ABSTRACT

Crop production has increased significantly by extensive use of synthetic fertilizers which has resulted in fresh water and marine eutrophication. Soil salinity is another obstacle to overcome in rice production as it affects the agricultural land resulting in low yields. To alleviate the negative effects caused by fertilizers and salinity, worldwide agricultural practice is moving to an economical and environment friendly approach. Use of bacterial endophytes as a bioenhancer is one of the approaches for sustainable agriculture. To explore potential applications of bacterial endophytes, research work was initiated at Genetic Engineering lab in Faculty of Applied Sciences, Biotechnology department, AIMST University. The research described in this thesis is aimed to identify the plant growth enhancing EBIs and to develop endophytic bacteria based formulation for the growth enhancement of agricultural crop plants using rice as a model plant. In Phase- I, 800 Endophytic Bacterial Isolates (EBIs) were randomly selected and screened for auxin activity for its effect on early seedlings growth of rice. Surface sterilized rice seeds were treated separately with different EBIs and allowed to grow in Petri plates containing sterile cotton saturated with distilled water for 10 days. On the 10^{th} day, the root length of the rice seedlings was measured and recorded to determine the auxin activity of EBIs. The EBIs increased root length of inoculated rice seedlings was in the range of 58.30% to 81.68% in comparison to control. Results showed that 9 different isolates out of 800 EBIs screened have significant effect on rice root and shoot growth when compared to control. The selected 9 endophytic bacterial isolates were further screened for their plant growth promoting activities such as phosphate solubilization, nitrogen fixation, ammonia production, protease and cellulase activity in which 5 out of 9 EBIs showed positive results. In Phase- II, the selected five isolates were further screened for their ability to enhance growth of rice seedlings. In order to determine the effect of soil with EBIs on rice plant growth and development, river-bed sandy soil and loamy soil were used. The effects of salinity on specific physiological and biochemical responses such as root length, shoot length, relative water content (RWC), lipid peroxidation, hydrogen peroxide activity, chlorophyll content, protein content, proline content were examined. All five isolates 1.IC.3 (*Bacillus megaterium*), 9.AC.9 (*Pantoea agglomerans*), 9.P7.1 (*Bacillus fusiformis*), 5.HB.11 (*Bacillus cereus*) and 11.P1.7 (*Acinetobacter* sp.) showed plant growth enhancing activities with significantly higher shoot and root growth when compared with control plants grown under normal and saline conditions. The 5 selected EBIs increased the root length, shoot length, RWC, chlorophyll

content and protein content of inoculated rice seedlings in comparison to the controls. EBIs designated as 1.IC.3 and 11.P1.7 shown the most significant response for all physiological and biochemical parameters. In contrast, lipid peroxidation, hydrogen peroxide activity and proline content were decreased in plants obtained from EBIs inoculated seeds when compared to the controls. In case of plants grown in river-bed sandy soil, the endophytes showed potential capacity in promoting the growth of the rice plants when compared to control plants. However, results clearly indicated that the soil type can influences the efficiency of EBIs. Using five EBIs (1.IC.3, 9.AC.9, 9.P7.1, 5.HB.11 and 11.P1.7), talc-based formulation and liquid formulation were prepared and evaluated at lab scale in Phase- III. Results indicated that Endophytic Bacteria Based (EBB) powder formulation showed superiority in increasing the yield under saline stress and were able to promote the plant growth effectively. Based on the results, it is concluded that the selected isolates of endophytic bacteria can be used as bioenhancer in increasing agricultural crop productivity. These research findings do have a potential in minimizing the usage of synthetic fertilizers in agriculture. However, further study is required at pilot scale to determine the efficiency and effectiveness of endophytic bacteria based formulations in enhancing the yield of paddy and other agricultural crops.