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Importance of Azotobacter in Plant Growth

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Abstract: Due to its favourable impact on plant development, Azotobacter, a genus of free-living nitrogen-fixing bacterium, has attracted a lot of interest. This review investigates the significance of Azotobacter in enhancing nutrient availability, nitrogen fixation, and the generation of compounds that promote plant development. Understanding the methods that Azotobacter uses can help farmers practise sustainable agriculture and lessen their reliance on chemical fertilisers. The various functions of Azotobacter in promoting plant development are highlighted in this article, along with possible uses for sustainable agriculture.

Azotobacter is one of the bio-fertilizer which contains living organisms which when applied on soil surface or seeds helpin colonizing the rhizosphere or the interior parts of the plant parts and also help in promoting growth through the increase of the availability of primary nutrients to plants. Oval or spherical in form, Azotobacter is a free-living gram-negative bacterium. It is a crucial biofertilizer that improves soil fertility by fixing nitrogen, which subsequently aids in improving crop yield by facilitating the manufacture of physiologically active compounds for plant absorption. It also plays an important role in nutrient cycling and increases nutrient availability so it is more eco-friendly when compared to chemical fertilizer.

Keywords:Stressor, Agroecosystem, Siderophores, PGPR, Phytohormone, Nutrient. Living Organisms.

Introduction:

Nitrogen is an essential nutrient for plant growth, and its availability significantly influences plant productivity. Chemical fertilisers are applied in traditional techniques of nitrogen augmentation. However, the over usage of artificial fertilisers has resulted in several ecological issues and environmental damage. In this situation, using nitrogen-fixing bacteria, such Azotobacter, offers an environmentally friendly substitute for artificial fertilisers.

Azotobacter bacteria have several important roles in farming and agriculture, making them beneficial for crop production and sustainable farming practices. Here are some key aspects of Azotobacter's importance in farming:

Nitrogen Fixation by Azotobacter:

Azotobacter plays a vital role in nitrogen fixation, the conversion of atmospheric nitrogen into a form readily available for plants. Through the enzyme nitrogenase, Azotobacter converts atmospheric nitrogen into ammonium, which can be assimilated by plants. This process reduces the dependency on synthetic nitrogen fertilizers and helps in maintaining soil fertility.

These bacteria convert nitrogen gas into ammonia (NH3) and other nitrogen compounds through the process of biological nitrogen fixation. Since nitrogen is a crucial component for plant growth and development, nitrogen fixation is important. Azotobacter contributes to soil nitrogen enrichment by turning atmospheric nitrogen into a form that plants can use, which lessens reliance on artificial nitrogen fertilisers. This can reduce expenses for farmers and lessen the environmental effects of using too much fertiliser.

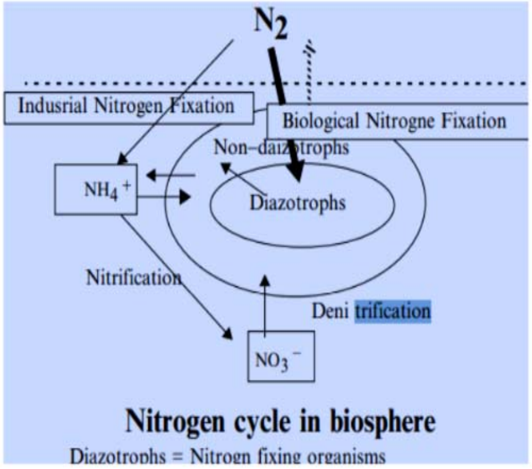

Fig. 1 Nitrogen Fixation by Azotobacter

Production of Growth-Promoting

Compounds: In addition to fixing nitrogen, Azotobacter also creates a variety of compounds that help plants develop. These compounds include vitamins, siderophores, and phytohormones (auxins, gibberellins, and cytokinins), which encourage root formation, improve nutrient intake, and drive plant growth.

Soil Fertility Enhancement: The nitrogen fixed by Azotobacter is released into the soil, which improves soil fertility. Nitrogen is a crucial element for the synthesis of proteins, nucleic acids, and chlorophyll, all of which are essential for plant growth. By providing a readily available source of nitrogen to plants, Azotobacter promotes healthy plant development, increased biomass, and improved crop yields. Moreover, the enrichment of soil with fixed nitrogen contributes to the overall nutrient balance, which is crucial for maintaining soil fertility and productivity in the long term.

Symbiotic Relationships: Azotobacter bacteria can establish mutualistic relationships with certain plants, forming a symbiotic association. In these associations, Azotobacter provides the host plant with fixed nitrogen, while the plant supplies the bacteria with carbohydrates and a suitable environment for growth. Both sides gain from this symbiosis, also referred to as associative symbiosis. Plants' ability to absorb nitrogen is boosted by the presence of Azotobacter in the rhizosphere, which benefits crop development, growth, and yield

Environmental Sustainability: The utilization of Azotobacter and other nitrogen-fixing bacteria in farming practices contributes to environmental sustainability. By reducing the reliance on synthetic nitrogen fertilizers, which often have negative environmental impacts, farmers can mitigate the risks of water pollution, soil degradation, and greenhouse gas emissions associated with fertilizer overuse. The preservation of soil biodiversity and microbial communities, which are essential for preserving soil health and ecosystem function, is also promoted by the use of Azotobacter and other biological nitrogen-fixing organisms.

Cost-Effectiveness: Incorporating Azotobacter into farming practices can have economic benefits for farmers. Azotobacter eliminates the need for pricey nitrogen fertilisers by fixing atmospheric nitrogen, which results in cost savings. Moreover, the enhanced nitrogen availability provided by Azotobacter can improve crop productivity and yield, resulting in increased profits for farmers.

Enhancement of Nutrient Availability: Azotobacter enhances the availability of essential nutrients to plants by solubilizing mineral phosphates, fixing atmospheric nitrogen, and releasing organic acids. In particular in nutrient-deficient soils, these mechanisms boost nutrient accessibility for plants. Azotobacter's capacity to move nutrients results in increased plant growth and general production.

Stress Tolerance and Disease Resistance: Azotobacter has shown that it can make plants more resilient to a variety of abiotic conditions, such as salt, drought, and heavy metal toxicity. Plants can withstand severe climatic circumstances thanks to Azotobacter's synthesis of osmoprotectants and stress-responsive enzyme. Additionally, Azotobacter strains have been found to exhibit biocontrol activities against plant pathogens, further protecting plants from diseases.

Azotobacter is being used as a powerful biofertilizer:

As the Azotobacter is a non-symbiotic microbe, its maximum potential to enhance plant productivity can be exhausted by co-inoculating it with some other biofertilizers as compared to its single application. In addition to directly benefitting the plants through enhanced mineral uptake, Azotobacter also accelerate beneficial activities of other biofertilizers, if used in As the Azotobacter is a non-symbiotic microbe, its maximum potential to enhance plant productivity can be exhausted by co-inoculating it with some other biofertilizers as compared to its single application. In addition to directly benefitting the plants through enhanced mineral uptake, Azotobacter also accelerate beneficial activities of other biofertilizers, Because Azotobacter is a non-symbioticbacterium, co-inoculating it with various other biofertilizers can maximise its ability to increase plant production as opposed to using it alone. If used in conjunction with other biofertilizers, Azotobacter also accelerates the positive effects of other fertilisers, in addition to directly benefiting the plants through improved mineral absorption. Additionally, reports of additional microbes increasing Azotobacter's plant growth activities are also known. Currently, there are multiple examples of Azotobacter being used in combination with other microorganisms, which is greatly preferred by researchers and farmers.

Sustainable Agriculture Application:

There are several advantages to using Azotobacter as a biofertilizer in agriculture. It lessens environmental contamination, lessens reliance on chemical fertilisers, and fosters sustainable soil development. Azotobacter can also be employed to create microbial consortia with other helpful microbes, which will further enhance plant development and soil fertility.

Challenges and Future Perspectives:

Despite the promising potential of Azotobacter, its practical application in agriculture faces certain challenges, including inconsistent performance, competition with native soil microorganisms, and limited knowledge of specific mechanisms. Additional study is necessary to overcome these obstacles in order to maximise the usage of biofertilizers based on Azotobacter and create customised strategies for various crops and environmental situations.

Conclusion& Future Research:

Azotobacter, as a nitrogen-fixing bacterium, offers a sustainable solution for enhancing plant growth and reducing the reliance on chemical fertilizers. Its ability to fix atmospheric nitrogen, produce growth-promoting substances, enhance nutrient availability, and confer stress tolerance and disease resistance makes it a valuable asset in sustainable agriculture. Continued research on Azotobacter's mechanisms and application strategies will undoubtedly contribute to the development of environmentally.

The use of Azotobacter spp. can be quite helpful in removing different stressors. To enhance the soil's physical and chemical qualities, potential strains are also introduced. In the presence of the appropriate strains, the microbiome of the rhizosphere is also altered, which is thought to be particularly advantageous for the enhancement of plant health. It has been argued and supported that the use of Azotobacter spp. in different field crops has eliminated plant stresses of diverse origins. The manufacturing of several beneficial organic compounds has been accelerated in plant tissue, strengthening the plants and enhancing their ability to fend off stresses. To fully understand the methods by which Azotobacter spp. eliminate stresses and improve plant health, substantial study is still required. When taken as a whole, Azotobacter spp. might reduce the stressors that biotic and abiotic agents cause to different agricultural crops.

References:

1. Chatterjee, R. and Bandyopadhyay, S., (2011). Effect of boron, molybdenum and Bio fertilizers on growth and yield of cowpea (Vigna unguiculata L. Walp.) in acid soil of eastern Himalayan region. Journal of the Saudi Society of Agricultural Sciences, 16(4), pp.332-336.
2. Singh, M., Dotaniya, M.L., Mishra, A., Dotaniya, C.K., Regar, K.L. and Lata, M., (2012). Role of Bio fertilizers in conservation agriculture. In Conservation Agriculture (pp. 113-134). Springer, Singapore.
3. Wani, Sartaj A., Subhash Chand, Muneeb A. Wani, M. Ramzan, and Khalid Rehman Hakeem. "Azotobacter chroococcum–a potential bio fertilizer in agriculture: an overview." Soil science: agricultural and environmental prospective (2013): 333-348.
4. Sharma, K., Dak, G., Agrawal, A., Bhatnagar, M. and Sharma, R., (2007). Effect of phosphate solubilizing bacteria on the germination of Cicerarietinum seeds and seedling growth. Journal of Herbal Medicine and Toxicology, 1(1), pp.61-63.
5. Abo-Amer, A. E., Abu-Gharbia, M. A., Soltan, E. S. M., Abd El-Raheem, W. M., 2014. Isolation and molecular characterization of heavy metal-resistant Azotobacter chroococcum from agricultural soil and their potential application in bioremediation. Geomicrobiol. J., 31(7), 551-561.
6. Abo Amer, A. E., Ramadan, A. B., Abo State, M., Abu Gharbia, M. A., Ahmed, H. E., 2013. Biosorption of aluminum, cobalt, and copper ions by Providencia rettgeri isolated from wastewater. J. Basic Microbiol., 53(6), 477-488.
7. Akram, M., Rizvi, R., Sumbul, A., Ansari, R. A., Mahmood, I., 2006. Potential role of bioinoculants and organic matter for the management of root-knot nematode infesting chickpea. Cogent Food Agric., 2(1), 1183457.
8. Ansari, R. A., Mahmood, I., 2009a. Plant Health Under Biotic Stress: Volume 1: Organic Strategies. Springer Singapore.
9. Arora, M., Saxena, P., Abdin, M. Z., Varma, A., 2007. Interaction between Piriformospora indica and Azotobacter chroococcum governs better plant physiological and biochemical parameters in Artemisia annua L. plants grown under in vitro conditions. Symbiosis, 75(2), 103-112.
10. Aseri, G. K., Jain, N., Panwar, J., Rao, A. V., Meghwal, P. R., 2008. Biofertilizers improve plant growth, fruit yield, nutrition, metabolism and rhizosphere enzyme activities of pomegranate (Punica granatum L.) in Indian Thar Desert. Sci. Hortic., 117(2), 130-135.