Journal of Advances and Scholarly Researches in Allied Education
Vol. 15, Issue No. 12, December-2018, ISSN 2230-7540

An Analysis of the Role of Rhizobacteria that Promote Plant Growth in Agricultural Sustainability

Richa Pandey[1]* Santwana Rani[2]

[1] PhD Scholar, Department of Biotechnology, College of Commerce, Arts, Science, Magadh University, Patna

[2] Assistant Professor, Department of Botony & Biotechnology, College of Commerce, Arts, Science, Magadh University, Patna

Abstract – Sustainable agriculture involves the effective use of agricultural capital to meet evolving human needs while preserving or improving environmental sustainability and preserving natural resources. Plant Growth Use The promotion of rhizobacteria will play an impotent function in achieving the sustainable agriculture objectives. Rhizobacteria are known as Rhizosphere-resident bacteria. The goal is to research the function of Rhizobacteria and promote plant growth in farming sustainable development.

Keywords – Plant Growth, Rhizobacteria, Sustainable Agriculture

---------------------------------X---------------------------------

INTRODUCTION

Agriculture is one of the practices of human beings that contributes most through over-use of synthetic chemical fertilizers and pesticides, causing more harm to the ecosystem and possible health threats. Nitrous oxide (N2O) is an example of chemicals produced by excessive nitrogen fertilizer use, and is a major source of global warming greenhouse gases. In addition, agricultural soil management, the largest single source, represented 74% of total US N2O emissions in 2013. (1). Nitrogen fertilizers also reduce the biological fixation of nitrogen in the soil. Farmers use a high level of nitrogen fertilizers in ammonium nitrate to fertilize their soils to cultivate crops. The influx of ammonium means that plants no longer have symbiotic microbes to supply ammonium, which leads to a decrease in the degree of symbiosis. In addition, nitrifying bacteria also use this excess ammonium to produce nitrate. This high nitrate level is then used to manufacture N2O and excess nitrate leaches by denitrifying bacteria (2). Increased processes of microbial nitrification and denitrification therefore increase the supply of natural N2O. Denitrification is the stage during which microorganisms release nitrogen oxides into the environment in gas commodity, and nitrification is a two-stage ammonium phase (NH4) (3).

Plant growth promoters (PGPs) are substances that improve overall plant health growth and development. These substances can also be produced in synthesis or from biological derivatives. Plant growth promoters (PGP) are effective in significantly increasing crops, quality and productivity. PGPs are simpler and safer, especially biological derivatives. They're going to be advised for all crops.

Among PGPs, Amino acids, organic derivatives obtaining biological resources such as fish waste, animal waste, plant macromolecules such as soya, maize, groundnut, etc. Amino acids currently play a substantial market share among completely different categories of PGPs, thanks to their properties which facilitate plant growth and development such as flowering, mature and overall yield increase. It is clear from the top of the table that there is a high demand for Amino acids for its plant growth properties. There is therefore considerable potential for amino acids on the market of PGPs.

Rhizobacteria are root-associated bacteria with a sort of dependence on several plants. The name derives from the Greek rhiza, which means root. There are parasite rhizobacteria, the term sometimes refers to bacteria which have a relation useful to each parasite (mutualism). They are a crucial cluster of biofertilizer microorganisms. Biofertilization accounts for approximately 65 percent of the world's crop gas supplied. Required citation] Rhizobacteria are typically referred to as rhizobacteria that promote plant growth or as PGPRs.

Promoting plant growth Rhizobacteria have {different|totally completely different} relationships with various host plant species. The two main relationship categories are rhizosphere and endophyte. Rhizospheric relationships accommodate PGPRs that colonize the foundation surface or superficial host plant living areas, typically forming root nodules. The dominant species present in the rhizosphere may be a microorganism of the Azospirillum family. Endophytic interactions include a decrease in the apoplastic region of host plants and the development of PGPRs.

Nitrogen fixation is one useful process performed by rhizobacteria in each of the main processes. Gas can be a major nutrient in plants, and volatilized gas ($N2$). The high energy required to interrupt the three-fold bond between the 2 atoms is not on the market.

Rhizopacteria can convert volatilized gas ($N2$) into ammonia ($NH3$) by means of biological processes and create a market-related nutrient to the host plant that can support and enhance plant growth. The host plant supplies amino acids to the bacterium so they are not forced to assimilate ammonia. The amino acids were then returned to the plant with new fastened gas. Accelerators are associated with enzymes.

Khan, A., et. al. Given climate change and the highly growing world population, feeding the entire population is an enormous challenge. A large number of fertilizers are used to meet this challenge and increase crop yield, but these have many side effects. Instead, researchers find helpful, environmentally friendly rhizobacteria which can improve crop yield and plant development. The microbial rhizosphere population plays a crucial role in plant development through its induction of physiology. The plant is dependent on valuable root and microbial interactions for growth, nutrient supply, production of growth, disease suppression and other key plant functions. Several mysteries of microbes have recently been revealed in the rhizosphere, as molecular and microscopic technologies have improved significantly. The study shows and discusses existing awareness of the development, maintenance, interactions and different processes of rheizobacterial communities usually employed by PGPR in the rhizosphere to encourage plant growth and mitigate stress conditions. This study also studied the function of PGPRs, mycorrhizal fungi and the microbiome factors in plant growth and stress reduction in the rhizosphere (4).

Plant Growth Promoting Rhizobacteria

Plant growth promoters of rhizobactéries (PGPR) are a group of rhizosphere bacteria (5). The term 'plant growth supporting bacteria' refers to bacteria colonizing plant roots (rhizosphere). Rhizosphere is the soil environment with the plant root and the area with maximum microbial activity leading to the extraction of essential macro- and micronutrients in a confined nutrient pool. The rhizosphere microbial population differs from the population around it relatively because of the presence of root exudates as a source of nutrients for microbial growth (6). Weller and Thomashow (7) prove that the narrow rhizospheric zone is high in microbial nutrients compared with bulk soil; the number of bacteria around the roots of the plants, generally 10 to 100 times higher than the amount of bulk soil, demonstrates this.

Bacteria, fungi, acticomycetes, protozoa, and algae are part of the microbial colonizing rock. However, the most abundant microbial in the rhizosphere are bacteria (8). The increase in plant growth is well known and proven by the application of these microbial populations (9, 10). For the benefiting microbes, Kloepper and Schroth (11) introduced the term "plant growth promoting rhizobacteria (PGPR)," paving the way for greater findings on PGPR. PGPR is not only linked to the root to have beneficial effects on plant development but also to control phytopathogenic microorganisms. Therefore, PGPR is an active ingredient in biofertilizer formulation.

PGPR may be split into symbiotic bacteria by interaction with plants, by living within plants and exchange metabolites directly with them and free-living rhizobacteria that live outside plant cells. The PGPR operating mechanisms can also be directly and indirectly separated. Direct mechanisms include biofertilisation, root growth stimulation, rhizoric remediation and control of plant stress. On the other hand, the biological control mechanism involving rhizobacteria, in the promotion of plant growth, is indirectly by reducing the effects of diseases, including antibiotics, systemic resistance and nutrient and niche competition.

Symbiotic bacteria are mostly found in host plant intercellular spaces, but certain bacteria can form interactions with their hosts and penetrate plant cells. Moreover, some are able to integrate their physiology with the plant and thus to form specialized structures. Rhizobia, the famous symbiotic mutualistic bactéries, could establish symbiotic associations with leguminous plants and attach plant atmospheric nitrogen to specific root structures known as nodules (12).

METHODOLOGY:

- **Inoculum Preparation and procedure for seed inoculation**

Bacillus strain 6 and Pseudomonas strain 6K were derived as positive controls from the Soil in laboratory. The strain of Bacillus was gram positive, aerobic, endosporeal, rapidly growing with white colonies. The strain of Pseudomonas was gram negative, rapidly growing, bar-like, with off-white colonies and mobile cells.

The Inoculum is produced by growing in a nutrient broth the two selected PGPR strains. It was incubated with 100 revs at 28°C and shaken at 1°C. Four days inaculum (107–108 CFU mL−1) was inserted in 100 mL of kg−1 peat and incubated for 24 hours at 28 °C following inoculation of wheat seed. Baked peat, the peat was made free of germs in an oven for 30 minutes at 180°F.

The incorporation of turf and 10% of the sugar solution (100 mL kg−1) in the peat process inoculate wheat seeds (sample 1 and sample 2), The power crop, while the turf and sugar solution is treated without PGPR, which has been dried under a shade for 6-8 hours.

- **Experimental treatments**

Two cultivars and two strains of PGPR have been evaluated (Bacillus sp. strain 6 and Pseudomonas sp. strain 6K). The two bacterial strains were inoculated either individually or along with the plants. Non-inoculated seeds often have been planted for regulation. The experiment was conducted randomly with a complete block design and three replications of the factorial arrangement. The size of the net plot was 1.8 m x 5 m. The seed of both varieties were sown with a single row hand boiler with a distance of 22.5 cm from row to row using 125 kg Ha-1 seed rate.

Based on soil analysis the fertilizer used as sources urea, diammonium phosphate (DAP) and potash muriate (MOP) at a rate of 120-90–60 kg N, P, K ha-1, respectively. At the time of the sowing, half of the nitrogen and the full dose of potassium and phosphorous were applied. The remainder of the half dose of nitrogen was used in the tilling process. Data on the population of Aphid (aphid per tiller) was recorded manually and then added to 20 tillers in each plot. In addition, following data were recorded concerning plant height (cm), production tillers (m2), spike length (cm), spike spike, straw yields (Mg ha−1), and grain yields (Mg ha−1).

- **Statistical analysis**

In the experiment the data collected were analyzed using the Fisher variance analysis (two-way anova) and the methods for the treatment were compared to the less important difference (LSD) test at 5% probability level. Data analysis was conducted in a factorial arrangement using the randomized complete design using statistical software 'Statistics 8.1.'

RESULTS

Both wheat cultivars are substantially different in plant height, active tillers, spicy weight, spicy spike spike, spicy seeds, organic yield, straw yield, grain yield, aphid. Similarly, the vaccination of both PGPR strains influenced the plant height, production tillers, duration of the spike, spike spike, spike grains, biological yields, straw yields, yield of the kernels and population of aphid substantially. The relationship between wheat cultivars and PGPR was also meaningful for plant altitude, tillers, spike lengths, spike spike, spike grains, biological production, grain yield the aphid population and straw yield (Tables 1–3).

Table 1: The plant growth effect that promotes rhizobacteria on plant height, tillers and the spike length of two varieties of wheat

Treatment	Plant height (cm)		Productive tillers (m^{-2})		Spike length (cm)	
	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
T_0	78.7 f	82.0 de	232 d	263 c	8.9 f	9.04 ef
T_1	84.1 bc	84.0 bcd	277 bc	273 bc	9.8 de	9.8 de
T_2	81.8 e	82.3cde	289 bc	288 bc	10.5 cd	11.9 b
T_3	85.2 b	88.9 a	300 b	339 a	11.1 bc	13.7 a
LSD ($p \le 0.05$)	1.99		30		0.85	

The interaction numbers for Bacillus sp. strain 6 at p 0.05 don't vary significantly; T0 = no inoculation of seed; T1 = strain of bacillus sp. 6 inoculation of grain; T2 = strein of pseudomonas sp. 6K inoculation; T3 = strain of bacillus sp. 6 + strain of pseudomonas sp.

Table 2: Plant growth effect that promotes spikeletal rhizobacteria, spike grain and biological production of two wheat varieties

Treatment	Spikelets per spike		Grains per spike		Biological yield (Mg ha^{-1})	
	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
T_0	15.7 e	16.9 cd	37.2 e	39.2 d	14.1 f	15.1 d
T_1	16.5 d	17.5 bc	40.3 de	41.8 c	14.5 e	15.4 b
T_2	16.9 cd	17.8 ab	40.9 cd	44.4 b	14.6 e	15.6 b
T_3	17.1 c	18.4 a	42.1 c	46.7 a	15.3 c	15.9 a
LSD ($p \le 0.05$)	0.65		1.45		0.14	

Interaction statistics for the same case letter are not substantially different from p to 0.05; T0 = no inoculation of seed; T1 = strain Bacillus sp. 6 seed inoculation, T2 = strain Pseudomonas 6K, T3 = strain inoculation Bacillus sp.

Table 3: Effect of plant development on the straw yield and grain yield of two varieties of wheat

Treatment	Straw yield (Mg ha^{-1})		Grain yield (Mg ha^{-1})	
	Sample 1	Sample 2	Sample 1	Sample 2
T_0	6.0 g	7.6 e	3.6 h	4.0 g
T_1	7.3 f	8.1 c	4.1 f	4.2 e
T_2	7.9 d	8.6 b	4.4 d	4.5 c
T_3	8.2 c	9.0 a	4.6 b	5.0 a
LSD ($p \le 0.05$)	0.12		0.04	

Interaction characteristics of Bacillus sp. strain 6 do not vary greatly from p0.05; T0= no inaculation of seed; T1=Bacillus sp. strain 6 seed inoculation; T2=Pseudomonas strain 6K inoculation;

The aphid population was greatly decreased by the application of PGPR strains. In qlab-90 the minimum aphid population, (2,1 aphids per tiller) was reported as a seed therapy, statistically comparable with Inqlab-90-inoculates, when inoculated in a combination of PGPR strains (Bacillus + Pseudomonas Strains). In example 1, the maximum aphid population (8.2 aphids per tiller) was reported by bacterial varieties without inoculation (Figure 1).

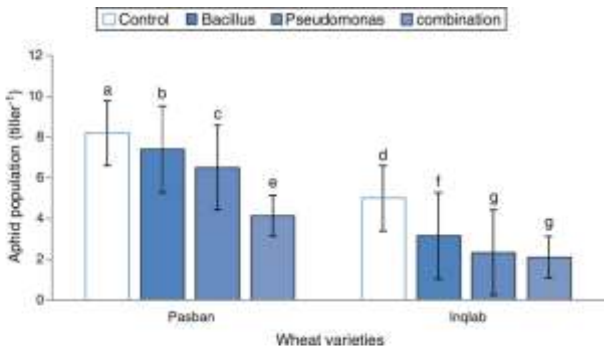

Figure 1: Apid population influenced by the application of bacterial strains

Sample 2 seed inoculations with both bacterial strains (Bacillus + Pseudomonas strains) were recorded as being interactive with PGPR strains with highest plant height, efficient tillers, lenght of the spike, spike spike tablets, spike crop, organic yields, straw yields and grain yield. Similar to Sample 2, grain inoculation raised grain per spike by 25.5% for both bacterial strains. Inqalab-91 seed yields for both bacterial strains were also increased by 38.9 percent with seed inoculation. In Sample 1, the yield of grain inoculated with both bacterial strains as controls was increased by 35.5percent (Tables 1–3).

CONCLUSION:

Significant progress was made worldwide in PGPR biofertilizer technology. PGPR was also seen to be highly productive and possible microbes to improve soil productivity and increase farm production. PGPR are good examples for the usage of new genetic components and bioactive chemicals in agriculture and biotechnology environmental sustainability. Present and future changes in our understanding of the diversity of PGPR could promote their production as trustworthy components in sustainable management of agricultural systems through colonization capability, intervention, and formulation and implementation mechanisms. It is found that the two strains of PGPR, Bacillus sp. strain 6+ Pseudomonas sp. strain 6K, are used together. This provides an enticing choice for decreasing aphid population and growing production of bread wheat.

REFERENCES:

1. Butterbach-Bahl, K.; Baggs, E.M.; Dannenmann, M.; Kiese, R.; Zechmeister-Boltenstern, S. (2013). Nitrous oxide emissions from soils: How well do we understand the processes and their controls? Philos. Trans. R. Soc. B 2013, 368.

2. Draft U.S. (2016) Greenhouse Gas Inventory Report: 1990–2014. Available online: https://www3.epa.gov/ climatechange/ghgemissions/usinventoryreport.html (accessed on 23 March 2016).

3. Armada, E.; Portela, G.; Roldan, A.; Azcon, R. (2014). Combined use of beneficial soil microorganism and agrowaste residue to cope with plant water limitation under semiarid conditions. Geoderma, 232, pp. 640–648. [CrossRef]

4. Khan, A., Ding, Z., Ishaq, M., Khan, I., Ahmed, A. A., Khan, A. Q., & Guo, X.: Applications of beneficial plant growth promoting rhizobacteria and mycorrhizae in rhizosphere and plant growth: A review. International Journal of Agricultural and Biological Engineering, 13(5), pp. 199-208.

5. Ahmad, F.; Ahmad, I.; Khan, M.S. (2008). Screening of free-living rhizospheric bacteria for their multiple plant growth promoting activities. Microbiol. Res., 163, pp. 173–181. [CrossRef] [PubMed]

6. Burdman, S.; Jurkevitch, E.; Okon, Y. (2000). Recent advances in the use of plant growth promoting rhizobacteria (PGPR) in agriculture. In Microbial Interactions in Agriculture and Forestry; Subba Rao, N.S., Dommergues, Y.R., Eds.; Science Publishers: Enfield, NH, USA; pp. 229–250.

7. Weller, D.M.; Thomashow, L.S. (1994). Current challenges in introducing beneficial microorganisms into the rhizosphere. In Molecular Ecology of Rhizosphere Microorganisms: Biotechnology and Release of GMOs; O'Gara, F., Dowling, D.N., Boesten, B., Eds.; VCH: New York, NY, USA; pp. 1–18.

8. Kaymak, D.C. (2010). Potential of PGPR in agricultural innovations. In Plant Growth and Health Promoting Bacteria; Maheshwari, D.K., Ed.; Springer-Verlag: Berlin/Heidelberg, Germany.

9. Saharan, B.S.; Nehra, V. Plant growth promoting rhizobacteria: A critical review. Life Sci. Med. Res., 21, pp. 1–30.

10. Bhattacharyya, P.N.; Jha, D.K. Plant growth-promoting rhizobacteria (PGPR): Emergence in agriculture. Wood J. Microb. Biotechnol., 28, pp. 1327–1350. [CrossRef] [PubMed]

11. Kloepper, J.W.; Schroth, M.N. (1978). Plant growth-promoting rhizobacteria on radishes. In Station de Pathologie, Proceedings of the 4th International Conference on Plant Pathogenic Bacteria, Tours, France, 27 August–2; Végétale et Phyto-Bactériologie, Ed.; pp. 879–882.

12. Egamberdieva, D.; Lugtenberg, B. (2014). Use of Plant Growth-Promoting Rhizobacteria to Alleviate Salinity Stress in Plants. In Use of Microbes for the Alleviation of Soil Stresses; Springer: New York, NY, USA, 2014; Volume 1, pp. 73–96.

Corresponding Author

Richa Pandey*

PhD Scholar, Department of Biotechnology, College of Commerce, Arts, Science, Magadh University, Patna

pandey.richa768@gmail.com