INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND TECHNOLOGY
ISSN 2582-7358
Impact Factor 6.328
Peer-Reviewed Journal

Importance of Plant Growth Promoting Rhizobacteria (PGPR) in Sustainable Vegetables Production

Dr. Shalini Saxena

Lab. of Cytogenetics, Department of Botany, Bareilly College Bareilly

Abstract

Vegetable cultivation is an important economic activity of small and margincal farmer's for their livelihood security. But, the yield of vegetables is highly depends on more pesticide application as they frequently experience yield losses due to pest and disease. Recently, use of plant growth promoting rhizobacteria (PGPR) is measured as a major asset for efficient pest management. PGPR CSR Bio is a unique microbial consortia developed for improving yield and income of farmers. In this context, demonstrations were conducted on performance of CSR Bio on major vegetable cultivation (okra, onion and brinjal). Where, CSR Bio was used for seed treatment (3%), soil application (5kg/ha) and foliar spray (3%). The results shows that, application of CSR Bio recorded more yield in okra (21.1 t/ha), onion (15.5 t/ha) and brinjal (18.3 t/ha). Where as in farmers practice, 17.4t/ha, 13.5t/ha and 17.2 t/ha of yield in okra, onion and brinjal was recorded respectively. Favourable net return of Rs. 192024/-, Rs. 232970/- and Rs. 344792/- per hectare and Cost benefit ratio of 2.74, 3.13 and 4.0 in okra, onion and brinjal respectively was obtained through CSR Bio application. Sucking pest and disease incidence was reduced (50-60%) under CSR Bio application. The results of the survey indicated that CSR Bio was useful in getting more income and reduce pesticide application. But, timely non availability of PGPR and lack of awareness were identified as major reasons for non adoption of PGPR application. Hence, it is essential to enhance the availability of PGPR in all vegetable growing areas, create awareness regarding the adoption of PGPR.

Keywords: PGPR, Pest incidence, Vegetables, Yield

Introduction

Plant Growth Promoting Rhizobacteria (PGPR) is a group of beneficial bacteria that actively colonize in plant roots. The application of PGPR to control diseases is an

biological approach to increase yield and income without affecting the soil and environment. In general, PGPR application induced the biocontrol activity to release of nutrients, niche exclusion, induced systemic resistance and antifungal metabolites production. Interaction of beneficial rhizobacteria with the plant roots can result in plant resistance against some pathogenic bacteria, fungi, and viruses. PGPR improve plant growth directly or indirectly through supply of nutrients and inhibitory effect on pest and disease. Commonly available PGPR such as *Pseudomonas, Trichoderma, Bacillus, Azospirillum are* capable of facilitating the growth and yield of vegetables.

Vegetables are an integral part of human dietary systems for healthy life. Because, they supply several important nutrients, vitamins, antioxidants for daily need of human health. Annual vegetable crops such as okra, onion and brinjal are cultivated in tropical and subtropical regions. Okra is considered a high-value vegetable crop owing to its high levels of vitamins, minerals, carbohydrates, and fats (Habib, 2016). Onion is a very common crop grown all over the India and is consumed by every family either as raw in the form of salad or as cooked along other spices and vegetables, sometimes flowering shoot 'scape' is also used as vegetable. Onion contains nutrients, carbohydrate, proteins and vitamins etc., Besides it also contains useful medicinal properties. Correspondingly brinjal is also a popular vegetable, highly cosmopolitan and is considered as poor man's crop, thereby grown in almost all parts of India, all round the year except higher altitudes (Jayalakshmi and Praneetha, 2018). Brinjal has high nutritive value and it contains high amount of carbohydrates (6.4%), protein (1.3%), fat (0.3%), calcium (0.02%), phosphorus (0.02%), iron (0.0013%) and other mineral matters. The production and demand for okra, onion and brinjal are relatively high. These crops are grown by farmers during *Kharif* as well as *Rabi* seasons.

Vegetable growers frequently complain yield losses due to insect pests, the yield of these vegetable per hectare is highly depends on use more pesticide. To overcome the yield loss caused by pest and disease incidence, farmers penetrating in adoption of disease-resistant varieties, crop rotation and other disease control measures, but all these methods have not been successful and effective. The indiscriminate use of agrochemicals including pesticides in vegetable production adversely affects the soil

fertility and consequently it accumulate inside the plant parts, thus making it unhealthy for human consumption (Rizvi *et al*., 2017). Now-a-days, the plants inoculation with PGPR is a major asset for organic agriculture. Recently PGPR is receiving more attention as a way to reduce the chemicals without facing yield loss (Pacome *et al*., 2013). CSR Bio is a unique microbial consortia developed by Central Soil Salinity Research Institute, Lucknow for improving yield and income of farmers. It contains *Bacillus pumilus*, *Bacillus thuringensis* and *Trichoderma harzianum*. CSR Bio act as a nutrient mobilizer, soil vitalizer, biocontrol agents for soil born diseases and growth enhancer for salt affected soil. In this context, KVK Tiruchirappalli demonstrated the importance of PGPR in combination on the major vegetable crops such as okra, onion and brinjal grown in Tiruchirappalli region of Tamil Nadu to create the awareness among the farming community to reduce the overload of chemicals on soil and environment.

Materials and Methods

Krishi Vigyan Kendra, Tiruchirappali District, Tamil Nadu conducted demonstration in 15 ha of land area on the performance of PGPR on okra, onion and brinjal in Trichy district during 2016-17, 2017-18 and 2020-21 respectively under KVK operational area. Through field survey, farmers meeting and field diagnostic visit during the cropping period, income of the farmers affected by pest and disease was conceived for this demonstrations. During the demonstrations, improved and recommended technologies under okra, onion and brinjal cultivation were adopted as intervention during the course of front line demonstration. Under the technology demonstration seeds were treated with CSR Bio 3%, further soil application (5kg/ha) and foliar spray at flowering and 15 days later (3%) was done. Trial has been taken up in 15 ha (each 5 ha in 5 locations) of targeted area. Visit of the farmers and extension functionaries were organized at trial plots to disseminate the message at large scale. Yield and economic data were collected from farmers practice (control) and demo plot (CSR Bio applied) and cost of cultivation, net income and cost benefit ratio were computed and analysed.

An interview schedule was developed during 2021 to collect the data on farmers' adoption and constraints faced in PGPR adoption with 75 farmers in the same village.

The survey included several open-ended questions to elicit farmers perceptions regarding the system and the broader aspects of income changes in their field. All categories of farmers *i.e.* small (upto 2 ha), medium (>2- 4 ha) and large (>4 ha) were selected and 25 vegetable growers were selected from each group through random technique. The responses were scored on 4 points scales fitting to the statements as very much (4), much (3) not so much (2) and not at all (1) important.

Table 1. Effect of PGPR CSR bio application on the performance of vegetables.

S.No.	Crop	Pests observed	Incidence (%)		Yield (t/ha)		Net income (Rs.)		BC ratio	
			FP	Demo	FP	Demo	FP	Demo	FP	Demo
1.	Okra	Fruit Borer	23	11	17.4	21.1	161038	192024	2.38	2.74
2.	Small Onion	Basal rot	32.5	9.4	13.5	15.5	185150	232970	2.74	3.13
3.	Brinjal	Fruit Borer	28	15	17.2	18.3	310650	344792	3.6	4.0

FP - Farmers Practice

Results

Effect of PGPR on the yield of vegetables

The yield of vegetables was recorded in CSR bio applied plots and compared with farmers practice Table 1. Results indicated that application of CSR bio produced more yield in okra (21.1 t/ha), onion (15.5t/ha) and brinjal (18.3 t/ha), with an increased yield level of 21.2%, 14.8 % and 6.3% respectively. Where as in farmers practices, 17.4t/ha, 13.5 t/ha and 17.2 t/ha of fruit yield were recorded in okra, onion and brinjal respectively. The increased yield of vegetables by the application of PGPR could be due to the application of PGPR-CSR bio involved in enzymes, proteins, antibiotics,

etc.. Similar results was obtained by Yagmur *et al*. (2021) and Damodaran *et al*. (2013).

Effect of PGPR on Economics in vegetable production

The economic indicators *viz.*, net income and benefit cost ratio is presented in Table 1. Favouable net return of Rs. 192024/- and cost benefit ratio of 2.74 in okra, net return Rs. 232970/- and cost benefit ratio of 3.13 in onion and net return Rs. 344792/- with cost benefit ratio of 4.0 in brinjal was obtained through CSR bio application. They clearly revealed that the additional net return of Rs. 30986/-, RS.47820/- and Rs.34142/- from the trials were subsistence higher than control i.e. farmers practices in okra, onion and brinjal respectively. Higher economic status might be due to the increasing yield of vegetables and of lesser pest incidence in the PGPR CSR bio applied plots.

Effect of PGPR on pest and disease incidence

Effect of PGPR CSR Bio in pest management is shown in Table 1. Fruit borer is major pest affecting the yield in most of the vegetables. Fruit borer affect fruit quality and yield loss reached more than 30 -45%. Application of CSR Bio reduced 50-60% of fruit borer in okra and brinjal, which could be due to the indirectly benefit, antibiotic production, parasitism of CSR Bio on deleterious microorganisms or root pathogens that inhibit plant growth (Bhattacharyya and Jha, 2012). With respect to basal rot in onion, it was observed minimum damage (9.4%) in CSR Bio applied plot than in farmers practice (32.5 %). Where CSR Bio consists *Bacillus* pumilus*, Bacillus thuringiensis and Trichoderma harzianum,* which act as a beneficial microorganism that are widely used as a bio pesticide and also improve the resistance for pest and disease incidence (Gangwar, 2017). Gholamreza Salehi Jouzani *et al*. (2017) and Jamshidnia, *et al*. (2018) expressed the same view in application of PGPR in Tomato. Hence, to optimize the vegetable production with reduced input, PGPR in vegetable cultivation is recommended (Mekonnen and Kibret, 2021). Pravin Vijan *et al*. (2016) expressed that application of PGPR like *Bacillus*, *Pseudomonas*, *Serratia*, *Arthrobacter*, and *Stenotrophomonas* are involved in systnesis of volatile compound like enzymes, proteins, antibiotics, which help to prevent pest and disease incidence.

Extend of adoption and contraints in PGPR application

The reason for adoption and contraints in use of CSR Bio was diversified and diffères from individual to individual (Table 2). Most of the farmers expressed that application of PGPR useful in getting more income, easy for application, safe for soil and environment through reduction in chemical application. But, timely non availability of input and lack of awareness were identified as major reasons for non adoption of PGPR. The survey indicated that most of the constraints were related to government actions that need to be solved to make use of PGPR effectively. All farmers favoured its adoption in vegetable cultivation. So it was found that all the sampled farmers were favoured in principle, but the farmers were seeking government assistance for adoption.

Table 2: Farmers feedback on adoption and contraints in PGPR application

S.No.	Particulars	M.F M.S	S.F M.S	B.F M.S	Average M.S.
I	**Reason for adoption of PGPR CSR bio**				
1.	Easy for application	3.2	3.7	3.6	3.5
2.	Reduction in pest and disease incidence	2.8	3.2	3.5	3.2
3.	Helpful for yield enhancement	3.4	3.1	3.5	3.3
4.	To obtain more income	3.2	3.7	3.8	3.6
5.	Low cost of input	3.1	3.4	3.2	3.2
6.	Beneficial for soil and environment	3.3	3.5	3.7	3.5
7.	Helpful to reduce pesticide usage	3.1	3.5	3.8	3.5
II	**Constraints in adoption of PGPR CSR bio**				
	Lack of awareness	3.4	2.8	3.1	3.1
	Timely non availability of inputs	3.5	3.1	3.8	3.5
	Lack of guidance from extensional personnel	2.5	2.9	3.6	3.0

	In adequate training to famers	2.7	2.9	3.4	3.0
	Inadequate demonstration of new technology	2.9	3.5	2.3	2.9
	Deficiency in technical know-how	2.9	2.4	2.8	2.7
	Insufficient follow up service	2.1	2.5	2.9	2.5

M.F.-Marginal farmers , S.F. -Small farmers, B.F- Big farmers, M.S.-Mean score

Conclusion

The findings of the study concluded that application of PGPR favourably influence the yield and reduce the pest damage in vegetable. Therefore, PGPR is highly recommended to reduce the heavy usage of pesticides and to improve the yield and quality of vegetables. Application of PGPR is a cost effective and outstanding approach to attain sustainable vegetable production and also for environmental sustainability. It was evident from the study that farmers were aware of the use of PGPR to save environment, soil and living beings. But, timely non availability of input and lack of awareness were identified as major reasons for non adoption of PGPR. Hence, it is essential to enhance the availability of suitable PGPR in all vegetable growing areas, create awareness to improve knowledge, skill and attitude regarding the adoption of PGPR in vegetable production by extension organizations through organizing various training, demonstration, exposure visit and awareness programmes *etc*.

References

1. Bhattacharyya, P. and Jha, D. (2012). Plant growth-promoting rhizobacteria (PGPR): emergence in agriculture. World Journal of Microbiology and Biotechnology. 28: 1327-1350.
2. Damodaran, T, Rai, R. B,, Jha, S. K,, Dhama, K,, Mishra, V.K., Sharma, D. K., Singh, A. K. and Himanshu Dixit. (2013). Impact of CSR bio - an eco-friendly bio-growth enhancer on increasing the profitability of horticultural crops to small and marginal land holders. International Journal of Current Research. 5(9): 2682-2685.

3. Gangwar, R.K. (2017). Role of biological control agents in integrated pest management approaches. Acta Sci Agri.1:9–11.
4. Gholamreza Salehi Jouzani , Elena Valijanian and Reza Sharafi. (2017). Bacillus thuringiensis: a successful insecticide with new environmental features and tidings. Appl Microbiol Biotechnol.101(7): 2691-2711.
5. Habib, S.H., Hossain Kausar., and Halimi Mohd Saud. (2016). Plant Growth-Promoting Rhizobacteria Enhance Salinity Stress Tolerance in Okra through ROS-Scavenging Enzymes. BioMed Research International. 1-10.
6. Jamshidnia, A., Abdoli, S, Farrokhi, S and Sadeghi R. (2018). Efficiency of spinosad, *Bacillus thuringiensis* and *Trichogramma brassicae* against the tomato leaf miner in greenhouse. Biocontrol. 63(5): 619–627.
7. Jayalakshmi, K. and Praneetha, S. (2018). Evaluation of brinjal (Solanum melongena L.) local types for yield and its quality characters. International Journal of Chemical Studies. 6(3): 292-297
8. Mekonnen, H. and Mulugeta Kibret. (2021). The roles of plant growth promoting rhizobacteria in sustainable vegetable production in Ethiopia. Chem. Biol. Technol. Agric. 8:1-11
9. Pacome, A.N., Eméric, K., Yedeou, O. D., Adolphe, A., Marcellin, A., Rachidatou,S., Emma W. G., Simeon O. K., Lamine, B.M. (2013). Effect of Different Plant Growth Promoting Rhizobacteria on Maize Seed Germination and Seedling Development. American Journal of Plant Sciences. 4: 1013-1021.
10. Pravin Vejan , Rosazlin Abdullah, Tumirah Khadiran, Salmah Ismail and Amru Nasrulhaq Boyce. (2016). Role of Plant Growth Promoting Rhizobacteria in Agricultural Sustainability—A Review. 21: 573-190.
11. Rizvi, A., Almas, Z., Khan, M.S, Saif, S., Ahmed, M. and Shahid, M. (2017). Growth Improvement and Management of Vegetable Diseases by Plant Growth-Promoting Rhizobacteria. In: Growth Improvement and Management of Vegetable (A. Zaidi, M.S. Khan, eds.). Springer International Publishing AG. 99-123.
12. Yagmur, B. and Gunes, A. (2021). Evaluation of the Effects of Plant Growth Promoting Rhizobacteria (PGPR) on Yield and Quality Parameters of Tomato

Plants in Organic Agriculture by Principal Component Analysis (PCA). Gesu*nde Pflanzen*. 73: 219-228.

13. Pott, D. M., Osorio, S. and Vallarino, J. G. (2019). From central to specialized metabolism: an overview of some secondary compounds derived from the primary metabolism for their role in conferring nutritional and organoleptic characteristics to fruit. Frontiers in plant science, 10, 835.
14. Rath, B. (2005). Globalisation, global trend in herbal market, and the impact thereof on medicinal plants in Orissa. VASUNDHARA, Bhubaneswar Orissa (India)
15. Seca, A. and Pinto, D. (2019). Biological Potential and Medical Use of Secondary Metabolites. Medicines (Basel, Switzerland), 6(2).
16. Senthilkumar, S. and Vijayakumari, K. (2016). A Review-pharmacology of Medicinal Plants, International Journal of Universal Pharmacy and Bio Sciences, 5, 37-59.
17. Hartmann, T. (2007). From waste products to ecochemicals: fifty years research of plant secondary metabolism. Phytochemistry, 68(22-24), 2831-2846.
18. Kessler, D., Gase, K., and Baldwin, I. T. (2008). Field experiments with transformed plants reveal the sense of floral scents. Science, 321(5893), 1200-1202.
19. Kossel, A. (1891). Arch Anat Physiol. Physiol Abteilung, 181-186.