AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 03 Issue: 05 May 2022 Article No: 14

Role of Rhizobium in Nitrogen Fixation

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SUMMARY

Soil management practices rely heavily on inorganic chemical-based fertilizers, posing a severe health and environmental risk. Because of their potential significance in food safety and sustainable crop production, the use of beneficial microorganisms as a biofertilizer has become more important in the agriculture sector. Plant growth promoting rhizobacteria (PGPRs), endo and ecto mycorrhizal fungi, cyanobacteria, and many other helpful microscopic organisms were used in a variety of ways to promote nutrient uptake, plant growth, and plant tolerance to abiotic and biotic stress. Rhizobium biofertilizer contains symbiotic Rhizobium bacteria which is the most important nitrogen-fixing organism. These organisms have the ability to drive atmospheric Nitrogen and provide it to plants.

INTRODUCTION

Biofertilizers contains living organisms that is used to improve soil fertility. It increases the plant's growth by boosting the soil's content and enhances the availability of a variety of nutrients to the plant. It is preferable to chemical fertilizers since it produces far less pollution. It also prevents infections from pathogens. Rhizobium, Azotobacter, and blue-green algae are examples of biofertilizers (BGA). Rhizobium is a bacterium that lives in a symbiotic relationship with leguminous plants' root nodules. Nitrogen fixation is not possible on its own. So, host plant is required for nitrogen fixation. Rhizobium is an important supplier of nitrogen for agricultural soils, especially in arid region.

Classification of Rhizobium Bacteria

Rhizobium is classified based on types of the plant they are associated with and also the rate of growth. For example,

- *Rhizobium fredii*- soybean
- *Rhizobium phaseoli*- common bean
- *Rhizobium japonicum*- soybean, ground nut,cowpea
- *Rhizobium trifolii*- clover
- *Rhizobium leguminosarum*- peas

Nitrogen Fixation

The biological process of nitrogen fixation is the first step in the nitrogen cycle. In this process, certain bacterial species such as Rhizobium, Azotobacter, and others transform free nitrogen in the atmosphere into ammonia (another type of nitrogen), and the entire process is carried out by natural processes.

Role of Rhizobium

Rhizobium are prokaryotes that convert stable nitrogen gas in the environment into a physiologically usable form. Nitrogenase is the enzymes that converts dinitrogen into ammonia. The nitrogen fixation process consumes a lot of energy, and oxygen inactivates the nitrogenase enzymes permanently. The nitrogenase activity is measured using an acetylene reduction test. Only a small percentage of species are capable of nitrogen fixing.. Nitrogen is one of the most abundant plant nutrients, and it is also one of the most prevalent soil deficiencies. Several environmental issues have been raised about nitrogen supply to the soil.

Leguminous plants are infected with Rhizobium. They normally live in the soil and create nodules after infecting leguminous plants. As a result, nitrogen gas in the atmosphere is fixed. This nitrogen is made available to the plants, which aids in their development and growth. There will be a disintegration of nodules as the legume dies. Rhizobium is then returned to the cell, where it can infect a new host. Specific strains of Rhizobium are required to make the nodules functional in order to carry out the process. This increases the yield of the crops. Legume inoculation has been an agricultural practice for several years and has constantly improved over time.

Method of Penetration

In soil, Rhizobium species such as *R. leguminosarum* can be discovered. Leguminous plants (lentil, sweetpea, etc.) are, nonetheless, their major habitat. Exudates from various leguminous plants (dicarboxylic acids, for example) attract Rhizobium species in the soil. Flavanoids play an important role in attracting the bacteria given that they are easily absorbed through the membrane of the organisms (passively). Once the bacteria detect these chemicals, they actively swim towards and attach to the legume root. These chemicals play an important role of activating genes involved in producing Nod factors. Nod factors induce the branching of root hair, as well as the hydrolysis and distortion of the cell wall in plants. The modifications in the plant roots attract bacteria through exudates, making it easy for the organism to access the cells of the root hair for symbiosis.

The bacteria induce the plasma membrane of the cells to invaginate when they come into touch with the root hair. The plant creates new cell wall material at the spot as the bacteria penetrate the cell, not only to conceal the bacteria but also to allow them to enter further into the root hairs. Once the bacteria infect the cells of the root hair, the symbiotic process may produce the following types of nodules:

There are two types of nodules produced by Rhizobium.

- Determinate nodules: it is spherical in shape with big lenticels and are found in plants such as soybeans. In contrast to indeterminate nodules, determinate nodules form once the root hairs' tips begin to grow. Indeterminate nodules, on the other hand, have a persistent meristem.
- Indeterminate nodules: these are cylindrical in shape and frequently branching when compared to determinate nodules. They are commonly seen in plants such as peas and alfalfa, and they begin to form even before the root tip grows.

CONCLUSION

Biofertilization of crops with plant growth promoting microorganisms is now thought to be a healthier option to chemical fertilisation. Only microbes that are harmless for humans can be utilised as biofertilizers. The Rhizobium-legume symbioses have received most attention and have been examined extensively. Some strains of rhizobia form effective (N_2-fixing) symbiosis with their host legumes under salt, heat, and acid stresses, and can sometimes do so under the effect of heavy metals. Reclamation and improvement of the fertility of arid lands by application of organic (manure and sewage sludge) and inorganic (synthetic) fertilizers are expensive and can be a source of pollution. The Rhizobium-legume symbiosis is suggested to be the ideal solution to the improvement of soil fertility and the rehabilitation of arid lands and is an important direction for future research.

REFERENCES

Aarons S R, Graham P H. Response of *Rhizobium leguminosarum* bv. *phaseoli* to acidity. Plant Soil. 1991;134:145–151.

Burns R C, Hardy R W F. Nitrogen fixation in bacteria and higher plants. New York, N.Y: Springer-Verlag; 1975.

Graham P H, Viteri S E, Mackie F, Vargas A T, Palacios A. Variation in acid soil tolerance among strains of *Rhizobium phaseoli*. Field Crops Res. 1982;5:121–128.

McNeil D L. Variation in *Rhizobium japonicum* strains to nodulate soybean and maintain fixation in the presence of nitrate. Appl Environ Microbiol. 1982; 44:647–652.