CHAPTER I

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Actinomycetes are a group of Gram-positive bacteria bearing a superficial resemblance to fungi. They are widely distributed in soil, water, root nodules and other natural environments. The population and the types of actinomycetes in an ecosystem are determined by numerous physical, chemical and biological factors. They have acquired a great industrial importance as a source of antibiotic, growth promoting factors, extra cellular enzymes and other secondary metabolites with diverse chemical structures and biological activities (Polsinelli and Mazza, 1984).

The fixation of atmospheric nitrogen by actinomycete–nodulated, dicotyledonous plants represent a substantial contribution to the global nitrogen cycle, (Baker and Torrey, 1979). Actinorhizal nitrogen fixation is the result of a symbiotic association between Frankia, a nitrogen fixing actinomycete and a variety of woody dicotyledonous plants, (Wall, 2000). These actinorhizal symbioses are important both ecologically and economically. They act as nitrogen providers for the biosphere.

Frankia was named after A.B. Frank in 1886, (Lechevalier and Lechevalier, 1989). He is a Swiss microbiologist who coined the word “Symbiosis”. Based on cross infectivity studies, four host specificity groups are found among Frankia (Baker, 1987). Frankia is considered as a plant growth promoting rhizobacteria (PGPR) (Caru et al., 2003).
Two unique developmental structures that are critical for the survival of *Frankia* are the vesicles and the spores. The vesicles are the site of actinorhizal nitrogen fixation and spores are the reproductive structure of *Frankia* (Krumholz *et al.*, 2003). *Frankia* populations inhabit two distinct ecological niches, the root nodules and the soil. But the data on *Frankia* population in soil is scarce. *Frankia* species often survive in soils where host plant species do not exist. (Maunuksela *et al.*, 1999).

Biological nitrogen fixation is a process that can only be performed by prokaryotes (Gualtieri and Bisseling, 2000). Nitrogen fixation in all diazotrophs is performed by the enzyme nitrogenase (Misra and Verghese, 2004). The immediate product of symbiotic nitrogen fixation within root nodule of legumes and actinorhizal plants is ammonium (Valverde and Wall, 2003). It is then assimilated into amino acids and other biomolecules that enable gaseous nitrogen to be assimilated into life processes. Nitrogen fixation is probably the second most important biochemical pathway after CO₂ fixation (Wall, 2000).

The actinorhizal plants are perennial angiosperms which are diverse in habit and habitat. Except *Casuarinas* and *Alnus*, none of them are crop plants. They are found mostly in nutrient poor soils, disturbed sites and sand dunes. Also they are adapted to extreme environments such as saline sands, semi-arid plains or polar environments. This makes the actinorhizal symbiosis ecologically
significant (Berry, 1994). Actinorhizal plants have applications in silviculture and ligniculture. A biofertilizer role also has been demonstrated by many actinorhizal plants. (Rodriguez-Barrueco and Moiroud, 1990).

The ability of *Casuarina* to fix the nitrogen through *Frankia* contributes immensely in establishing the plantations at adverse sites. Also *Casuarina* develops mechanisms to absorb nutrients from soils, especially phosphorus uptake through mycorrhiza and cluster roots. *Casuarinas* are typical angiosperms trees that are used in rotational agriculture to improve the nitrogen status of the soil. Biomass accumulation, energy fixation and storage and litter production in *Casuarina* plantations in dry tropics is important on afforestation and rehabilitation of degraded forest ecosystems (Srivastava, 1995). Compounds present in *Casuarina* tissues are able to stimulate the growth of *Frankia* and inhibit the growth of other soil microorganisms (Zimpfer *et al.*, 2004).

*Azotobacter* is a free living non-symbiotic nitrogen fixing aerobic soil bacteria found in well aerated moist soil and found in close association with plants in the rhizosphere. Under appropriate conditions, they can enhance plant development and promote the yield of several agriculturally important crops in different soils and climate regions. (Rodelas and Gonzalez Lopez, 1999). These effects are mainly attributed to improved root development, increased rate of
water and mineral uptake by roots and displacement of plant pathogens and by biological nitrogen fixation.

Excessive and imbalanced use of chemical fertilizers and synthetic pesticides have emerged as a serious concern of soil health hazards causing depletion of soil fertility and affecting crop productivity (Rajput et al., 2004). The agriculturally beneficial microorganisms have their unique place and scope in the overall context of agrobiodiversity. They play an important role in nutrient acquisition for plants (Kauraw and Rawat, 2002). Use of bioinoculant technology can upgrade the soil structure, improve soil health and can manage natural resources and thereby increase crop productivity without harming the ecosystem.

The present research deals with the role of Frankia on the growth and yield of Casuarina in Kerala. Detailed studies on Casuarina–Frankia symbiosis are only limited in Kerala. This symbiosis can provide an alternate method to improve the soil fertility without the application of chemicals that will deteriorate the soil health. The interaction effect of Frankia with Azotobacter, a non-symbiotic nitrogen fixing soil bacteria, on the growth and yield of Casuarina and the nitrogen status of the soil is also not available. In the light of the above factors, the present study was undertaken with the following objectives:
1. To enumerate the *Frankia* population in major *Casuarina* growing areas of Kerala.

2. To screen the most suitable medium for the favourable growth and multiplication of *Frankia*.

3. To study the characteristics of *Frankia* isolated in the studies.

4. To study the effect of *Frankia* on the various biochemical properties of *Casuarina* species under study.

5. To find out the effectiveness of *Frankia* on the growth performance of test crop.

6. To find out the interaction effect of *Frankia* and *Azotobacter* on the nitrogen status of soil and on the growth of *Casuarina* species.