

# Non-rhizobial endophytes in root nodules

## Abstract

Plants of leguminous family are associated specifically with *Rhizobium* sp. which plays a crucial role in agriculture, forestry and nutrient cycling by maintaining soil fertility through biological nitrogen fixation. The Rhizobia includes genus *Rhizobium*, *Mesorhizobium*, *Bradyrhizobium*, *Ensifer* and *Azorhizobium* belongs to  $\alpha$  proteobacteria. Despite the high specificity between *Rhizobium* and legumes, the presence of non-rhizobia in root nodules has been reported. These are belonging to  $\alpha$ ,  $\beta$  and  $\delta$ -Proteobacteria. This review through a light on diversity and role of these non-rhizoidal species in their host.

**Keywords:** Legume, Non-rhizobial endophytes, plant growth promotion, *Rhizobium*

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## Introduction

Leguminosae family of plants has more than 19000 species. Currently worldwide revealed that the legumes nodules both wild and cultivated inhabited by Rhizobia. The genus *Rhizobium*, *Mesorhizobium*, *Bradyrhizobium*, *Ensifer* and *Azorhizobium* collectively called rhizobial largely attributed to fix atmospheric nitrogen, a major contributor to the global nitrogen cycle. In addition to strains that can elicit nodules root nodules also accommodate various non-rhizobial bacteria having definite influence on the survival, nodulation and grain yield of the crop.<sup>1</sup> In the absence of positive nodulation tests, they can be regarded as non-rhizobial endophytes (NRE).<sup>2</sup> In past decade, several non rhizobial symbionts capable of forming nodules and fixing nitrogen in legume roots have been documented and grouped under  $\alpha$  and  $\beta$ -subclass of Proteobacteria, which include *Methylobacterium nodulans*, *Blastobacter denitrificans*, *Devosia* sp., *Ochrobactrum lupini*, *Agrobacterium*, *Phyllobacterium trifolii*, *Herbaspirillum lustianum*, *Ralstonia taiwanensis*, *Burkholderia tuberum*, *Burkholderia phymatum*, *Burkholderia cepacia*. Few  $\gamma$ -proteobacteria (*Pantoea*, *Enterobacter* and *Pseudomonas*).<sup>3</sup> Actinobacteria (*Arthrobacter*, *Microbacterium* and *Curtobacterium*) and Firmicacteria (*Bacillus*, *Paenibacillus* and *Staphylococcus*) also documented in root nodules. The occurrence of *Bacillus* species as endophyte has been also reported from different plants such as pigeon pea, wheat, kudzu and soybean nodules.<sup>4</sup> These NRE bacteria have beneficial effects on the host plants, including plant growth promotion viz. nitrogen fixation and phosphate solubilization and thereby increase the availability of nutrients to synthesize important biomolecules like nucleic acids, amino acids, proteins etc. which is reflected as better plant growth.<sup>5-8</sup> (Vessey, 2003). Moreover, some are capable of producing IAA which plays a crucial role in plant growth and development by inducing the cell differentiation and regeneration of the vascular tissues and is a regulator of numerous biological processes from cell division, elongation, fruit development, lateral root development, tropistic response and senescence which thereby improve root growth and surface area. In addition, some produce siderophores.<sup>9</sup> Rajendran et al., (2008) and were also capable of producing stress release enzyme ACC deaminase collectively provides excellent plant growth. Some are involved in biological control of plant pathogens.<sup>7</sup>

## Conclusion

Rhizobia are wide spread soil bacteria able to induce the formation of root nodules and to fix nitrogen in both cultivated and wild leguminous crops. These rhizobia are of economic importance in low input sustainable agriculture, agroforestry and land reclamation. Currently there are five genera of rhizobia in a-Proteobacteria recognized as *Azorhizobium*, *Bradyrhizobium*, *Rhizobium*, *Mesorhizobium* and *Ensifer*.<sup>3</sup> Besides these genera, several  $\alpha$ - and  $\beta$ -Proteobacteria and several unclassified  $\delta$ -Proteobacteria were recently isolated from nodules of diversified legume plants. These are non nodulating but demonstrate plant growth promotion by different attributes like nitrogen fixation, phosphate solubilization, growth hormone production, Siderophores production and control of pathogens by antagonism.

## Acknowledgment

None.

## Conflict of interest

None.

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