Review Article: Plant Growth Promoting Rhizobacteria (PGPR): Apply as potential biofertilizer in banana plant


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ABSTRACT

Plant growth in agricultural soils may influenced by many abiotic factors. The thin layer of soil surrounding to plant roots is an extremely important and active area for root activity and their metabolism which is known as rhizosphere. The rhizosphere concept was first introduced by Hiltner to describe the narrow zone of soil surrounding the root areas where microbe populations are stimulated by root activities. A large number of microorganisms such as bacteria, fungi, protozoa and algae coexist in the rhizosphere area. Plant growth promoting bacteria fund in soil, it may be bacteria, fungi, actinomycetes, protozoa and algae.

PGPR microorganisms enhance the plant growth and also protect the plants from disease. It may serve as alternative source of chemical fertilizer, which causes negative impact on soil ecosystem.

Keywords: PGPR (Plant growth promoting bacteria), growth hormones, organic acid producers, siderophore producing microorganisms

V.G. Bhargavi Rayavarapu and Tallapragada Padmavathi (2016) studded that Plant Growth Promoting Rhizobacteria (PGPR) present in the rhizosphere influences the plant growth and its productivity by various mechanisms. Most efficient PGPR strains are involved in the development of plant growth by producing various regulatory hormones or chemicals in their vicinity of the rhizosphere, they may fix atmospheric nitrogen, reduce toxic compounds, synthesize siderophores like compounds and suppress the growth of pathogenic microorganisms. The Bacillus was isolated from rhizosphere and biochemically characterized and screened in vitro for their PGPR traits like production of IAA, Phosphate solubilization, Siderophore, Ammonia, HCN, Catalase, Organic acid production and observed for heavy metal and salinity tolerance.bacillus showed positive response towards all the PGPR traits which are responsible for plant growth. Thus, Bacillus can enhance the plant growth and also combat with heavy metal and salinity stress of soil. It is eco friendly. It may be recommended as bio fertilizers for agricultural crops instead of using as chemical fertilizers. The main objective of study was Bacillus being a potent plant growth promoting rhizobacteria (PGPR) was added as biofertilizer for increasing the crop yield instead of using chemical fertilizers.

M.A. BASET MIA et al (2017) reported that Banana, an important fruit crop, requires high amounts of chemical fertilizers for commercial cultivation; it is very costly and can be hazardous to the environment, when used excessively. Plant growth promoting rhizobacteria (PGPR) could be used for growth promotion, nutrient uptake and some time as an alternative source of N-fertilizer of non-leguminous crops. Research on PGPR for crop improvements are gaining prominence and thousands of research works have been published so far. However, use of this noble technique in banana production system is limited. various experimental findings suggested that PGPR strains could successfully formed colonies on the root surface of bananas, where more bacterial cells were found in the root hair

proliferation zone. Application of PGPR alone could not produce significant benefits that require minimal or reduced levels of fertilizer-N consequently could produce a synergistic effect on root growth and development. The inoculation also increased the N yield and fixed N2 in association with banana roots subsequently increased the yield, improved the physical attributes of fruit quality and initiated early flowering. PGPR are effective as a bioenhancer and biofertilizer for banana cultivation.

N. Ayyadurai, P et al (2005) reported that Bacterium FP10 was isolated from the banana rhizosphere and Production of plant growth hormone, indole-3-acetic acid (IAA), siderophores and phosphate-solubilizing enzyme in FP10 was determined. Strain FP10 tested negative for hydrogen cyanide, cellulase and pectinase, the deleterious traits for plant growth. The antibiotic produced by FP10 was confirmed as DAPG using thin layer chromatography; high performance liquid chromatography and Fourier transform infrared and tested for fungal antibiosis towards banana pathogens. Procedures for encapsulation of banana shoot tips with FP10 are described which can enhance the productivity of plant.

A.R.Apastambh (2016) studded that Plant Growth Promoting Rhizobacteria (PGPR) are free living soil microorganisms that exert beneficial effects on plants. Total 8 strains of fluorescent pseudomonas and four strains of Bacillus were isolated from Banana rhizosphere of nanded, Maharashtra. These strains were characterized morphologically and biochemically and studied for their plant growth promoting activities such as IAA production, GA production, Phosphate solubilization. Bio-control traits of the isolates were also studied such as siderophore production and HCN production. These strains were tested for antifungal activity against plant pathogens Alternaria solani and Fusarium oxysporum. Yps 8 exhibited the most effective antifungal activity against Alternaria and Yps1 exhibited the most effective antifungal activity against Fusarium oxysporum.

Faisal Islam (2015) Salinity, a frequently occurring abiotic stress, is a major constraint for crop productivity worldwide. plant growth promoting rhizobacteria (PGPR) Bacillus cereus Pb25, isolated from soil irrigated with saline water, to promote Vigna radiate (mungbean) growth in the absence and presence of salt stress (9 dS m-1). Results demonstrated that B. cereus promoted V. radiate plant growth significantly even in the presence of salt. Inoculations with PGPR improved the plant growth and increased the root, shoot fresh and

dry biomass and yield as compared to plants with no bacterial treatment (control). Results showed that both chlorophyll content and plant growth were inhibited by saline stress and the salt-induced oxidative damage (measured by MDA, H2O2) was alleviated by PGPR inoculation. Furthermore, PGPR inoculation significantly increased the antioxidant enzymes (POD, SOD and CAT) activities and enhanced the accumulation of proline, potassium, nitrogen and phosphorus as well as decreased sodium accumulation in saline stressed plants. Regarding the soil biological activity, inoculated PGPR enhanced the activity of dehydrogenase, alkaline phosphatase, microbial biomass carbon, available phosphorus and total organic carbon under saline stress as compared to saline treatment alone. These results suggest that B. cereus can be used in salinized agricultural lands as bio-inoculants to increase crop productivity.

P.D. Sarode (2007) Studied on indigenous micro-flora of local rhizosphere and identification of efficient plant growth promoters is important for development of good bioinoculants for re-strengthening of otherwise derailing IPM initiative. Performed screening for efficient siderophoregenic PGPRs from rhizospheres Pseudomonas putida DFC31 isolated and identified and able to improve overall vigor/ percent germination of groundnut seeds and also partially inhibit the growth of potent phyto-pathogens. Its sidero-analysis revealed that this siderophore molecule contains hydroxamate as well as catecholate iron chelating groups. Spectrometric study in various forms of siderophores confirmed that this siderophore belongs to pyoverdine type. In addition to siderophore production, IAA production and phosphate solubilization attributes were observed. data Presented herewith lays foundation for advanced studies on strain, in near future.

Aras Muhammad Khudhur(2018) noticed that Plant growth promoting rhizobacteria (PGPR) are a group of bacteria which can enhance growth parameters and yield of host plants and can be used as biofertilizers. Fluorescent pseudomonads are considered to be one of the most promising groups of plant growth promoting rhizobacteria involved in promoting of plant growth. The current study was aimed to isolate and identify plant growth promoting fluorescent pseudomonads from Erbil soil, and evaluate the plant growth promoting bioagents of the isolated strains then selecting the most efficient isolates and use to improve Zea mays growth and yield. For this purpose, random sampling from the rhizosphere area was performed. Fluorescent Pseudomonads were isolated by culturing in enriched and

selective King B medium and were identified based on morphological and biochemical assays. A total of 14 strains of fluorescent Pseudomonads were isolated and 8 isolates identified as Pseudomonas fluorescens and 6 isolates belonged to Pseudomonas putida. Plant growth promoting traits of the isolates were also studied such as phosphate solubilizing activity, IAA, siderophore, and HCN production. All isolates exhibited high potential of phosphate solubilisation, IAA, HCN and siderophore production, except (Ppu9) isolate and (Pfl6, Pfl12, and Ppu13) isolates showed negative results in HCN and siderophore production, respectively. The most efficient isolates (Pfl3, Pfl10, Ppu8, and Ppu11) were selected for pot experiment and used to inoculate Zea mays seeds before sowing. collected on shoot and root length, shoot and root dry weight, number of grain per cob, grain yield per plant and grain yield per hectare. Results showed that all isolates had significantly ($p \leq 0.05$) increased crop growth and productivity. The highest growth and yield were found in combined inoculated plants with Pfl3+Ppu8 followed by Pfl3+Ppu11treated plants, which increased significantly over than single inoculated and non-inoculated plants. The results revealed that plant growth promoting fluorescent pseudomonads can be used as biofertilizer to improve plant growth.

Luisa F (2016) tested a funnel-like strategy to bioprospect aerobic endospore-forming bacteria (AEFB) that could be useful to develop a biotechnological product to promote the growth of banana plants. First, 837 aerobic endospore-forming bacteria were obtained from the rhizosphere of banana and plantain. Then, the isolates were assessed for both: their capacity to promote growth of maize seedlings (used as a model plant) and to display specific biochemical PGPR-associated traits. Twenty-two of these strains significantly increased the dry weight of maize seedlings, some of them showing in vitro PGPR traits. Based on this screening, four isolates were selected to conduct evaluations on banana plants, from which, the bacterial strain Bacillus subtilis EA-CB0575 was chosen as a promising plant growth-promoting isolate. Further studies with this strain showed that the application of either spores, vegetative cells (both at concentrations 1 × 107and 1 × 108CFU/mL), or the cell-free supernatant (CFS) of its fermentation significantly increased the dry weight of banana plants, compared with the non-treated control. Our results suggest that both cellular structures of B. subtilis EA-CB0575 and the metabolites and/or elements contained in its CFS enhance the growth and development of banana plants.

S. Harish a (2006) reported that rhizosphere and endophytic bacterial isolates from the roots and corms of banana were tested for their bio-control efficiency against Banana bunchy top virus (BBTV). Molecular characterization using RAPD and microsatellite markers revealed genomic variability in the endophytic Pseudomonas and Bacillus isolates. Bio-formulations of mixtures of the rhizobacterial isolate. In addition to disease control, a significant increase in the yield (53.33%) was noticed in the bacterized plants when compared to the control plants. Pathogenesis-related (PR) proteins, chitinase and b-1,3-glucanase and defense-related proteins, peroxidase, polyphenol oxidase, phenylalanine ammonialyase and phenolic compounds were significantly activated in the bacterized plants, thus inducing resistance against bunchy top virus. Populations of endophytic bacteria also remained high and stable throughout the growing period. Thus, application of mixtures of rhizosphere and endophytic bacteria increases yield and has a potential role in inducing resistance against Banana bunchy top virus.

Sadaf Kalam (2012) reported that rhizosphere microbial community has diverse metabolic capabilities and plays a crucial role in maintaining plant health. Oligotrophic plant growth promoting rhizobacteria (PGPR), along with difficult-to-culture microbial fractions, might be involved synergistically in microbe-microbe and plant-microbe interactions in the rhizosphere. Among the difficult-to-culture microbial fractions, Acidobacteria constitutes the most dominant phylum thriving in rhizospheric soils. They selected effective PGPR for tomato and black gram and studied their effect on population densities of acidobacterial members. they suggested that putative interactions between these two bacterial groups thriving in rhizospheric soils could be beneficial for plant growth.

Oscar A *et al* (2011) noticed that Plant growth-promoting rhizobacteria (PGPR) naturally occur in the rhizospheres of pasture, but still little is understood regarding how soil agricultural practices affect them. they examined the effects of long-term nitrogen (N) fertilisation on the occurrence of potential culturable PGPR in rhizosphere soils from pastures grown in Chilean Andisols.they also evaluated in vitro the effects of organic acids (citric, malic and oxalic acids), metals (Al and Mn) and N supply (urea and ammonium sulphate) on indole acetic acid (IAA) production and phosphorus (P) liberation by selected strains. Compared with non-Nfertilised pasture, N fertilisation significantly increased (30%) the occurrence of culturable phosphobacteria but decreased (7%) the occurrence of IAA-producing rhizobacteria. Most efficient IAA-producing phosphobacteria were identified as Bacillus, Enterobacter, Pseudomonas and Serratia. At low pH (4.8), the assays showed that

the IAA production by Serratia sp. N0-10LB was increased (31–74%) by organic acids. On the other hand, the IAA production by Pseudomonas sp. N1-55PA was increased two- to fivefold by metals. In all strains, the growth and IAA production were significant decreased by 500 µM of Al, except Serratia sp. N0-10LB, suggesting its potential as PGPR for Chilean Andisols. When urea was added as main N source, the bacterial growth and P utilisation significantly increased compared with ammonium sulphate. The influence of environmental factors that are typical of Chilean Andisols on rhizobacterial communities will provide better management practices to enhance their PGPR functions as well as a better selection biofertilisers to be used in Chilean Andisols.

Jun Yuan (2012) Bacillus reported that amyloliquefaciens strain NJN-6 is an important plant growth-promoting rhizobacteria (PGPR) which can produce secondary metabolites antagonistic to several soil-borne pathogens. In study, the ability of a bio-organic fertilizer (BIO) containing NJN-6 strain to promote the growth and suppress Fusarium wilt of banana plants was evaluated in a pot experiment. The results showed that the application of BIO significantly decreased the incidence of Fusarium wilt and promoted the growth of banana plants compared to that for the organic fertilizer (OF). To determine the beneficial mechanism of the strain, the colonization of NJN-6 strain on banana roots was evaluated using scanning electron microscopy (SEM). The plant growth-promoting hormones indole-3-acetic acid (IAA) and gibberellin A3 (GA3), along with antifungal lipopeptides iturin A, were detected when the NJN-6 strain was incubated in both Landy medium with additional L-tryptophan and in root exudates of banana plants. In addition, some antifungal volatile organic compounds and iturin A were also detected. In summary, strain NJN-6 could colonize the roots of banana plants after the application of BIO and produced active compounds which were beneficial for the growth of banana plants.

CONCLUSION

Sustainable agriculture implies successful management of resources for agricultural to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources. Use of Plant Growth Promoting Rhizobacteria can play an important role toward achieving the objectives of sustainable agriculture. Bacteria which live in Rhizosphere region are called Rhizobacteria. Some of these bacteria are attached to

the soil particles. Usually bacteria population density, are around the root plant, because of abundant food sources around the plants root that support the growth sources and bacteria metabolism. High amounts of agrochemicals are regularly used for increasing yields in cultivation of banana like plants. The use of plant growth-promoting rhizobacteria (PGPR) could represent an environmentally friendly alternative that can improve productivity. Various chemical fertilizers are used in different doses for crop improvement purpose in agriculture. But for several side effects of agrochemicals there is an increased concern on the co-operative activities between plants and the rhizospheric microbes. the PGPR (Plant Growth Promoting Rhizobacteria) application opening a new gateway to solve these problems. The PGPRs not only can improve soil fertility but also enhance plant growth and soil ecosystem.

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