A REVIEW PRESENCE OF PLANT GROWTH PROMOTING MICROORGANISM IN CACTI PLANT

[1]Anjali Vasantbhai Patel, [2]Trupti Pandya

[1]M.Sc. Microbiology Student, [2]Teaching Assistant
[1]Department of Microbiology
[1]Bhagwan Mahavir College of Basic & Applied, Bhagwan Mahavir University, Surat, India
E.mail- truptipandya1996@gmail.com

Abstract: Soil is a dynamic living matrix that is essential for all life processes and not just for producing agricultural products. The ecology is greatly harmed by using chemicalfertilizers in agriculture to increase yields and control weeds, pests, and diseases. An understanding of the cooperative behaviours of plants and rhizosphere microbialcommunities has been developed due to current public concerns about the symptomsof agrochemicals. Therefore, there is a need for biological agents that are known around theworld. Plant Growth Promoting Rhizobacteria (PGPR) provides a superior solution to this issue. PGPR are bacteria that can help plants respond more effectively to biotic and abiotic challenges. Several natural elements, including soil type, plant cultivar, environmental change, anthropogenic activities, and more, impact rhizosphere microbiomes, which have been shown to enhance plant development and productivity. Rhizobacteria that fix nitrogen in a free-living and endophytic state can help achieve this goal. To improve both above-ground and underground biomass, Rhizobium, Pseudomonas, Azospirillum, and Bacillus have been found to affect crops. These organisms may therefore play an important role in achieving sustainable agribusiness results. As a result, it's critical to take this rhizosphere microbiome into account using increasingly sophisticated culture-free techniques. It emphasizes the need to investigate variables that can alter the rhizosphere microbiome and focus on the contributions of nitrogen-fixing microorganisms to productive horticultural outcomes at a reasonable cost and the methods that can be applied to improve them. Future research into rhizosphere science will be based on the advancement of sub-atomic and biotechnological methods to deal with the growth in our understanding of rhizosphere science and to achieve coordinated management of the soil microbial population. Acinetobacter, Alcaligenes, Azospirillum, Azotobacter, Bacillus, Beijerinckia, Burkholderia, Derxia, Enterobacter, Gluconacetobacter, Herbaspirillum, Ochrobactrum, Pseudomonas, Rhodococcus, Serratia,. Most Cactaceae species have modified axillary buds termed areoles, which are axillary buds with spines and lack leaves. The cacti are mostly succulent and have evolved to thrive in extremely xeric environments. Numerous varieties are currently grown extensively worldwide, largely as ornamentals and curiosities, due to their frequently unusual structures and appearances. Some cacti species are employed as hedge plants, fruit and fodder sources, and food for livestock. Opuntia ficus-indica (Linnaeus) Miller, commonly called "prickly pear" or "cactus pear," is the most widespread and economically significant species in the Cactaceae. Numerous locations cultivate this species.

Keywords: Rhizospheric soil, IAA, N2 fixation, PSBs, Bacillus, EPS, Drought area, PGPR, siderophores, Cacti Plant, Hydroponic

INTRODUCTION

Cactus, plural cacti or cactuses seed plant family with nearly 2,000 species and 139 genera. Basic anatomical features of Cactaceae have been studied since the 16th century [57, 22]. More recently, other features have been observed for cultivated plants. Eight genera and 318 endemic species belonging to 42 families were listed within the Biome. Boosfeld[14] was one of the primary to emphasize the correlation of internal anatomy with external forms mayalso have very different external forms can also have very different internal structures. Among the modifications accompanying the evolution of cacti from a leafy ancestor that employs C3 photosynthesis to stem photosynthesis. Crassulacean acid metabolism (CAM) succulent is a stem with a rise in stomatal frequency. Recent research studies have shown that microorganisms can affect the plant since they produce compounds like phytohormones and siderophores [74].

Furthermore, microbes act as phosphate solubilizers and N2-fixers and are antagonists against fungal pathogens [74, 44, 64]. These characteristics are directly or indirectly involved in plant growth promotion [40]. 40% of the carbon fixed by the plant is changed over into root exudates [52] which contains particle, free oxygen, water, enzyme and carbon-based compound, and root-derived compounds among microorganisms. The Association of plants with beneficial microbes, collectively called plant growth-promoting Rhizobacteria(PGPR), Includes nitrogen-fixing bacteria, mycorrhizal fungi and biocontrol agents, which are bunch emphatically collaborating living beings. Negative connection plant with pathogenic microorganisms or growths. The nodule is the plant part where the bacteria, once transformed into a bacteroid,carry out the biological process [40]. Cacti occur within the new world from western and southern Canada. Genus Rhipsalis has scattered normally, without a doubt, by birds to tropical Africa and Madagascar and across to country and Southern India [62].

Table 1: Types of Cacti:[45]

Common name	***Scientific name***	**Soil pH**	**Special Characteristics**
Acanthocalycium glaucum	*Acanthocalycium glaucum*	6.1-7.8	Container, showy flowers.
Armatocereas Oligogonus	*Armatocereas Oligogonus*	6.1-7.8	Showy flowers.
Arrojadoa penicillata	*Arrojadoa penicillata*	6.1-7.8	Container
Austrocylindropuntia	*Austrocylindropuntia*	6-8	Container
Ball cactus	*Parodia Magnifica*	6.1-7.8	Container, Tolerates drought and is easy to grow.
Beaver Tail cactus	*Opuntia basilaris*	6.1-7.8	Container, Tolerates drought.
Brain cactus	*Stenocactus Multicostatus*	6.1-7.8	Container, Tolerates drought.

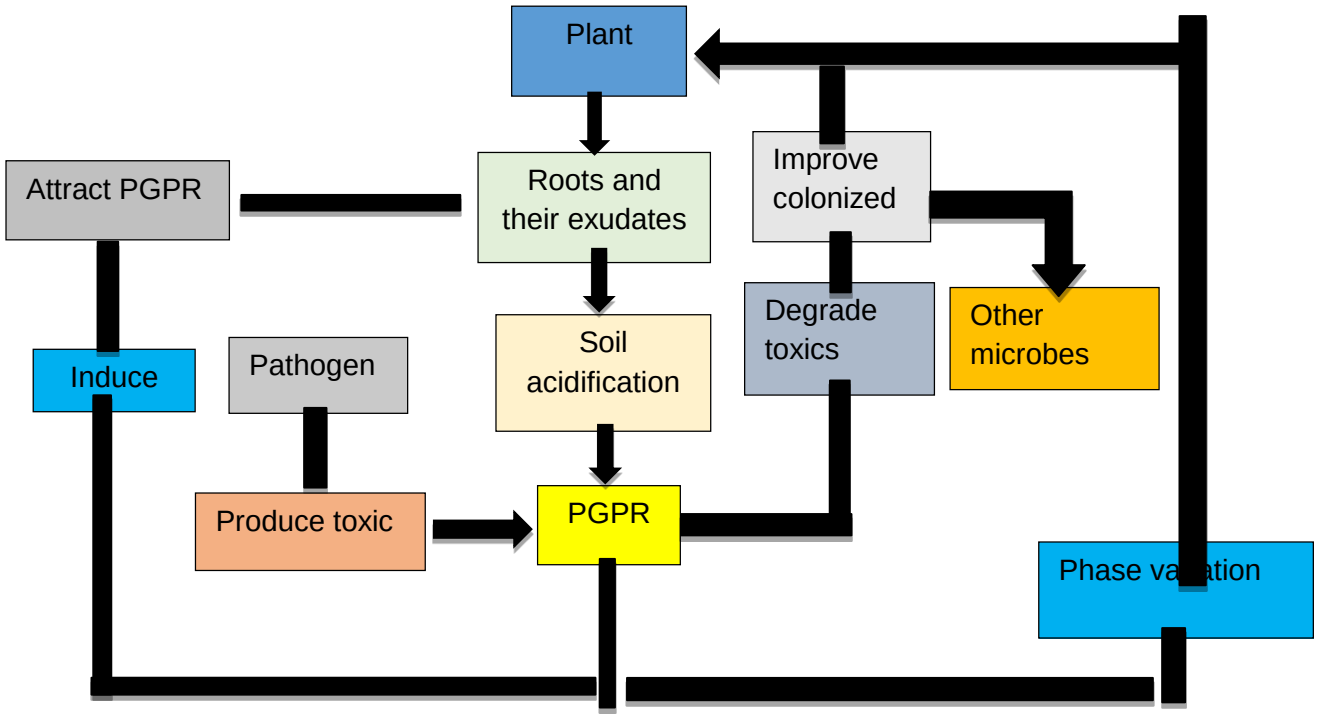

Figure 1 Interaction of plant root exudates, pathogens, PGPR, and other beneficial microbes in the rhizosphere [38].

In 1888 Beijerink obtained the grist pure bacterial culture named *Bacillus radicicol. Nodule suspension.* These isolates could nodulate Pisum, and vicia was later renamed *Rhizobium leguminosarum* [27, 40] and collected the soil sample from different sides. Root portion soil collected. Add into sterile H_2O and quiet down the soil after dilution and plating. Perform the gram staining and motility and another test. Isolation and screening in organism's *pseudomonas stutzeri, Bacillus Cereus, Bacillus subtilis, Bacillus amyloliquefaciens, Bacillus spp, pseudomonas spp, serratia, Azotobacter spp, microbacterium, S. aureus, E. Coli, Klebsiella, Enterobacter.*

Table 2 Some indirect mechanisms of PGPR

Mechanisms	**Associated Micro-Organisms**	**Reference**
Phosphate solubilization	*Bacillus spp.* *Enterobacterium* *microbacterium* *Pseudomonas spp.* *Rhizobium* *Serratia*	[77, 78]
Nitrogen fixation	*Azotobacter spp* *Rhizobia spp* *Azospirillum spp.* *Bacillus polymyxa*	[77, 78]
Production of siderophores	*Staphylococcus aureus* *Escherichia coli*	[51, 77, 78]
Indole Acitic Acid produce	*Klebsiella* *Enterobacter*	[77, 78]
Exopolysaccharides produce	*Rhizobacteria*	[67, 77, 78]

I. INORGANIC PHOSPHATE SOLUBILIZATION

Plant development advancing rhizobacteria are the dirt microorganisms that colonized plant roots. Work with the plant development straightforwardly or by implication. Decrease the world's dependence on hazardous agricultural chemicals. Animate plant development through activating supplements in soils. Proficient at colonizing the foundation surface to survive, multiply and compete with other microbiota. Promote plant growth classification supported their functional activity as Biofertilizer, phytostimulators, Rhizoremediators, and Biopesticides. Plant development advancing rhizobacteria advance plant development straightforwardly and by implication [77].

Phosphate-solubilizing microbes utilize different mechanisms to achieve the insoluble types of phosphate into dissolvable structures. Natural acids delivered by the miniature life forms go about as great chelators of divalent cations of Ca2+ going with the arrival of phosphates from insoluble phosphatic compounds. Natural acids may frame dissolvable buildings with metal particles related to insoluble 'P', delivering the phosphate [36]. A considerable lot of the PSMs bring down the pH of the medium either by H+ expulsion [36] or by emission of natural acids, for example, acidic, lactic, malic, succinic, tartaric, gluconic, 2-ketogluconic, oxalic and citrus extracts. The contribution of microorganisms in the solubilization of inorganic phosphates was referred to as soon as 1903 [48]. Constitute 20 to 40% of the culturable populace of soil microorganisms, and a critical extent of these can be disengaged from rhizosphere soil [18]. Most PSB are confined from the rhizosphere of different plants and are known to be metabolically more unique than those secluded from sources other than the rhizosphere. These low degrees of P are because of the great reactivity of dissolvable P with calcium (Ca), iron (Fe) or aluminium (Al), which prompts P precipitation. Inorganic P in acidic soils is related to Al and Fe compounds. However, calcium phosphates are the dominating type of inorganic phosphates in calcareous soils. Natural P may likewise make up an enormous part of solvent P, however much half in soils with high natural matter substance [10].

Soil phosphates are delivered accessible either by plant roots or by microorganisms. Therefore, phosphate-dissolving soil microorganisms play an important role in correcting the phosphorus deficiency of crop plants [87]. Pikovskayas Agar was modified by Sundara Rao and Sinha [88, 82] to detect phosphate-solubilizing bacteria from soil.

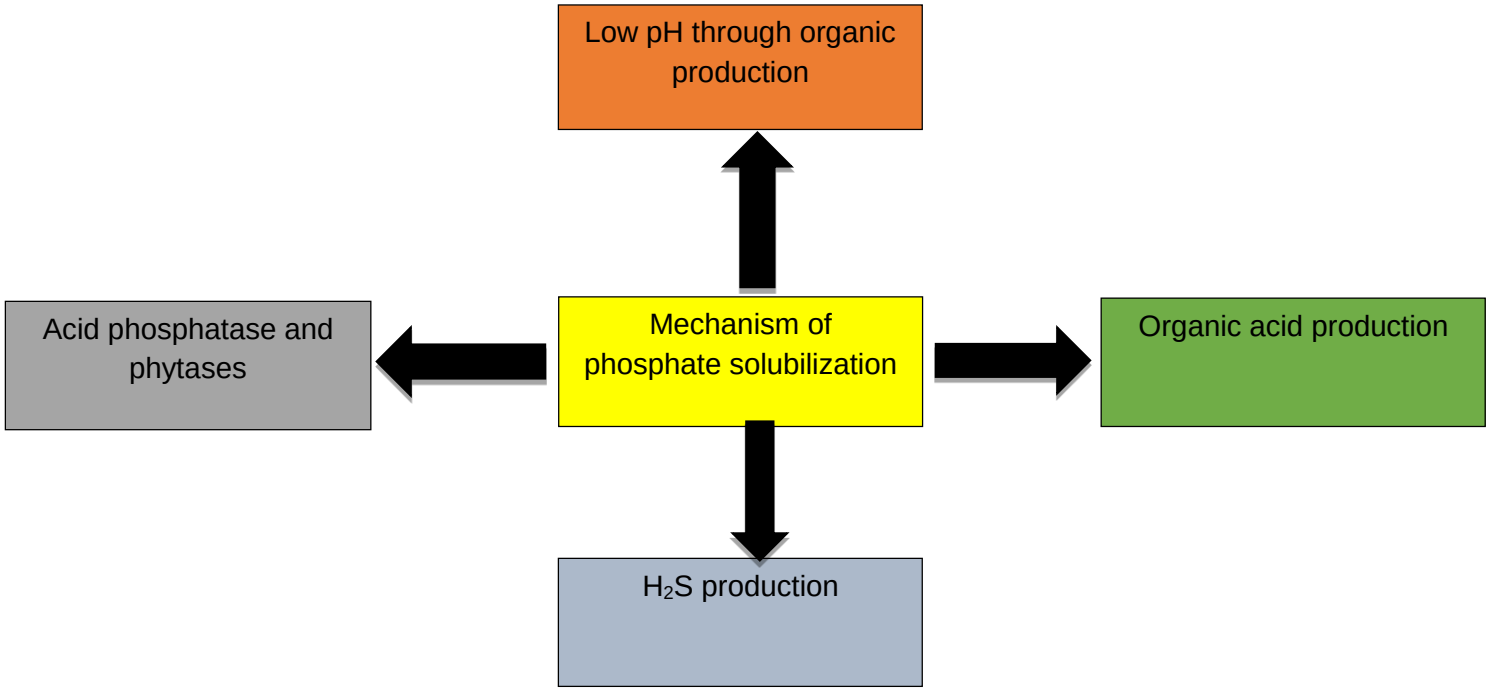

Figure 2 Mechanism of phosphate solubilizing[24].

II. ASYMBIOTIC ORGANIC PROCESS

A Symbiotic biological process fixes atmospheric nitrogen and supplies it to plants by two mechanisms. I. Symbiotic organic process. The mutual relationship between microbe and the plant. II. Non-symbiotic nitrogen fixation: Is administrated by free lifestyle diazotrophs. Biological nitrogen-fixing PGPR helps in disease management and growth-promoting activity and maintain nitrogen level in agricultural soil [77].

Rhizosphere-related N-fixing microbes have progressively been utilized in non-vegetable yield species, for example, Sugar beet, Sugar stick, Rice, Jatropha, Maize, and Wheat [76]. For instance, exploring different avenues regarding *Bacillus species* showed yield expansions in cereals [15] and maize [65]. They were taking advantage of PGPR's potential to upgrade crop efficiency utilized N2-fixing microorganisms, with the understood presumption that this movement delivered the improved harvest yields. One concentrate in Russia to test the capability of a kind of A. radiobacter, detached from the rhizosphere of rice, on winter wheat and spring grain seemed to give huge increments (5-30%) in yield in 2 out of 3 years. Simultaneously, it assessed that the commitment of N2 obsession to add up to N osmosis was somewhere between 23 and 32% [9].Such as *Enterobacter, Klebsiella, Burkholderia*, and *Stenotrophomonas*, have been considered in the new years in light of their relationship with significant yields and potential to improve plant development [71]. N-fixing bacterial strains *Pseudomonas putida RC06, Paenibacillus polymyxa RC05* and *RC14*, and *Bacillus OSU-142* have extraordinary potential and have plans; they are utilized as biofertilizers for improved yield and the nature of wheat, sugar beet, and spinach development [16]. The N-fixing *Bacillus* strains and *A. brasilense sp246* have the potential for plant development action of spring wheat and grain development in natural and low-N input farming [17].

Ashbys Agar Media are formulated [87]. It is utilized to separate *Azotobacter*, a non-harmonious nitrogen-fixing microorganism that involves mannitol as a carbon source and air nitrogen as a nitrogen source. Dipotassium phosphate provides buffering to the medium. Different fundamental particles expected to advance the development of *Azotobacte*r are additionally accessible in this medium.

III. SIDEROPHORES PRODUCTION

Siderophores could be an iron-chelating compound that helps in the assimilation of iron. Siderophores are applied in both direct and indirect enhancement of plant growth. Impact of microbially secreted siderophores on plant growth [51,77].

Siderophore is a low atomic weight compound (400-1,500 Dalton), specially chelate iron (Fe+3) and transports into the cell across the cell layer. The bacterium that initially blended the siderophores takes up the iron siderophore complex by utilizing a receptor that is well defined for the complex and is situated in the external cell layer of the bacterium. The iron is delivered and accessible to help microbial development when inside the cell. Iron is a significant micronutrient utilized by microorganisms and is fundamental for their digestion. In the dirt, it is inaccessible for direct osmosis by microorganisms because ferric iron (Fe3+), which prevails in nature, is just sparingly solvent and too low in focus to help microbial development. Soil microorganisms combine and discharge this low-sub-atomic iron restricting compound. The siderophores tie the majority of the Fe+3 in the rhizosphere and successfully forestall the multiplication of infectious microorganisms by denying them accessible iron [46]. Concealment of the microbes emerges because lack of iron causes development restraint, the decline in nucleic corrosive amalgamation hindrance of sporulation, and causes changes in cell morphology [54].Therefore, each siderophores structures a hexadentate octahedral complex with Fe+2. Catecholates are synthetically subordinates of 2, 3, dihydroxy benzoic corrosive. Each catecholate gave two oxygen particles to chelation with iron so that a hexadentate octahedral complex is shaped [20]. A horde of ecological variables can adjust the siderophore amalgamation, pH, iron level and types of iron particles, presence of minor components, and a sufficient inventory

of C, N, and P [23].Microbial siderophores differ broadly in general construction; however, most contain hydroxamate and catechol gatherings, which are used to chelate the ferric particle [60].
Chrome azurol sulfonate (CAS) assay is one of the most used assays for detecting siderophores produced by the microbes. Cultures were point immunized on CAS agar plates and hatched at room temperature [72].Siderophore production was studied using a succinate medium (SM) [75].

IV. INDOLE COMPOUNDS

Indole Carboxylicacid production Produced via way of means PGPR. Help in plant natural procedure and differentiation. Stimulates seed and tuber germination, Biosynthesis of various metabolites, and resistance to traumatic conditions. *Pseudomonas*, *Rhizobium*, *Bradyrhizobium*, *Agrobacterium*, *Enterobacter* and *Klebsiella* are IAA-generating PGPR.The colorimetric technique is employed [77].
Indole-3-acidic corrosive (IAA) is a critical plant chemical that governs various plant blast and improvement parts. It is the maximum not unusual place evidently to be had and physiologically vital phytohormone of the auxin class, even though numerous compounds like 4-chloroindole 3-acetic acid, phenylacetic acid, indole-3-butyric acid, and indole-3-propionic acid with comparable activity. The function of bacterial IAA is numerous in terms of the interplay among plant life and microorganisms. Previously, bacterial auxin manufacturing was believed to be especially related to pathogenesis, particularly bacterial gall formation. However, it's miles apparent that numerous phytopathogenic micro-organisms, gall-inducing in addition to plant boom selling micro-organisms, can synthesize IAA. Besides being produced employing plant life, it's also synthesized via root-related micro-organisms like *Rhizobium sp.*, *Pseudomonas sp.*, and *Azospirilliumsp* [83].
The production of IAA was assayed qualitatively determined by using the Salkowski method.Tryptophan was an amino acid that plays a key role in some microorganisms' precursor production of IAA [32].

V. EXOPOLYSACCHARIDES

Production of exo-polysaccharides is vital in biofilm formation and root colonization. Effective colonization of plant roots by EPS-producing microbes helps carry the free phosphorous and circulating essential nutrients to the plant [67]. Functions performed by EPS-producing microbes constitute shielding from desiccation attachment to surfaces, plant invasion, and plant defence response in plant-microbe interactions [34,77].
Exopolysaccharides are starch polymers emitted by a wide assortment of plant development advancing rhizobacteria. They can remain related to the cell wall to shape a bound container layer or be delivered into cells encompassing as extracellular ooze [31]. EPS play fundamental parts in an assortment of cycles, for example, arrangement of biofilm [13], assurance of bacterial cell from desiccation, keeping up with essential cell capabilities, what's more, antibacterial movement against hunters, gelling skill, toxin corruption energy [29], bioremediation movement and plasma subbing limit.
The EPS production was checked in a modified medium by Guimarães et al. [34], a drop of 3% KOH (w / v in H2O), and then stirred repeatedly using a needle ose. Lift loopful ordinarily from the suspension surface, see whether the structure of the microorganism a tacky suspension lifted like a string with a needle ose. When the suspension turned slimy, sticky and lifted like a thread with a needle ose, meaning Gram-negative (-), on the other hand, assuming the suspension stays weakened, not rose like the needle string circle, meaning Gram-positive (+). The selected bacterium is gram-negative bacteria. To prove and validate whether these bacteria are gram-negative bacteria producing exopolysaccharides grown on the Macconkey medium is characterized by the presence of slime formed [73].

VI. IN VITRO ROOT COLONISATION

Surface disinfectant maize seed(alcohol, sodium hypochlorite, convective washed in sterile distilled water), Transfer to check tubes contributing, and keep two plates per pot. Experiments were founded to check the power of respective bacteria to induce maize growth and water deficit tolerance. A capacity of 80%was used.

VII. HYDROPONIC

PGPRs are primarily used in horticulture and agriculture, with forestry and phytoremediation applications growing in importance [52]. Several PGPR formulations are offered as commercial goods for agricultural productivity and are divided into two categories. Categories of biocontrol and biofertilizer goods. Frequently, combinations fall under the first category, comprising many bacteria, the latter being frequently one species. However, not much is done to determine whether these PGPR combinations are better for single species; elucidating synergistic effects will take a lot of investigation [46].In a review of the bacterial species employed and examined over the last 30 years, Lucy et al.Count 49 out of 80 years, suggesting that most applications took place in field trials. (as illustrations) over the greenhouse, and as anticipated from application in soils, permit a better input-output connection. Hydroponics offers the chance to regulate microbial communities and nutrient availability compared to soil. The more direct cause of stress relief's success to the single PGP-cause-and-effect bacterium's interaction. Even the persistence of the It is possible to retain beneficial organisms at optimal densities for a longer time or with less effort adjusted. Whenever specific information on a single bacterial feature or function is available, their use in controlled settings can, for instance, release salinity tension. Advised for more efficacy.

CONCLUSION

The search for plant growth-promoting phosphate solubilizing bacteria is isolated for use for more than economically important crops. Phosphate solubilizing bacteria offers an environmentally sustainable approach to increasing crop production and health. Investigating that contribution to bacterial survival under adverse conditions during inoculants productions, storage,inoculation

and colonization of seeds and plants is very important. It is crucial to understand better the role of cells storage materials like PHAs, cell surface components like EPS, LPS and surface protein in enhanced resistance of bacteria to diverse stress conditions. Nitrogen-fixing microorganisms convert vaporous N from the air to inorganic blenders. Even though the job of vegetables in N obsession is obvious, the undertaking is excessively hard for them alone. The obsession interaction happens thanks to the beneficial interaction of vegetables and nitrogen-fixing microscopic organisms. It is typical for Rhizobium, colonizing vegetable roots. Be that as it may, their advantageous interaction isn't the main choice: free-living and related N obsession life forms exist. This work showed the capability of Bacillus spp. for maize development advancement. Other than this is the main report to depict desert flora-related microbes from plant development advancing capacities.

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