ABSTRACT

IMPROVING COLD TOLERANCE OF ASIAN RICE THROUGH PLANT GROWTH PROMOTING BACTERIA AND RICE GENE MANIPULATION: MECHANISMS OF PSEUDOMONAS MOSSELII AND OSMADS27

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It is estimated that by the year 2050, the human population will extend to 9.7 billion and therefore the demand for food will increase. It is important to find ways to maintain production of critical crops, like rice, to match the demand. Climate change affects crop productivity as it is the reason for extreme warm or cold weather fluctuations. Asian rice (Oryza sativa L.) generally is grown in tropical and subtropical regions and thus, is sensitive to cold temperatures. This study hypothesized two strategies could improve growth and cold tolerance of rice plants: (1) use of plant growth promoting bacteria (PGPB), (2) gene manipulation of rice plants. To test the hypothesis concerning PGPB, a total of 140 bacteria were isolated and characterized from the root surface and inner tissues of roots and shoots of two-week-old indica and japonica rice plants. Out of the 140, 5 PGPB were selected, based upon their characteristics, for testing their in vivo plant growth promoting capabilities to improve rice cold tolerance. Results showed that 4 of these PGPB, Pseudomonas mosselii, Paenibacillus rigui, Paenibacillus graminis and Microvirga sp. improved growth in a rice genotype-dependent manner but only P. mosselii, improved both indica and japonica varietal plants’ cold survival through increasing antioxidants such as reduced glutathione and proline, respectively. Additionally, P. mosselii showed antagonisms against phytopathogens, Fusarium fujikuroi and Talaromyces aurantiacus, and improved cold survival of japonica plants through either production of secondary metabolites or upregulation of defense genes. The data supported the hypothesis that P. mosselii contributes to cold tolerance of O. sativa through different mechanisms depending on the rice genotype. For the second hypothesis, OsMADS27 was chosen to evaluate its influence on cold tolerance and interactions with P. mosselii. Results indicated that OsMADS27 stimulated defense and peroxidase genes to detoxify excess amounts of reactive oxygen species (ROS) in rice plants as a response to cold stress. Furthermore, the presence of P. mosselii increased the cold survival of OsMADS27 overexpressed indica plants. Further studies need to be performed to understand the interactions of OsMADS27 overexpression with P. mosselii in improving cold tolerance of rice plants.