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EFFICACY OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND YIELD PARAMETERS OF FENUGREEK

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ABSTRACT

Present investigation was undertaken to study the efficiency of FYM and biofertilizers on growth and yield attributes of fenugreek cv. Rajendra Kanti. For this, a field experiment was carried out in Randomized Block Design with three replications. The experiment was conducted at the Horticulture Research Block of Shri Guru Ram Rai School of Agricultural Sciences, during *rabi* season of 2017-18 on sandy loam soil at Dehradun. For the experiment, ten treatment combinations are taken viz. T_1-Control, T_2 – NPK @ 40-40-20 kg ha^{-1}, T_3–FYM @ 5 t ha^{-1}, T_4-FYM @ 5 t ha^{-1} + *Rhizobium*, T_5 -FYM @ 5 t ha^{-1} + PSB, T_6 –FYM @ 5 t ha^{-1} + KSB, T_7 -FYM @ 5 t ha^{-1} + *Rhizobium* + PSB, T_8 –FYM @ 5 t ha^{-1} + *Rhizobium* + KSB, T_9 -FYM @ 5 t ha^{-1} + PSB + KSB and T_{10} -FYM @ 5 t ha^{-1} + *Rhizobium* + PSB + KSB. The results revealed that significantly greater values of growth parameters *viz.*, plant height, number of branches, number and dry weight of root nodules, dry matter production, crop growth rate as well as yield attributes *viz*., number of pods plant^{-1}, length of pods, number of seeds pod^{-1}, seed yield and straw yield were recorded in the treatment T_{10} (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB + KSB) which is being at par with treatments T_2 (NPK @ 40-40-20 kg ha^{-1}), T_7 (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB), T_8 (FYM @ 5 t ha^{-1} + *Rhizobium* + KSB and T_9 (FYM @ 5 t ha^{-1} + PSB + KSB).

(Key words: FYM, Biofertilizers, *Rhizobium*, PSB, KSB, fenugreek, root nodules)

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) commonly known as methi is an annual legume crop which belongs to family Leguminaceae and sub-family papillionaceae. Fenugreek is one of the important spice crops of India which is one of the major producer as well as exporter of fenugreek. In India fenugreek occupied an area of about 2,11,110 hectares producing 2,99,870 tonnes of seeds (Anonymous, 2017) . In India, it is widely grown in states of Rajasthan, Gujarat, Tamil Nadu, Utter Pradesh, Himachal Pradesh, Madhya Pradesh and Andhra Pradesh. Gujarat contributes about 20 per cent in total production of fenugreek in India. Chemical analysis of fenugreek seed revealed that it contains 13.7 per cent water, 26.2 per cent protein, 5.8 per cent fat, 3.0 per cent mineral matter, 7.2 per cent fibers, 4.41 per cent carbohydrates, 0.16 per cent calcium, 0.37 per cent phosphrous, 14.1 mg iron, 333 calories and 160 IU carotene 100^{-1} g. (Agrawal *et al.,* 2001 and Kala and Nagajoyti, 2019). The maximum diosgenin 2.03 per cent was found in cotyledons of germinated seeds of fenugreek (Bhavsar *et al.,* 1980). Organic materials such as FYM have traditionally been used by farmers in their field. FYM supplies all macro nutrients such as N, P, K, Ca, Mg and S, as well as micronutrients like Fe, Mn, Cu and Zn which are necessary for plant growth. Hence, it acts as a mixed organic fertilizer.

FYM improves soil physical, chemical and biological properties. Biofertilizers helps to keep the soil environment rich in all kinds of macro and micro-nutrients *via* nitrogen fixation, phosphate and potassium solubilization or mineralization, release of plant growth regulating substances, production of antibiotics and biodegradation of organic matter in the soil providing better nutrient uptake and increased tolerance towards drought and moisture stress. Being a highly important spice crop, there was an essential need for standardization of biofertilizer packages consisting locally available organic sources integrated with chemical fertilizers. Keeping this in regard, the present experiment was carried out with the objectives to study the efficacy of organic manure and biofertilizers on different yield parameters of fenugreek.

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MATERIALS AND METHODS

The present experiment was carried out in D-4 plot of Horticulture Research Block of School of Agricultural Sciences, SGRRU, Dehradun, Uttarakhand (29°58' N, 77°34' E) during *rabi* season of 2017-18. The soil of the experimental plot was sandy loam in texture and slightly acidic in reaction with pH 6.8 and EC 0.55 dSm^{-1}. The soil was low in available nitrogen (283 kg ha^{-1}), high in available phosphorus (69 kg ha^{-1}) and medium in available potash (233 kg ha^{-1}). Ten treatments comprising of T_1-Control, T_2 – NPK @ 40-40-20 kg ha^{-1}, T_3 –FYM @ 5 t ha^{-1}, T_4-FYM @ 5 t ha^{-1} + *Rhizobium*, T_5 -FYM @ 5 t ha^{-1} + PSB, T_6 –FYM @ 5 t ha^{-1} + KSB, T_7 -FYM @ 5 t ha^{-1} + *Rhizobium* + PSB, T_8 –FYM @ 5 t ha^{-1} + *Rhizobium* + KSB, T_9 -FYM @ 5 t ha^{-1} + PSB + KSB and T_{10} -FYM @ 5 t ha^{-1} + *Rhizobium* + PSB + KSB with three replications. The improved cultivar "Rajendra Kanti" was used for sowing with seed rate of 25 kg ha^{-1} on 18th November during 2017. The seeds were placed at 3-5 cm depth, keeping inter row spacing of 30 cm and covered with the soil. The crop was uniformly fertilized with 20 kg ha^{-1} nitrogen and 40 kg ha^{-1} P_2O_5 in the form of urea and di-ammonium phosphate, respectively as a basal application just before sowing in only treatment plots. The observations were recorded on different growth and yield attributing characters like plant height, number of branches $plant^{-1}$at harvest, number of root nodules, weight of root nodules, dry matter $plant^{-1}$, cumulative growth rate, number of pods $plant^{-1}$, pod length, number of seeds pod^{-1}, seed yield, stover yield and biological yield. The statistical formulas were used for compilation of data and drawing of conclusion (Panse and Sukhatme, 1969).

RESULTS AND DISCUSSION

Growth parameters

Among different growth parameters *viz.,* plant height at 30, 60 DAS and at harvest (Table 1); number of branches $plant^{-1}$ at harvest, number and weight of root nodules $plant^{-1}$ at 60 DAS, dry matter $plant^{-1}$ at 30, 60 DAS and at harvest were having significantly highest value recorded under the treatment T_{10} (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB + KSB), which remained statistically at par with the treatments T_2 (N-P_2O_5-K_2O @ 40-40-20 kg ha^{-1}), T_7 (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB), T_8 (FYM @ 5 t ha^{-1} + *Rhizobium* + KSB) and T_9 (FYM @ 5 t ha^{-1} + PSB + KSB). Among the various treatments, significantly the maximum CGR at 30-60 DAS recorded with treatment T_{10} (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB + KSB) which remain statistically at par with treatment T_2 (40-40-20 kg N-P_2O_5-K_2O ha^{-1}). This might be attributed to fact that FYM increase the absorptive power of the soil for cation and anion and these ions were released slowly during the entire period of crop growth. The FYM also produce hormones and growth promoting substances that help to promote the plant growth. The inoculation of biofertilizer like *Rhizobium* increase the number of such microorganisms in the soil rhizosphere and consequently improve the extent of microbiologically fixed nitrogen for plant growth. They were used to fix nitrogen as well as to solubilise the plant nutrients like phosphate. Phosphate solubilising microorganism solubilises the unavailable bound phosphate of the soil and makes them available to plants which increase overall plant growth. The increase in growth characteristics due to the solubilization of nutrients in the soil by producing organic acids by KSB was also observed and are conformity with the findings of Summauria and Yadav (2009) and Meena *et al.* (2015).

Yield parameters

The yield influencing characters such as number of pods $plant^{-1}$, number of seeds pod^{-1}, pod length were significantly recorded highest value under the treatment T_{10} (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB + KSB) and it was found statistically analogous to treatments T_2 (N-P_2O_5-K_2O @ 40-40-20 kg ha^{-1}), T_7 (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB) and T_9 (FYM @ 5 t ha^{-1} + PSB + KSB). The seed yield, stover yield and biological yield were also recorded significantly higher in treatment T_{10} (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB + KSB), T_2 (N-P_2O_5-K_2O @ 40-40-20 kg ha^{-1}), T_7 (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB) and T_9 (FYM @ 5 t ha^{-1} + PSB + KSB) as compared to other treatments. These observations might be attributed due to application of FYM which helps to increase the photosynthetic activity in fenugreek and the translocation of photosynthates in plant. Improvement of all the yield parameters might be due to the better availability of nutrients and their translocation resulted in significantly higher seed and stover yield in fenugreek under *Rhizobium* inoculation along with PSB and KSB in soil application. The results corroborated with the observations of Mehta *et al.* (2012). They reported that higher seed and stover yield was observed by the combined application of FYM and *Rhizobium* in fenugreek whereas Shivran *et al.* (2016) and Godara *et al.* (2017) recorded highest biological yield in fenugreek with joint application of FYM and biofertilizers.

Based on experimental results, it seems quite logical to conclude that higher production of fenugreek cv. "Rajendra Kanti" can be obtained by application of FYM @ 5 t ha^{-1} along with seed treatment of *Rhizobium* @ 30 ml kg^{-1} seed and soil application of PSB + KSB @ 3 l ha^{-1} each on sandy loam soil under low hill regions of Uttarakhand.

Table 1. Effect of various INM treatments on growth parameters of fenugreek cv. Rajendra Kanti

Treatments	Plant height (cm)			No. of branches plant^{-1} at harvest	No. of root nodules at 60 DAS	Weight of root nodules at 60 DAS (mg)	Dry matter plant^{-1} (g)			CGR (g day^{-1}) at 30-60 DAS
	DAS	DAS	Harvest				At 30 DAS	At 69 DAS	At Harvest	
T_1	11.29	31.17	49.46	5.00	26	134.64	0.23	0.92	3.17	0.023
T_2	14.75	37.68	61.80	6.93	31	167.55	0.60	2.70	4.74	0.070
T_3	11.49	31.73	52.93	5.10	27	141.07	0.24	1.10	3.18	0.029
T_4	12.62	33.83	57.03	6.06	30	156.28	0.42	2.15	3.89	0.058
T_5	12.55	33.04	55.85	5.70	29	152.77	0.35	1.88	3.78	0.051
T_6	12.35	32.10	54.54	5.37	28	146.71	0.30	1.35	3.35	0.035
T_7	14.69	36.80	60.90	6.60	31	165.42	0.56	2.40	4.64	0.061
T_8	13.52	35.13	58.93	6.14	30	158.27	0.43	2.21	4.20	0.059
T_9	14.29	35.74	60.01	6.18	30	160.67	0.50	2.25	4.35	0.058
T_{10}	15.25	38.28	62.59	7.15	33	168.41	0.60	3.00	5.53	0.080
SEm ±	0.73	1.63	2.70	0.33	1.42	7.26	0.02	0.10	0.45	0.001
CD at 5%	2.17	4.84	8.03	0.97	4.22	21.58	0.07	0.30	1.32	0.003
CV %	9.52	8.16	8.15	9.4	8.34	8.11	9.49	8.52	9.62	11.29

Treatment details: T_1 (Control), T_2 (40-40-20 kg N-P_2O_5-K_2O ha^{-1}), T_3 (FYM @ 5t ha^{-1}), T_4 (FYM @ 5 t ha^{-1} + *Rhizobium*), T_5 (FYM @5 t ha^{-1} + PSB), T_6 (FYM @ 5 t ha^{-1} + KSB), T_7 (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB), T_8 (FYM @ 5 t ha^{-1} + *Rhizobium* + KSB), T_9 (FYM@ 5 t ha^{-1} + PSB + KSB) and T_{10} (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB + KSB)

Note: a. *Rhizobium* seed treatment @ 30 ml kg^{-1} seeds; b. PSB soil application @ 3 l ha^{-1}; c. KSB soil application @ 3 l ha^{-1};

d. The treatment T_2 was kept outside the organic plot

Table 2. Effect of various INM treatments on growth and yield parameters of fenugreek cv. Rajendra Kanti

Treatments	No. of pods plant^{-1}	Pod length (cm)	No. of seeds pod^{-1}	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})
T_1	19.73	9.34	12.08	1021	1901	2922
T_2	23.43	11.33	15.77	1632	2767	4399
T_3	20.06	9.59	12.32	1254	2124	3378
T_4	21.70	10.31	13.38	1351	2480	3831
T_5	21.23	10.11	12.84	1323	2267	3589
T_6	20.93	9.69	12.49	1285	2198	3483
T_7	23.01	11.19	14.75	1508	2660	4168
T_8	22.10	10.61	13.63	1354	2302	3657
T_9	22.47	10.87	14.35	1402	2540	3942
T_{10}	25.49	11.49	16.29	1712	2814	4525
SEm.±	1.09	0.49	0.80	82.33	119.59	141.86
CD at 5%	3.24	1.45	2.39	244.61	355.32	421.51
CV %	8.57	8.08	10.09	10.16	8.53	6.41

Treatment details: T_1 (Control), T_2 (40-40-20 kg N-P_2O_5-K_2O ha^{-1}), T_3 (FYM @ 5t ha^{-1}), T_4 (FYM @ 5 t ha^{-1} + *Rhizobium*), T_5 (FYM @ 5 t ha^{-1} + PSB), T_6 (FYM @ 5 t ha^{-1} + KSB), T_7 (FYM @ 5 t ha^{-1} + *Rhizobium* + PSB), T_8 (FYM @ 5 t ha^{-1} + *Rhizobium* + KSB), T_9 (FYM@ 5 t ha^{-1} + PSB + KSB) and T_{10} (FYM @5 t ha^{-1} + *Rhizobium* + PSB + KSB)
Note: a. *Rhizobium* seed treatment @ 30 ml kg^{-1} seeds; b. PSB soil application @ 3 l ha^{-1}; c. KSB soil application @ 3 l ha^{-1};

d. The treatment T_2 was kept outside the organic plot

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