0.474	130.52
4	15.26	39.02	34235	4.49	0.699	3.29	0.494	140.71
6	15.54	40.04	31279	4.60	0.725	3.46	0.500	149.15
SEm ±	0.40	0.78	375	0.07	0.011	0.06	0.004	2.83
CD (p = 0.05)	1.15	2.26	1083	0.20	0.030	0.19	0.011	8.16
Sulphur (kg ha ⁻¹)								
0	12.04	31.69	25859	3.85	0.602	2.73	0.439	121.36
20	13.75	36.32	31415	4.22	0.644	2.99	0.474	130.90
40	15.05	38.80	35311	4.48	0.683	3.29	0.497	140.97
60	15.46	39.92	36265	4.53	0.710	3.28	0.500	148.42
SEm ±	0.40	0.78	375	0.07	0.011	0.06	0.004	2.83
CD (p = 0.05)	1.15	2.26	1083	0.20	0.030	0.19	0.011	8.16

overall availability of nutrient of soil for better growth and development of plant. Similar findings were also reported by (Patel *et al.*, 2013) and (Kumawat *et al.*, 2009).

The number of total (27.06) and effective root nodules (15.00), leghaemoglobin content in root nodules (1.91 mg g⁻¹) of fenugreek were significantly increased with the application of sulphur up to 40 kg ha⁻¹. Since sulphur is needed for synthesis of protein, thiamine, biotin, co-enzyme A, ferredoxin and chlorophyll which involve in different metabolic and enzymatic activities, all these activities are likely to be increased under adequate supply of sulphur to plant, consequently, it also creates needs of higher quantity of nitrogen which ultimately results in development of more root nodule along with leghaemoglobin content to fulfill increased nitrogen requirement of plant by fixing more atmospheric nitrogen in root nodules. (Sharma and Mishra, 1993) also noted similar results.

Increasing application of sulphur up to 40 kg ha⁻¹ significantly increased seed and straw yield to the tune of 25.00 and 22.43 percent over control and 14.20 and 14.61 per cent over 20 kg ha⁻¹, respectively. Sulphur in adequate amount helps in flower primordial initiation for its reproductive parts, which in turn governs the number of pods per plant and number of

seeds per pod. Thus, the increase in these growth and yield attributes due to sulphur application might have increased the seed (15.05 q ha⁻¹) and straw yields (38.80 q ha⁻¹) of fenugreek. These results are in close conformity with those of (Rajkhowa *et al.*, 2003).

The application of Sulphur 40 kg ha⁻¹ significantly increased the total uptake of N, P, K and S in seeds and straw compared to 0 and 20 kg ha⁻¹ Sulphur and comparable with 60 kg ha⁻¹ Sulphur. The significant increase in N (4.48 kg ha⁻¹), P (0.683 kg ha⁻¹), K (3.29 kg ha⁻¹) and S (0.497 kg ha⁻¹) uptake was due to the fact that increase in biomass is a major factor in increasing the uptake of nutrients, therefore, increase in the seed and straw yield of fenugreek was associated with increase in uptake of these nutrients in seed and straw of fenugreek. This can again be supported by synergistic uptake mechanism of N, P, K and S and their assimilation which is manifested in the form of increase in yield along with higher nutritional demand for plant growth. These results are in close conformity with findings of (Kumawat *et al.*, 2009) and (Tuncturk *et al.*, 2011). Similar results were found in available nitrogen content of soil after harvest of crop. Their significant increase may be ascribed to the beneficial role of sulphur due to its effect of lowering down the soil pH and bringing it down to near neutrality where

availability of nitrogen increases in soil. (Khandkar *et al.*, 1985) also noted similar results.

From the present study it was concluded that significantly higher growth attributes, root nodules, leghaemoglobin content, seeds and straw yields, net returns and nutrient uptake of fenugreek could be obtained with application of 4 t ha⁻¹ vermicompost and 40 kg S ha⁻¹.

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