International J. Seed Spices 2(2), July 2012:30-33

Effect of plant growth promoting rhizobacteria on growth and yield of cumin (*Cuminum cyminum.* L)

A. C. Shivran*, E.V.D. Sastry, K.S. Shekhawat, G.K. Mittal and S.S. Rajput

All India Coordinated Research Project on Spices

S.K.N. College of Agriculture, SKRAU, Jobner, Rajasthan, India 303 329

ABSTRACT

The Field experiment was conducted 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 cumin. 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 results of the experiment indicated that plant height increased significantly with bioformulation FK 14 + FL 18 over control and was comparable with FK 14 and FL 18, however, FK 14 and FL 18 could not bring significant improvement over control. Number of primary and secondary branches/plant, number of umbel/plant, number of umbellets/umbel, number of seeds/umbellet and seed yield (311 kg/ha) improved significantly with bioformulation FK 14 + FL 18 over control and bioformulation FK 14 and was comparable with FL 18. The bioformulation FK 14 also improved number of primary branches significantly over control. Different bioformulation treatments could not affect days to 50 % flowering and days to maturity over untreated control. The number of secondary branches/plant, yield attributes and yield were also significantly higher in untreated control over local control. The seed yield increased by 18.29, 41.15, 50.50 and 55.88 per cent with untreated control, bioformulation FK 14, FL 18 and FK 14 + FL18, respectively over local control.

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

INTRODUCTION

Cumin (*Cuminum cyminum* L.) is an important seed spice crop of arid and semi-arid regions of India. Among seed spices, cumin is an important crop of western Rajasthan and is mainly grown in the districts of Jalore, Pali, Barmer, Ajmer, Tonk and Jodhpur. The total area covered under this crop is 330637 hectare producing 114925 tonne annually (2010-11). In fact, the extreme susceptibility to disease like wilt, powdery mildew and blight and also to aphids and lack of knowledge of suitable agricultural practices are the reasons of poor productivity in this crop. There is no doubt that this crop has tremendous scope and the availability of suitable improved practices will result in increase in area as well as production by solving the above constraints.

Bacterial strains isolated from the rhizosphere hold great promise as seed inoculants in new agricultural systems to promote plant growth and yield. Plant growth promoting rhizobacteria (PGPR) was first defined by Kloepper and Schroth to describe soil bacteria that colonize the roots of plants following inoculation on to seed and that enhance plant growth. The implicit in the colonization process are ability to survive inoculation onto seed, to multiply in the spermosphere (region surrounding the seed) in response to seed exudates, to attach to the root surface, and to colonize the developing root system. The ineffectiveness of PGPR in the field has often been attributed to their inability to colonize plant roots. A variety of bacterial traits and specific genes contribute to this process, but only a few have been identified. These include motility, chemotaxis to seed and root exudates, production of specific cell surface components, ability to use specific components of root exudates, protein secretion, and quorum sensing (Benizri *et al.,* 1). 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 on growth and yield of cumin.

*Corresponding author: Email: acs_shivran@rediffmail.com

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 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 14 kg seed/ha on 25 November, 2011. 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 (3). LSD at P = 0.05 were used to determine the significant differences between treatment means.

RESULTS AND DISCUSSION

The results of the experiment indicated that plant height increased significantly with bioformulation FK 14 + FL 18 over control and was comparable with FK 14 and FL 18, however, FK 14 and FL 18 could not bring significant improvement over control (Table 1). Number of primary and secondary branches per plant improved significantly with bioformulation FK 14 + FL 18 over control and bioformulation FK 14 and was comparable with FL 18. The bioformulation FK 14 also improved number of primary branches significantly over control. Different bioformulation treatments could not affect days to 50% flowering and days to maturity over untreated control. The local control variety and untreated control were comparable for all growth attributes except number of secondary branches per plant. The bioformulation treatments significantly improved yield attributes and yield of cumin over control (Table 2). The bioformulation FK 14+ FL 18 recorded significantly higher number of umbel/plant (18.66), number of umbellets/umbel (4.98), number of seeds/umbellet (26.33) and seed yield (311 kg/ha) over control and FK 14 and was comparable with FL 18. The yield attributes and yield were also significantly higher in untreated control over local control. The seed yield increased by 18.29, 41.15, 50.50 and 55.88 per cent with untreated control, bioformulation FK 14, FL 18 and FK 14 + FL18, respectively over local control. The direct mechanism of plant growth promoting rhizobacteria include the increase in bioavailable phosphorus for plant uptake, biological nitrogen fixation, production of plant hormones like auxins, cytokinins and gibberellins and decrease of ethylene level. The indirect mechanism used by plant growth promoting rhizobacteria include the biotic protection against pathogenic bacteria, reduction of iron available to phytopathogens in the rhizosphere, synthesis of fungal cell wall lysing enzymes and competition with detrimental microorganisms.

Inoculation studies with PGPR and

Table 1. Effect of bioformulations on growth attributes of cumin

Treatment	Plant height(cm)	No. of primary branches/plant	No. of secondary branches/plant	Days to 50% flowering	Days to maturity
Bioformulation FK14	26.15	5.29	10.59	81.50	131.75
Bioformulation FL18	27.01	5.68	11.35	83.50	132.75
Bioformulation FK14+FL18	27.48	5.93	11.80	83.25	130.75
Control	25.25	4.60	9.09	80.00	128.75
Local control	24.21	4.18	8.06	77.00	127.50
CD (P=0.05)	2.15	0.54	0.93	3.72	5.04

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

Treatments	Number of umbel/plant	Number of umbellets/ umbel	Number of seeds/ umbellet	Seed yield (kg/ha)	% yield increase over check
Bioformulation FK14	16.88	4.50	23.91	281.25	41.15
Bioformulation FL18	18.02	4.80	25.52	300.25	50.50
Bioformulation FK14+FL18	18.66	4.98	26.33	311.00	55.88
Control	15.09	3.83	20.32	236.00	18.29
Local control	13.52	3.06	16.53	199.50	-
CD (P=0.05)	1.54	0.45	1.98	28.82	-

Bradyrhizobium japonicum have also demonstrated increased soybean plant root and shoot weight, seed yield, plant vigour, nodulation and nitrogen fixation (Verma *et al.*, 8). Disease incidence as well as pathogen population in soil were significantly reduced in response to seed treatment with with talc based formulations of *P. fluorescens* and *T. harzianum* and simultaneous application of organic amendments. These treatments also led to considerable increase in shoot and root lengths and dry weight of cumin plants (Chawla and Gangopadhyay, 2). Polonenko *et al.* (6) found 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 number 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 dry matter, nutrient content and yield were recorded in 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, present study indicated that seed coating of cumin 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 control, however, better results can be obtained when combination of bioformulations FK 14 and FL 18 is used.

REFERENCES

1. Benizri, E., Baudoin, E., and Guckert, A. 2001. Root colonization by inoculated plant growth promoting rhizobacteria. *Biocontrol Science and Technology* **11**:557-574.
2. Chawla, N. and Gangopadhyay, S. 2009. Integration of Organic Amendments and Bioagents in Suppressing Cumin Wilt Caused by *Fusarium oxysporum* f. sp. Cumini. *Indian Phytopathology* **62** (2) : 209-216.
3. Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research*. 2nd edn. An International Rice Research Institute Book. A Wiley-Interscience Publication, John Wiley and Sons, New York.
4. Jarak, M., Mrkovacki, N., Bjelic, D., Josic, D. Hajnal-jafri, T. and stamenov, D. 2012. Effect of plant growth promoting Rhizobacteria on maize in green house and field Trial. *African journal of Microbiology Research* **6** (27) : 5683-5690.
5. Karnwal, A. 2012. Screening of plant growth promoting Rhizobacteria from Maize (*Zea mays*) and wheat(*Triticum aestivum*). *African journal of Food, Agriculture, Nutrition and Development* **12** (3) :

6. Polonenko, D.R., Scher, F.M., Kloepper, J.W., Singleton, C.A., Lalibete, M., Zaleska,I. 1987. Effect of root colonizing bacteria on nodulation of soybean roots by *Bradyrhizobium japonicum* . *Canadian journal of microbiology* **33** : 498-503.

7. Prakashverma, J., Janardanyadav and Nathtiwari, K. 2012. Enhancement of Nodulation and yield of chickpea by co-inoculation of Indigenous *Mesorhizobium* spp. and plant growth promoting Rhizobacteria in Eastern Uttar Pradesh. *Communications in soil science and plant analysis* **43** (3) : 605-621.

8. Verma, D.P.S., Fortin, M.G., Stanley, V.P., Mauro, S., Purohit, S. and Morrison, N. 1986. Nodulins and nodulin genes of *Glycine max* : A perspective. *Plant Molecular Biology* **7** : 51-61.

Received : January 2012; Revised : March 2012; Accepted : May 2012.