ABSTRACT

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Title: Rice bacterial endophytes: diversity and role in managing biotic and abiotic stress

Endophytic bacteria are an emerging field of research in this century to maintain and improve crop productivity without causing any substantial harm to the environment. Implementations of these bacteria in plants have shown to improve plant growth and productivity to a great extent. But microbial inoculants do not always work effectively under field conditions due to interference of indigenous microbial populations. So it's better to formulate strategies while keeping in mind the indigenous microflora. In this respect, this thesis was undertaken to study diversity of endophytic bacteria that inhabit roots of rice cultivated throughout West Bengal to identify potential plant growth promoting endophytic bacteria of rice. In addition, efforts were also made to unravel the bacterial diversity of rice root gall. In both the cases, metagenomic studies were first performed to understand bacterial diversity followed by culture dependent isolation and characterization. The strains were then subjected to evaluate their potential in alleviating stress response in plants.

Metagenome analyses revealed that the diversity of endophytic bacteria differed among the agro-ecological regions which may be due to variations in environmental parameters. Some classes were abundant in zones characterised by fertile soil while other classes were prevalent in stressful environments. Few genera were ubiquitously associated with rice and found all over West Bengal while some others were specific to particular zones. Culture dependent studies also corroborated with findings of culture independent approaches. Certain genera were found to possess many plant growth promoting traits and they were also able to improve growth of rice plants under laboratory conditions. Our findings also gave instances of specific bacterial strains resistant to salinity that were able to mitigate salt stress in rice by improving both germination percentage and plant growth. These bacteria when applied under greenhouse conditions also promoted growth in rice. A single bacterial strain isolated from our work was successful in controlling infection by another pathogenic bacterium under both *in vitro* and *in vivo* conditions. It was observed that these endophytic bacteria adopt different mechanisms to successfully ameliorate stress. Some produce osmolytes, antioxidant compounds and enzymes; some secrete secondary metabolites while

others modulate the defence response in plants through induced systemic resistance. In general, the endophytes isolated in the current work were found to exhibit these modes of action inside plants. Colonization attributes of the bacteria also suggested their potential in being endophytes. The bacterial strains were inoculated in rice seeds but they were successful in establishing themselves in both the roots and shoots of plants as has been observed with SEM. Studies on gall microbiome showed that the microbial community has formed distinct separation between gall and non-infected root indicating nematode infection drastically altered the bacterial diversity in plants. Some endophytes were found to be more prevalent in gall which may be associated with nematodes as symbionts. Non-infected root tissue also possessed few genera unique to them that have plant growth promoting properties. From the non-infected root an endophyte was also obtained which could successfully inhibit the nematode causing rice root gall.

Hence, it can be concluded that this thesis has provided a holistic view on the diversity of bacterial endophytes and at the same time have identified few potential strains capable of being plant growth promoters. These indigenous bacteria were able to mitigate the harmful effects of stress on plants and at the same time improved plant growth. So, these endophytes can further be exploited to gain knowledge on their mode of interaction with plants for development of effective bio-fertilisers and biological control agent.

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