RESEARCH REVIEW JOURNALS
Volume-03
Issue-12
December -2018

ISSN: 2455-3085 (Online)
RESEARCH REVIEW International Journal of Multidisciplinary
www.rrjournals.com [UGC Listed Journal]

Study on Plant Growth Promoting Rhizobacteria as Bio Fertilizer and Bio-Control Agents

[1]Pradeep & [2]Dr. KomalLata Nagpal

[1,2]Department of Botany, OPJS University, Churu (Rajasthan) (India)

ARTICLE DETAILS

Article History
Published Online: 10 December 2018

Keywords
Plant, Rhizobacteria, biofertilizer

ABSTRACT

Plant Growth Promoting Rhizobacteria (PGPR) are a group of free-living bacteria that colonize the rhizosphere and contribute to increased growth and yield of crop plants. PGPR have many traits that make them appropriate as biofertilizer and bio-control agents. These include the ability to grow rapidly, rapid utilization of seed and root exudates, colonization as well as multiplication in the rhizosphere and even in the interior of the plants as endophytes. Direct plant growth promotion mechanisms include (a) bio-fertilization, (b) stimulation of root growth, (c) rhizoremediation and (d) plant stress control. Mechanisms of biological control by which rhizobacteria can promote plant growth indirectly are by reducing the level of disease which include antibiosis, induction of systemic resistance and competition with pathogens for nutrients and niches. In this artical we will explore the study about "plant growth promoting rhizobacteria as bio-fertilizer and bio-control agents".

1. Introduction

In the present situation of expanding human population (FAO, 2009) and disturbing global environmental change there is a general need to support and improve agricultural productivity. This is particularly valid with regards to abiotic worries when all is said in done and drought specifically, that establish a noteworthy compel for agricultural productivity around the world. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is an international research focused on agricultural research in the dry land tropics, covering more than 55 nations in Asia and sub-Saharan Africa that is homestead the world's poorest of poor people. The Semi-Arid Tropics (SAT) are described by the eccentric weather, restricted and flighty rainfall, nutrient-poor soils and event of a few nuisances and ailments being the major compels constraining yield productivity.

Drought is the main factor constraining yield productivity in the rain-nourished generation frameworks of the SAT. Notwithstanding its immediate impacts on yield, drought decreases both, carbon osmosis through photosynthesis because of restricted gas trade and also Symbiotic Nitrogen Fixation(SNF), in vegetable crops. In addition, drought additionally prompts afla-toxin pollutions that outcome in noteworthy decreases in harvest yield, soil fertility and product esteem. Climatologists trust that the following global atmosphere changes may deliver considerably more extreme and across the board dry conditions in these locales with possibly genuine ramifications for global farming, trim productivity and food accessibility soon. Food security would be weak without noteworthy increment in the harvest yields in these minimal rain-nourished agricultural lands of SAT that contribute altogether to the world food generation.

2. Foundational acquired resistance (SAR) and induced fundamental resistance (ISR)

The term 'cross protection' was at first used to describe upgraded tolerance to illness in previously contaminated perennials. Today, cross protection comes in two appearances, Systemic Acquired Resistance(SAR) and Initiated Systemic Resistance (ISR).

Endless supply of a pathogen, plants regularly initiate the hypersensitive response, resulting in rapid cell passing of tainted tissue to slaughter the pathogen and prevent it from spreading further. Notwithstanding the locally successful hypersensitive response, pathogen recognition likewise triggers various inducible fundamental defenses. In plant parts removed from the site of primary contamination, foundational responses build up an upgraded cautious limit against ensuing disease. This biologically actuated resistance in fundamental tissue is known as Systemic Acquired Resistance(SAR) and has been appeared to be viable in many plant species. The achieved condition of resistance is dependable and successful against a broad spectrum of pathogens, including pathogenic bacteria, fungi and viruses. SAR requires both local and fundamental Salicylic Acid (SA) accumulation and the acceptance of a subset of the Pathogenesis-Related (PR) genes, yet SA itself isn't the mobile signal. In plant defense research, PR genes serve as powerful molecular markers for the beginning of SAR. Despite the fact that SA can be integrated from phenylalanine, the predominant pathway for all over again SA biosynthesis during pathogen disease is through chorismate by means of Isochorismate Synthase (ICS).SA, orchestrated from chorismate by methods for ICS, is required for local and fundamental acquired resistance responses. Non-Expressor of Pathogenesis Related1(NPR1, otherwise called Non-Immunity1 [NIM1]) is a central positive regulator of SAR signaling. NPR1 protein contains an ankyrin repeat and a BTB/POZ area and capacities downstream of SA. NPR1 regulate PR gene expression through interaction with TGA transcription factors.

Signaling Pathways Induced by Multiple Stress Responses

The interaction between abiotic and biotic stress actuates complex responses to the different stressors. Under stress, the accumulation of certain metabolites emphatically influences a plant's response to the two stresses and therefore protects it from multiple aggressors. Callose accumulation, changes in ions fluxes, ROS and phytohormones are the first responses induced to battle the stress and the resulting signal transduction triggers metabolic reprogramming towards defense.

Reactive Oxygen

Species a rapid generation of ROS is observed after stress detecting. One of the major roles of ROS is to serve as signaling atoms in the cells. The production of ROS is fine-balanced by the plant to keep away from tissue damage. ROS have for some time been known to be destructive and harmful mixes in stressed organisms. However, it has been demonstrated that while high levels of ROS prompt cell passing, lower levels are generally responsible to regulate the plant's stress responses. In biotic stress, ROS are mostly engaged with signaling. This again may weaken the oxidative stress caused by abiotic stress. Furthermore, ROS could interfere in cross-tolerance. ROS are engaged with stress-induced tolerance in *Arabidopsis thaliana* after contamination with the vascular pathogen *Verticillium spp.* by increasing drought tolerance because of all over again xylem formation and the resulting upgraded water flow. Also, the production of ROS can help in cell-to-cell correspondence by increasing the signal through the Respiratory Burst Oxidase Homologue D and can go about as a secondary messenger by altering protein structures and actuating defense genes. ROS respond to abiotic and biotic stress, yet differently from one stress to another. Demonstrated that the transcription factor Zat12 was associated with both abiotic and biotic stress and that Zat12 could be a regulator in ROS rummaging ROS may conceivably be the central process intervening cross-tolerance between abiotic and biotic stress responsive networks. In *Arabidopsis*, ROS production can be detected by ROS-delicate transcription factors prompting the acceptance of genes participating in the stress responses. ROS were inducers of tolerance by enacting stress response-related factors like mitogen-activated protein kinases (MAPKs), transcription factors, cancer prevention agent compounds, dehydrins and low-temperature-induced, warm stun and pathogenesis-related proteins.

3. Transcription factors and molecular responses in cross-tolerance

Changes in gene expression occur after recognition of a given stress and the reprogramming of the molecular machinery is regulated by the activity of transcription factors. The altered expression of certain genes is a key occasion in helping plants to set up a compelling guarded state and there is convincing proof that numerous genes are multi utilitarian and capable induce tolerance in plants towards more than one stress. The action of such genes involved in defense is mediated by particular phytohormones like ABA, SA, JA and Ethylene. For instance, the movement of the Botrytis Susceptible1 (BOS1) gene is mediated by both ABA and JA and induces resistance against osmotic stress and necrotrophic pathogens and bos1 mutant plants are more powerless to the two stresses. In*Arabidopsis*, the transcription factor MYB96 assumes an important role in plant protection under pathogen infection by mediating the molecular link between both ABA induced by drought stress and SA expressed following pathogen infection. SlAIM1 in tomato responds decidedly to the combination of abiotic stress and infection with *Botrytis cinerea* and OsMAPK5, which has kinase action, is a positive regulator of the rice response to drought, salt and chilly tolerance and ailment resistance interestingly, numerous PR genes are additionally endless supply of a plant to abiotic stress ensuring malady resistance. PR proteins are crucial for plant resistance against pathogens and their expression is strongly up-regulated when plants are assaulted. Over-expression of certain transcription factors in plants confronted with chilly stress and infection initiates cool responsive PR genes, thereby conferring protection against the two stressors. The up-regulation of some transcription factors after exposure to abiotic stress prompts an accumulation of PR proteins. The transcription factors C-repeat Binding Factors (CBF), Dehydration-Responsive Element-Binding proteins (DREB) and No Apical meristem ATAF and Cup-Shaped Cotyledon (NAC) have been widely contemplated as players of the primary abiotic stress signaling pathways ensuring tolerance under stress. CBF is induced under chilly stress together with a group of PR proteins. Transgenic *Arabidopsis* overproducing the NAC transcription factor NTL6, or, in other words chilly stress, improve their defense response against pathogen assault by promoting an up-regulation of the PR1 gene. The transcription factor DREB could regulate the response of cross-tolerance between abiotic and biotic stress insuring the resistance of*Arabidopsis* response to cool and pathogen.

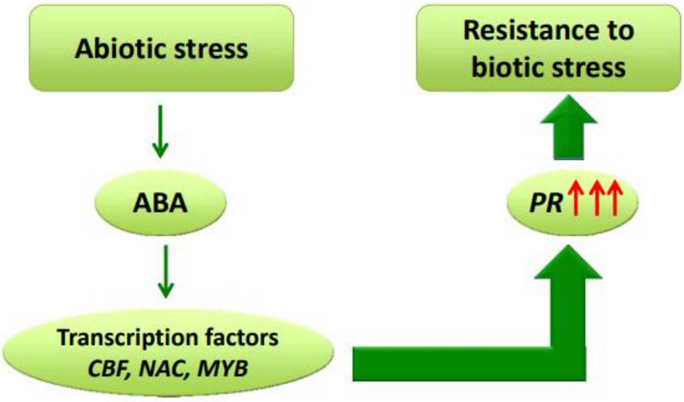

Figure 1: Abiotic stress can enhance the expression of specific transcription factors (TFs) like C-repeat Binding Factors (CBF), No Apical meristem ATAF and Cup-Shaped Cotyledon (NAC), MYB mediated by Abscisic Acid (ABA)

Signal Interplay between different Induced Defenses

Defense responses reliant on SA are frequently successful against biotrophic pathogens, whereas defenses subject to JA are for the most part viable against necrotrophic pathogens and insects. To accomplish a successful condition of resistance after recognition of the invader, plants are thought to fine-tune different defense signaling pathways by methods for synergistic and adversarial interactions. A synergistic impact was reported between SA-subordinate SAR and rhizobacteria-mediated Induced Systemic Resistance (ISR). ISR is activated by root-colonizing, non-pathogenic fluorescent *Pseudomonas spp*. and provides broad spectrum resistance to pathogen assault. ISR signal transduction isreliant on an intact

JA ethylene response and interestingly, requires the capacity of the regulatory protein NPR1. Consequently, SAR and ISR signaling pathways are distinct in their requirement for SA and JA ethylene, yet join in their downstream requirement of NPR1. Other than signal synergy between SA and JA subordinate defense responses, cases of threat between these two signaling particles have likewise been reported. The JA resisted tobacco hornworm *Manduca sexta* inflicted more damage on SAR induced tobacco plants compared to control plants. Moreover, tobacco plants hushed for the expression of the phenylpropanoid biosynthesis gene PAL (phenyl alkali lyase) show reduced SAR against TMV, however displayed upgraded resistance to insect infestation. Conversely, plants over expressing PAL were more resistant to TMV, whereas resistance to insect assault was lost. Albeit cross-talk between the SA and JA signal might be regulated differently depending on the plant species, in any event in *Arabidopsis* regulatory protein NPR1 assumes a crucial role.

Plant-herbivore interaction

Terrestrial plants are food source for an expected one million or more insect species from diverse taxonomic groups. Plant-herbivore interactions are happened on spatial scales that include the cellular responses, very much concentrated in plant-pathogen interactions and in addition responses that capacity at entire plant and community levels. The plant's injury response assumes a central role yet is frequently altered by insect-particular elicitors, giving plants the potential to streamline their defenses. Insects utilize various strategies to obtain nutrients from all above and below ground plant parts. Around two-third of all known herbivorous insect species are leaf eating bug (*Coleoptera*) or caterpillars (*Lepidoptera*) that reason damage with mouth parts developed for chewing and tearing. Defense against microbes can be highly compelling on little spatial scales like the Hypersensitive Response (HR), in which cells promptly surrounding the infection site rapidly kick the bucket and load up with antimicrobial mixes to prevent the spread of the pathogen. Indeed, even HR can be successful against sedentary herbivores like aphids feeding on particular tissue like phloem, But HR can not be viable against most free-living herbivores, which keep away from a HR by essentially moving to another feeding site, thereby expanding the spatial size of the plant-herbivore interaction to include entire plant responses as well as the community in which the plant lives (Fig 1).

Plant Responses to Herbivores

As sessile organisms, plants rely intensely on chemical defenses to thwart the insect assault. Plant responses to herbivores are broadly categorized as direct and indirect defenses and tolerance. Intensifies that exert repellent, anti-nutritive, or dangerous consequences for herbivores are usually referred to as direct defenses. Proteins Inhibitors(PI) (anti-digestive proteins) are inducible by wounding and herbivory and influence herbivore performance by inhibiting insect stomach related compounds. Physical barriers, for example, leaf strength and trichomes that increase plant wellness in the presence of herbivores go under direct defenses. Lethal mixes (e.g., alkaloids, terpenoids, phenolics) that poison generalist herbivores likewise comprise a part of direct defense. Indirect defenses are plant traits that attract predators and parasitoids of herbivores. Unpredictable organic mixes (VOCs) released by herbivore-assaulted plants attract natural foes of the herbivore. A plant genotype is termed tolerant on the off chance that it can sustain tissue misfortune with almost no decrease in wellness relative to that in the undamaged state. The components underlying in varying tolerance displayed by different genotypes isn't clearly understood.

4. Plant resistance to disease and insect pests

Parasites and pathogens of plants are a noteworthy and growing threat to crop production worldwide. The objective of producing crops with increased and durable resistance to a spectrum of diseases is, therefore a major concentration in plant research. Genetic engineering can possibly take care of these problems by inserting carefully chose and conceivably multiple genes as transgenes and the search is therefore on for genes that confer durable broad-spectrum resistance that is additionally alright for every other organism. Increasing information of plant defense has prompted more modern transgenic approaches to enhancing resistance. The number of candidate genes set forward by transcriptomics, proteomics and protein interaction considers provides us with a large spectrum of genes that can be utilized.

Manipulating the expression of 'master switch' genes (McDowell and Woffenden 2003, for example, kinases and transcription factors, which regulate many target genes that could help signaling through large portions of the pathogen induced signaling network and thereby prompt an increase in disease resistance. The inconvenience with this approach is that control of some master switch genes could be detrimental to plant improvement. The WRKY transcription factors have likewise been appeared to be important in quantitative resistance to pathogens, for example, *Phytophthora infestans*. Another source of potential master-switch genes are protein kinases. Guide kinase (MAPK) signaling cascades are integral parts of numerous defense-signaling pathways, transient over expression of MKK4a, MKK5a or constitutively dynamic MEKK1 resulted in upgraded resistance to virulent *P. syringae* and *Botrytis cinerea*. Notwithstanding kinases and transcription factors, other signaling particles, for example, NPR1, NDR1, EDS1, PAD4, SGT1, COI1 and JAR1 that may represent important hubs in the signaling networks are candidates for this approach. For instance in *Arabidopsis*, over expression of NPR1 prompted improved resistance to diverse pathogens and crucially, this was accomplished without a considerable yield punishment. The reason for this appeared to be that the NPR1-overexpressing plants did not constitutively turn on their defenses yet rather appeared to be primed to respond to pathogen assault There have been numerous reports of transgenic plants with increased disease resistance as a result of the over expression of PR genes.

5. Plant growth promoting rhizobacteria

Soil bacteria are very important in biogeochemical cycles and have been utilized for crop production for decades. Plant bacterial interactions in the rhizosphere are the determinants of plant wellbeing and soil fertility. Interaction of Plant Growth Promoting Rhizobacteria (PGPR) with host plants is an intricate and interdependent relationship involving the two partners as well as other biotic and abiotic factors of the rhizosphere region (fig. 1.6). Plant growth-promoting rhizobacteria bacteria are free-living soil bacteria that can either directly or indirectly encourage rooting and growth of plants.

Over the most recent ten years, a number of PGPR that have been recognized has seen a great lift, mainly on the grounds that the role of the rhizosphere as a biological unit has gained importance in the functioning of the biosphere and additionally on the grounds that components of activity of PGPR have been profoundly contemplated. A putative PGPR qualifies as PGPR when it can produce a constructive outcome on the plant upon inoculation, henceforth demonstrating great focused abilities over the existing rhizosphere networks. Generally, around 2– 5% of rhizosphere bacteria are PGPR. PGPRs are the potential tools for sustainable agriculture and trend for the future. One of the instruments by which bacteria are adsorbed onto soil particles is by basic particle trade and a soil is said to be naturally fertile when the soil organisms are releasing inorganic nutrients from the organic reserves at a rate adequate to sustain rapid plant growth.

Free nitrogen fixing Plant growth promoting rhizobacteria

Rhizosphere related N-fixing bacteria have increasingly been utilized in non-legume crop species, for example, sugar beet, sugar stick, rice, jatropha, maize and wheat. For instance, experiments with*Bacillus* species indicated yield increases in cereals and maize. Biological Nitrogen obsession can occur in mass or rhizospheric soil. Settled nitrogen can then is acquired through root take-up and contribute to the nitrogen record of the crop. The earliest large-scale experiments, exploiting PGPR potential to improve crop productivity utilized N_2-fixing bacteria, with the understood suspicion that it was this activity that was producing the upgraded crop yields. One examination in Russia to test the potential of a strain of *A. radiobacter,* confined from the rhizosphere of rice *(Oryza sativa L.),* on winter wheat and spring barely appeared to give critical increases (5– 30%) in yield in 2 out of 3 years. In the meantime, it was assessed that the contribution of N_2obsession to total N assimilation was between 23 and 32%. Free-living PGPR diazotrophs in soil, there is proof that endophytic bacteria, particularly *Azoarcus spp*. in Kallar grass *(Leptochloa fusca (L.) kunth.)* and *Gluconacetobacter diazotrophicus* and *Herbaspirillum spp.* In sugar stick (*Saccharum spp*.) may assume a major role in N_2 obsession.

6. Conclusion

Plant growth hormones produced by PGPR are signal atoms acting as chemical messengers and assume a crucial role in the growth and advancement of the plants. The phytohormone auxin produced by fluorescent *Pseudomonas* is extraordinary compared to other understood models. Indole Acetic Acid (IAA) is a standout amongst the most physiologically dynamic auxins. IAA is a typical product of L-tryptophan digestion produced by several microorganisms including PGPR. IAA is released as a secondary metabolite in view of the rich supplies of substrates radiated from the roots.

References

1. Costa RCL, Lobato AKS, Oliveira NCF, Maia PSP, Alves GAR, Laughing house HD. Biochemical and physiological responses in two *Vigna uguiculata* (L.) Walp. cultivars under water stress. Journal of Agronomy. 2008; 7(1):98-101.
2. Lobato AKS, Oliveira Neto CF, Costa RCL. Biochemical and physiological behaviour of *Vigna unguiculata* (L.) Walp, under water stress during the vegetative phase. Asian Journal of Plant Sciences. 2008; 7(1):44-9.
3. Rahdari P, Hosseini SM, Tavakoii S. The studying effect of drought stress on germination, proline, sugar, lipid, protein and chlorophyll content in purslane (*Portulacaoleracea* L.) leaves. Journal of Medicinal Plants Research. 2012; 6(9):1539-47.
4. Cunhua S, Jian-jie S, Dan W, Bai-wei L, Dong S. Effects on physiological and biochemical characteristic of medicinal plant pigweed by drought stresses. Journal of Medicinal Plants Research. 2011; 5(17):4041-8.
5. Guenaoui C, Gorai M, Smiti S, Neffati M. Biochemical and physiological changes in *Artemisia herba-alba* plants under water stress conditions. Middle East Journal of Scientific Research. 2008; 3(3):156-63.
6. Abdalla MM, El-Khoshiban NH. The influence of water stress on growth, relative water content, photosynthetic pigments, some metabolic and hormonal contents of two *Triticumaestivum*cultivars. Journal of
7. Applied Sciences Research. 2007; 3(12):2062-74
8. Kusvuran S. Influence of drought stress on growth, ion accumulation and antioxidative enzymes in okra genotypes. International Journal of Agriculture and Biology. 2012; 14:401-6.
9. Vaziri A, Motamed N, Naghavi MR, Yazdani B, Niknam V. Physiological and biochemical responses of *Aeluropus lagopoides* and *Aeluropus littoralis* to drought stress. Journal of Medicinal and Aromatic Plants. 2011; 2(2):5-14.
10. Wang CQ, Li RC. Enhancement of superoxide dismutase activity in the leaves of white clover (*Trifolium repens* L.) in response to polyethylene glycol-induced water stress. ActaPhysiologiaePlantarum.2008;30:841-7.
11. Mirzaee M, Moieni A, Ghanati F. Effects of drought stress on the lipid peroxidation and antioxidant enzyme activities in two canola (*Brassica napus L.*) cultivars. Journal of Agricultural Science and Technology. 2013; 15:593-02.
12. Kavas M, Baloglu MC, Akca O, Kose FS, Gokcay D. Effect of drought stress on oxidative damage and antioxidant enzyme activity in melon seedlings. Turkish Journal of Biology. 2013; 37:491-8.

