International J. Seed Spices 3(1), January 2013:16-19

Effect of plant growth promoting rhizobacteria (PGPR) coated bioformulations on fenugreek

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ABSTRACT

An experiment was conducted under field condition during winter season (*Rabi*) of 2011-12 on a loamy sand soil at SKN College of Agriculture, Jobner (Rajasthan) to study the effect of bioformulations (PGPR) on growth and yield of fenugreek. There were five treatments, *viz.* bioformulation FK 14, bioformulation FL 18, bioformulation FK 14 + FL 18, untreated control and local control as check in randomized block design with four replications. The strains in the bioformulations FK 14 and FL 18 were *Pseudomonas pituda* and *Microbacterium taraoxidens*, respectively. The bioformulations were applied as seed coating. The study revealed that seed treatment with bioformulation FK 14 + FL 18, being at par with bioformulation FK 14 and FL 18 alone, recorded significantly higher plant height, number of primary branches/plant, number of secondary branches/plant, number of pods/plant, number of seeds/pod and seed yield (1756.25 kg/ha) over control. The flowering resulted significantly earlier and higher pod length in bioformulation FK 14 + FL 18 as well as FL 18 over the control. The number of days to maturity remained unaffected with different bioformulation. The untreated treatment recorded significantly more number of secondary branches/plant, number of seeds/pod and seed yield over the local control variety whereas, untreated control and local check remained at par for rest of the growth attributes and number of pods/plant and pod length. The per cent yield increase over local check was 11.43, 26.06, 29.98 and 36.43 under control, bioformulation FK 14, FL 18 and FK 14 + FL 18, respectively.

Key words : PGPR, rhizobacteria, growth, yield, fenugreek

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum*) is a self pollinated crop belongs to family fabaceae. The major fenugreek growing states are Rajasthan, Gujarat, Madhya Pradesh, Tamil Nadu and Uttar Pradesh. More than 80 per cent area and production of India is contributed by Rajasthan state alone as fenugreek is fairly tolerant to salinity which makes it suitable for cultivation in major parts of the state. The crop has immense medicinal value and is a good source of vitamins, protein and essential oils. It is mainly used for culinary and medicinal purposes and continues to be important winter season legume spice mainly cultivated in India. Being an important *rabi* spice crop, farmers largely include it in their cropping plan. The seeds contain an alkaloid “Trigonellin (0.12 to 0.38%) is thought to reduce glycosuria in diabetes. Fenugreek seed helps not only reducing blood sugar levels with its high concentration of phytochemicals, but also reduced low density cholesterols and triacylglycerols. The productivity of the crop is below potential due to variety of reasons including environment.

Bacterial strains isolated from the rhizosphere hold great promise as seed inoculants in new agricultural systems to promote plant growth and yield. These bacteria are termed as plant growth promoting rhizobacteria (PGPR), to accentuate their intimate association with roots. Studies with PGPR indicate that the root microflora can profitably be manipulated through use of bacteria which live as epiphytes on roots and beneficially modulate the ecological niche. The direct application of microorganisms to seed or other plant parts give them a competitive advantage over pathogens that must complete for nutrients and sites for attachment prior to infection. Routine use of biological systems in controlling plant diseases and high yield have become more attractive due to the added benefits of enhanced plant growth. Keeping this in view a field experiment was conducted to study the effect of bioformulations (PGPR) on growth and yield of fenugreek.

MATERIALS AND METHODS

An experiment was conducted under field condition during winter season (*Rabi*) of 2011-12 on a loamy sand soil at Agronomy farm, SKN College of Agriculture, Jobner (Rajasthan) situated at latitude of $26^0$05’ N, longitude of $75^0$20’E and at an altitude of 427 m above mean sea level. The soil was low in organic carbon, available N, available P and medium in available K with

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alkaline in reaction at the beginning of the experiment. There were five treatments, *viz.* bioformulation FK 14, bioformulation FL 18, bioformulation FK 14 + FL 18, untreated control and local control as check in randomized block design with four replications. The strains in the bioformulations FK 14 and FL 18 were *Pseudomonas pituda* and *Microbacterium taraoxidens*, respectively. The bioformulations were applied as seed coating. The crop was sown in rows 30 cm apart using 20 kg seed/ha on 11 November, 2011. Plant to plant distance was maintained at 10 cm. One light irrigation just after sowing and four irrigations at different growth stages were applied to the crop. All improved package of practices were followed to raise the crop under irrigated conditions. Data obtained were statistically analyzed by using the F-test as per the procedure given by Gomez and Gomez (2). LSD at P = 0.05 were used to determine the significant differences between treatments.

RESULTS AND DISCUSSION

The results revealed that seed treatment with bioformulation FK 14 + FL 18, being at par with bioformulation FK 14 and FL 18, recorded significantly higher plant height, number of primary branches per plant and number of secondary branches per plant (Table 1). The flowering resulted significantly earlier in bioformulation FK 14 + FL 18 as well as FL 18 over the control. The number of days to maturity remained unaffected with different bioformulation treatments. The untreated treatment *i.e.,* control recorded significantly more number of secondary branches per plant over the local control variety whereas, untreated control and local check remained at par for rest of the growth attributes. All bioformulation treatments significantly increased yield attributes and yield and bioformulation FK 14 + FL 18, being at par with FK 14 and FL 18 alone, recorded significantly higher number of pods per plant, number of seeds per pod and seed yield (1756.25 kg/ha) over control (Table 2). The pod length was increased significantly with bioformulation FL 18 and FK 14 + FL 18 over control. The control recorded significantly more number of seeds per pod and seed yield over local control and was comparable for number of pods per plant and pod length. The per cent yield increase over local check was 11.43, 26.06, 29.98 and 36.43 under control, bioformulation FK 14, FL 18 and FK 14 + FL 18, respectively. PGPR enhance plant growth by direct and indirect means, but the specific mechanisms involved have not all been well characterized. Direct mechanisms of plant growth promotion by PGPR can be demonstrated in the absence of plant pathogens or other rhizosphere microorganisms, while indirect mechanisms involve the ability of PGPR to reduce the harmful effects of plant pathogens on crop yield. PGPR have been reported to directly enhance plant growth by a variety of mechanisms *viz*., fixation of atmospheric nitrogen that is transferred to the plant, production of siderophores that chelate iron and make it available to the plant root, solubilization of minerals such as phosphorus and synthesis of phytohormones. Direct enhancement of mineral uptake due to increases in specific ion fluxes at the root surface in the presence of PGPR has also been reported. PGPR strains may use one or more of

Table 1. Effect of bioformulations on growth attributes of fenugreek

Treatment	Plant height(cm)	No. of primary branches/plant	No. of secondary branches/plant	Days to 50% flowering	Days to maturity
Bioformulation FK14	74.65	5.03	13.79	54.50	143.25
Bioformulation FL18	76.79	5.18	14.20	52.00	144.00
Bioformulation FK14+FL18	80.26	5.43	14.68	52.50	143.75
Control	65.98	4.45	12.18	55.25	139.50
Local control	69.88	4.00	10.77	56.00	137.00
CD (P=0.05)	7.29	0.48	1.21	2.55	5.28

Table 2. Effect of bioformulations on yield attributes and yield of fenugreek

Treatments	Number of pods/plant	pod length(cm)	Number of seeds/ pod	Seed yield (kg/ha)	% yield increase over check
Bioformulation FK14	24.15	9.01	16.80	1622.75	26.06
Bioformulation FL18	24.88	9.32	17.25	1673.28	29.98
Bioformulation FK14+FL18	26.25	9.60	18.05	1756.25	36.43
Control	21.30	8.32	15.15	1434.52	11.43
Local control	18.93	7.69	13.63	1287.25	-
CD (P=0.05)	2.43	0.72	1.47	141.43	-

these mechanisms in the rhizosphere. Molecular approaches using microbial and plant mutants altered in their ability to synthesize or respond to specific phytohormones have increased our understanding of the role of phytohormone synthesis as a direct mechanism of plant growth enhancement by PGPR (Glick, 1).

Co-inoculation studies with PGPR and *Bradyrhizobium japonicum* have also demonstrated increased soybean plant root and shoot weight, seed yield, plant vigour, nodulation and nitrogen fixation (Verma *et al*., 9). Similarly, an increase in grain yield, nodule dry matter and nitrogenise activity were also obtained in chick pea inoculated with a mixture of *Azospirillum brasilense* and *Rhizobium* strains (Rai, 8). Grimes and Mount (3) found that a *Pseudomonas putida* strains (M-17), which had been selected as a potential biological control agent, markedly increased *Rhizobium* nodulation of bean in field soils. Polonenko *et al.* (6) found similar effects of certain rhizobacteria (primarily fluorescent pseudomonas) on nodulation of soybean roots by *B. Japonicum*. The plant growth promoting rhizobacteria are free living soil borne bacteria that colonize the rhizosphere and have great importance in governing the functional property of terrestrial ecosystems. The rhizospheric bacteria isolated from maize and wheat *i.e.*, *Pseudomonas*, *Bacillus*, *Azospirillum* and *Azotobacter* species, produces the varying amount of indole acetic acid (IAA) (Karnwal, 5). Jarak *et al*. (4) reported that the treatment with different rhizobacteria resulted in to increased population of bacteria in soil as well as plant height, dry matter yield and yield of maize in green house as well as under field conditions. Prakashverma (7) also reported that maximum signification increase in nodules/plant, dry matter, nutrient content and yield were recorded with co-inoculation of *mesorhizobium* species BHURCO2 and *Pseudomonas fluorescens* BHUPSBO6 followed by co-inoculation of *mesorhizobium* species, *Azotobacter chroococum* and Bacillus megatrium BHUPSB14 over uninoculated control in a 2 year field study on chickpea.

Therefore, results of present study revealed that seed inoculation of fenugreek with rhizobacterial bioformulation FK 14 or bioformulation FL 18 or bioformulation FK 14 + FL 18 resulted in higher growth and yield of the crop as compared to without inoculation, however, better results can be obtained when combination of bioformulations FK 14 and FL 18 is used for inoculation.

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Received : Sept. 2012; Revised : Oct. 2012; Accepted : Nov. 2012.