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BENEFITS AND DRAWBACKS OF PLANT GROWTH PROMOTING RHIZOBACTERIA ON PLANT GROWTH

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ABSTRACT

Numerous species of soil bacteria grow in rhizosphere region of plant &enhance the plant yield as well as soil fertility collectively called as PGPR (plant growth promoting rhizobacteria). Plant growth promoting rhizobacteria are the bacterial breed of rhizosphere that can enhance plant growth by wide range of mechanism such phosphate solubilisation, nitrogen fixation etc. They are mostly naturally occurring bacteria which can easily colonize the plant root & increase the plant yield. According to all above characteristic of the PGPR, are made to exploit them commercially as bio-fertilizer. Various PGPR that act as biofertilizerare: *Azotobacter, Potassium solubilizing bacteria, Nitrogen fixing bacteria, Phosphate solubilizing bacteria* etc. Along with the positive effect of biofertilizer there is also some negative effect that affects the plant yield as well as soil fertility. The purpose of this review is to find out the beneficial & harmful effects of PGPR on plant growth.

Keywords: - PGPR, biofertilizer, Plant growth, Detrimental effects

INTRODUCTION

Worldwide growth in population, increase in the demand of global food production, and environmental damage causing problems in agriculture yield are major concerns to the world. It is essential to significantly increase the agricultural productivity for next decades. Nowadays, farmer use chemical fertilizer because they provide immediate nourishment and increase the production of plant. However, the over use of chemical fertilizer can cause unanticipated environments impacts. Such as soil acidification, change in ph. of soil, increased pest control, & also produce some toxic material in soil which affect the fruits & vegetables **[1]**. One of the important alternative of chemical fertilizer is PGPR. PGPR promote plant growth by producing plant hormones and providing uptake of nutrients from the soil through different direct and indirect mechanisms **[2]**.

Today PGPR are commonly used in developing countries & inoculants are used on millions of hectors of land **[3]**. The term plant growth promoting rhizobacteria refers as soil bacteria which are able to colonize root system and either present in the rhizosphere, in the root surface or inhabiting space between cortical cell.

According to **[4]**, the plant growth promoting bacteria also have deleterious effects on plant growth as well as soil environment. The deleterious microorganism affect the plant negatively by different way.

Background study

In the broadest sense, beneficial rhizosphere microorganisms include symbionts (*Rhizobium, certain Actiomycetes, and mycorrhizal* fungi), and free living saprophytes that increase the availability of nutrients orplant growth substances to plants and/or suppress parasitic and nonparasitic pathogens **[5]**. The mechanisms by which the PGPR enhance plant growth are divers and include nitrogen fixation, phosphate solubilisation, counteraction of plant pathogen microorganisms, or regulation of different plant hormone levels **[3, 4]**.

According to **[6]**, whole microbial community in rhizosphere niche needs to be altered to mediate the plant growth promotion by PGPR. PGPR promote the plat growth either facilitating the direct mechanism (nitrogen fixation, phosphate solubilisation, etc.) & indirect mechanism (as bio control agent) **[7]**.

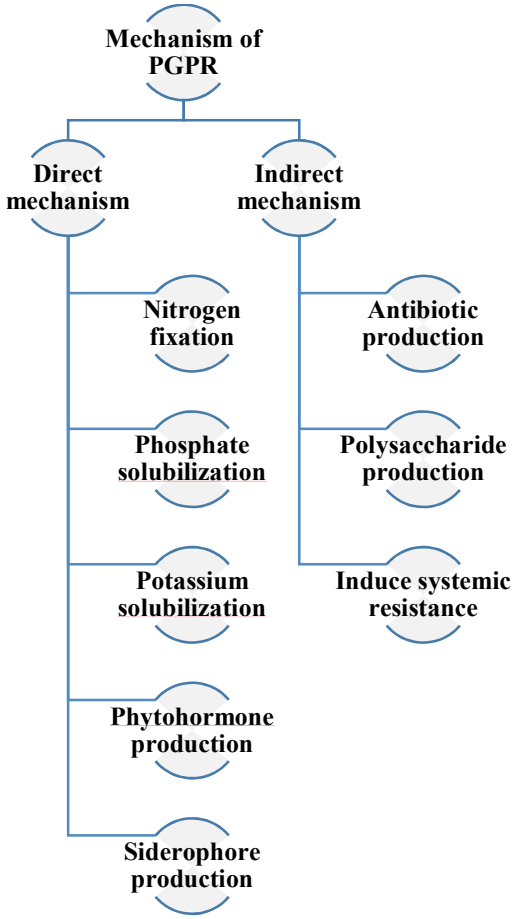

Figure 1: Mechanism of plant growth promoting rhizobacteria

Beneficial role of PGPR

Plant Growth Promoting Rhizobacteria (PGPR) is widely recognized, as they offer the use of soil microorganisms in practicing sustainable and climate resilient agriculture, reducing the use of chemical fertilizers and pesticides. The importance of PGPR increases when the soil become poor in nitrogen. The bacteria can effectively promote the plant growth by providing limiting element **[8]**.

1. PGPR as biofertilizer:-

Biofertilizer are the products carries with it living organism which, when introduce to the seeds or plant surfaces adjacent to soil, can colonize rhizosphere or promote the plant growth. The PGPR function as biofertilizer are often categorized into two groups, consistent with their mode of interaction with their host:

(1) Rhizospheric and (2) endophytic **[9, 10]**. The attribute of the PGPR acting as biofertilizer, and thus enhancing the nutrient status of host plant is categorized into five distinct areas by mechanisms:

1. Biological N2 fixation
2. Increasing the provision of nutrients in rhizosphere

3. Increase in root extent
4. Enhancing beneficial growth of the host
5. Collaboration of all the above modes of action

[11] reported that, PGPR also promote plant growth by presenting as both; biofertilizer and bio pesticide. For example, *Burkholderia cepacia* can increase growth of maize under iron-stress enviornment bysiderophore production as well as it has shown the biocontrol or antifungal activity against Fusarium spp. *Azotobacterium allorhizobium, Azorhizobium, Bradyrhizobium, Mesorhizobium, Rhizobium and Sinorhizobium* are the known potent PGPR strains for their ability to act as bio-fertilizers **[12]**.

2. Role of PGPR in growth enhancement:-

PGPRs are wont to support the plant growth, seed germination and overall yield of crop plants. Plant growth parameters like area of leaf, chlorophyll concentration and as a result total biomass have been reported to be increased; one such observation is made by **[13]**. PGPR strains namely *Achromobacter xylosoxidans, Bacillus subtilis, B. licheniformis, B. pumilus, Brevibacterium halotolerans* and *Pseudomonas putida* are known for their role in plant growth promotion **[14]**. According to **[15]**, when plant is inoculated with *Azospirillum sp*., the mass of some agriculturally important plants and considerable increase in the dry weight of the root and aerial parts of the plants were observed. **[16]** reported that inoculation of maize with *Azospirillum brasilense* resulted in a proliferation of root hairs which could have dramatic effects on increasing root surface area. Over the years, it has been observed that the PGPR increased the crop yield by 20-30%, along with that also replace the application of chemical fertilizer and make soil biologically active which enhance plant growth. So overall result of above research work prove that use of PGPR inoculant reduce the use of chemical fertilizer for plant growth.

3 Impact of PGPR on root growth of plant:-

Modifying the root system structure by PGPR allowed the development ofphytohormones and other signals that lead, the growth of lateral root branching and development of root hairs. Inoculation of seeds with PGPRs like *Agrobacterium, Bacillus, Pseudomonas, and Streptomyces* are reported to enhance root formation **[17]**. **[18]** observed the impact of PGPRs on rooting system and root growth of *Actinidia deliciosa* (kiwifruit) stem cuttings. PGPR also able to produce IAA (indole acetic acid), IAA can stimulate primary root elongation,

whereas high IAA levels increase the formation of lateral roots, decrease primary root length and increase root hair formation **[15]**. From above observation we conclude that PGPR provide positive impact to system for plant root development.

4. Production of volatile organic compound by PGPR and its role:-

Some strains of PGPR able to release volatile organic compounds (VOCs), which can be helping mechanism in plant growth promotion **[9]**. During study with *Arabidopsis thaliana*, **[19]** reported *Bacillus subtilis GB03, Bacillus amyloliquefaciens IN937a and Enterobacter cloacae JM22* releasing a mixture of volatile compounds which serve as signaling molecules for PGPR interaction to plant. VOCs are used as signaling molecule for understanding the plant & PGPR interaction.

5. Function PGPR in resistance of plant disease.

Different PGPR strains when blend in proper mixture and applied to the seeds of certain plants; can result in improving capacity of induced systemic resistance (ISR) against pathogens. **[20]** gave treatment to cucumber seeds with rhizobacterial strains like *P.putida* 89B-27 and *Serratiamarcescens* 90–166 and found the decreased level in bacterial wilt. Some strains of Bacillus like *B. amyloliquefaciens, B. subtilis, B. pasteurii, B. cereus, B. pumilus, B. mycoides and B. sphaericus*are recorded to elicit significant reduction in disease incidence on diversity of hosts in green house and field trials **[19]**.

6. PGPR as biocontrol agent:-

PGPRs act as biocontrol agent by competing for nutrients and niche, inducing systemic resistance and production of anti-fungal metabolites (AFMs). Commonly the PGPRs are reported to produce AFMs, of which phenazines, 2, 4-diacetylphloroglucinol (DAPG), pyoluteorin, and tensin are the frequently detected classes **[21]**. *Azospirillum, Azotobacter, Bacillus, Pseudomonas and Streptomyces* are the genera of PGPRs acting as biocontrolagent **[9]**.

Negative impact of PGPR on plant growth:-

Along with the beneficial impact of PGPR, they also have deleterious or negative impact on plant yield. Their deleterious activities include alteration of supply of water, ion, changing in root function **[4]. [21]** classified the rhizosphere microorganisms as beneficial (symbiotic) microbes, harmful (pathogenic)microbes, or having no effect on the plant (neutral) microbes. The bacteria which are produce harmful effect to rhizosphere called deleterious rhizosphere

microorganism (DRMO),that affect plant by their metabolites without parasitizing pant tissue **[22, 23]**. DRMO may affect plant mass by involving with the supply of plant growth substances or nutrients to plants by free-living rhizosphere microorganisms **[4]**.

1. **Proper selection of PGPR:-**

For introducing PGPR based product to commercial use, it is hard challenge to select effective strain of PGPR **[24]**. It is required to select the peticular the species of PGPR according to the requirement of product.

Successful establishment of the introduced bacteria depends on proper PGPR strain that must be tailored to soil & crop combination. Other basic issue of PGPR, inoculum production, storage, and delivery that have mostly remove the use of non-spore forming bacteria.

Microorganisms are able to make metabolites that inhibit root growth processes may have an effect on crop production **[25]**. **[26]** demonstrated the detrimental effect of indol acetic acidby rhizosphere-introduced *pseudomonads* on root elongation of sugar-beet seedlings. manyrhizosphere microorganisms have ability to make metabolites such as antibiotics that are toxic to plant roots **[27]**.

FUTURE PROSPECTS/CONCLUSION

By knowing the positive and detrimental effect of PGPR along with the mode of action of PGPR one can expect the new PGPR product becoming available. Genetic engineering techniques can used to improve colonization and effectiveness of PGPR strains; involved in improving plant growth. PGPR technology offers an environmentally feasible contribution in agricultural production that may lead to new products with improved effectiveness.

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