STUDIES ON THE EXPLORATION OF BIOFERTILIZERS IN TEA

Synopsis of the thesis to be presented in candidature for the award of the Ph.D. degree of the Calicut University

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Synopsis of the thesis entitled “Studies on the exploration of biofertilizers in tea” to be submitted by N. Tensingh Baliah for the fulfillment of the degree of Doctor of Philosophy of the Calicut University, Calicut- 673 635, India.

The thesis gives information of the research work carried out by the candidate in the division of Botany, UPASI Tea Research Foundation, Tea Research Institute, Valparai – 642 127

The thesis is divided into following chapters:

INTRODUCTION

REVIEW OF LITERATURE

MATERIALS AND METHODS

RESULTS

1. Isolation and selection of N-fixing and P-solubilizing bacteria
2. Biology and ecology of selected strains of Azospirillum and P-solubilizing bacteria
3. Mass multiplication of bioinoculants
4. Nursery and field performance of tea plants to biofertilizer application
5. Role of biofertilizers in organic farming

DISCUSSION

SUMMARY AND CONCLUSION

REFERENCES
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The basic principle of plant nutrition is universal but optimum fertilizer requirement will vary with plant types and nature of soil. Nitrogen, phosphorus and potassium are the major nutrients required by the plants. Other nutrients required are calcium, sulphur and magnesium. Nitrogen is an important constituent of chlorophyll, amino acids, proteins and nucleic acids. Phosphorus is one of the vital nutrients that could be limiting in tea soils. It is required for cell division and plays a key role in the formation of new wood and root. Potassium is considered to play a key role as an activator of enzymes involved in carbohydrate and protein metabolism, membrane permeability and stomatal opening.

Even though about 80 % of earth’s atmosphere is composed of nitrogen, only a limited group of organisms are capable of converting atmospheric nitrogen to assimilable form. Symbiotic microorganisms inhabiting the roots of some angiosperms and gymnosperms, certain heterotrophic soil bacteria which live in free state, photosynthetic blue green algae are examples for those organisms which fix atmospheric nitrogen. These organisms are called as nitrogen fixers. Among the nitrogen fixers, *Azospirillum* are the most widely recognized ones.

The phosphorus applied to soil can not be fully utilized by the plants due to its chemical fixation. However, some microorganisms are able to solubilize it and make available to the plants. Such organisms are called as phosphate solubilizers. Several soil bacteria, particularly those belonging to
the genera *Pseudomonas* and *Bacillus* possess the ability to solubilize the insoluble phosphate into soluble form.

Tea (*Camellia sinensis* (L.) O. Kuntze) is an important plantation crop. The crop is being cultivated around 4,35,000 ha in India with an annual production of 850 m.kg of black tea. Being a foliage crop, the nutrient requirement of tea is fairly high. In tea plantation the major nutrients are supplied through chemical fertilizers; nitrogen as urea, sulphate of ammonia and calcium ammonium nitrate, phosphorus as rock phosphate and potassium as muriate of potash. Researches on manuring schedule helped to increase tea production to a great extent. However, the continuous use of chemical fertilizers for decades changed the physico-chemical nature of the soil. There was a decline in organic matter content of the soil leading to the depletion of beneficial soil microbes, which inturn reduces the productivity of the soil.

Nitrogen fixers and phosphate solubilizers are naturally present in almost all soils but their population level may not be sufficient to bring out these biological processes to a significant level. Addition of efficient strains of these microorganisms is successfully in practice in many crops. Preparations of such beneficial microorganisms are called as biofertilizers. Or in other words “biofertilizers are carrier based preparations containing beneficial microorganisms in a viable state”. They improve soil fertility and help in plant growth by improving nutrient availability.
In plantation crop like tea, the use of biofertilizers has not yet been explored. Attempts have been made earlier to evaluate various commercial formulations of biofertilizers in tea with no fruitful results. This is because of the poor acid tolerance nature of the bacterial strains. The present problem has been taken up with the objective of selecting efficient region specific strains of nitrogen fixing *Azospirillum* and phosphate solubilizing bacteria from tea soils, which are suited for various agroclimatic zones of southern India.

Nitrogen fixers and phosphate solubilizers were isolated from the soil samples collected from tea soils of various tea districts of southern India. They were screened and potential strains were selected based on biochemical characteristics. Biology and physiology of the selected strains were studied in detail. Influence of physical parameters like pH and temperature on their growth, their fungicide, pesticide, and antibiotic tolerance were studied *in vitro*. Production of plant growth hormones such as IAA and GA3, exopolysaccharides, siderophores and poly β-hydroxybutyrate and by *Azospirillum* PSB and ammonium excretion by *Azospirillum* were studied *in vitro*.

Biodiversity study is essential to understand the bacterial community, structure and diversity in relation to environmental factors and ecosystem functions. The diversity study within a targeted bacterial population helps to screen the genotypes that are best adapted to particular environmental stresses or ecological habitats. RAPD analysis gives a considerable level of genetic diversity among the strains. The selected strains from various
agroclimatic zones were compared at molecular level by RAPD analysis and constructed a dendrogram based on their similarity/dissimilarity coefficient.

The beneficial microorganisms are generally applied through various carrier materials. Without carrier materials, the applied beneficial microorganisms will not survive for longer period. The carrier materials should have high organic matter content, high water holding capacity, neutral pH for the better survival of the organisms. Various organic materials and agricultural wastes such as composted coir pith, lignite, organic manure, vermicompost and vermiculite were tested as carrier materials in vitro and field conditions to select the best ones. Selected strains were mass multiplied and conditions for mass multiplication were standardized.

Efficacy of the selected *Azospirillum* strains on the rooting of vegetatively propagated (VP) cuttings and on the growth of VP plants as well as seedlings were tested on nursery experiments. Effect of biofertilizers on the growth characteristics was studied in terms of biometric as well as biochemical characteristics. Activity of the soil enzymes like nitrate reductase and phosphatase were studied in the biofertilizers applied nursery soils.

Field experiments were conducted with the objectives of optimization of dosage, time and method of application. Clonal preferences to biofertilizers, response of seedlings as well as clones to biofertilizer application, response of high yielding and low yielding fields to biofertilizers, evaluation of carrier materials were also conducted under field
conditions. Establishment of introduced nitrogen fixers and phosphate solubilizers in tea soil as well as their impact on soil nutrient status were also studied. Multilocational trials were conducted in Anamallais (Tamil Nadu), Nilgiri-Wayanad (Tamil Nadu) and High Range (Kerala).

The use of biofertilizers in combination with chemical fertilizers and organic manure offers a great opportunity to increase the crop productivity with less cost. With this objective, experiments were conducted to find out the success of biofertilizers in an organic farming system. The results are dealt with in detail and discussed in the thesis.