Development and application of bacterial endophytes on controlling rice seedling diseases

Miin-Huey Lee[1,2*], Chi-Kuan Tu[1,2], Pei-Han Wang[1], Wen-Di Huang[3] and Chih-Li Wang[1]

[1]Departmment of Plant Pathology, National Chung Hsing University, Taichung, Taiwan
[2]Advanced Plant Biotechnology Center, National Chung Hsing University, Taichung, Taiwan
[3]Plant Technology Research Center, Agriculture Technology Research Institute, Hsinchu, Taiwan

*Corresponding author, e-mail: mhlee@nchu.edu.tw

ABSTRACT:
Rice (*Oryza sativa*) is an important staple food worldwide, and most global production is from Asian countries. Highly automated nursery and transplanting are common practices in rice cultivation in many countries. The rice nursery industry produces commercial scale seedlings by an automatic system with the use of nursery trays that raise seedlings compatible with mechanical transplanting. In this system, intensive rice seedlings growing in nursery trays were required for transplanting. Nevertheless, a high planting density is often associated with the occurrence of seedling diseases caused by various pathogens in nursery trays. *Pythium* spp. are common pathogens that can cause rice root rot, seedling blight, and damping-off in nursery trays. Biocontrol with endophytic bacteria was developed to control rice seedling diseases. Three bacterial endophytes displayed strong protection of rice seedlings against *P. arrhenomanes* in a small-scale assay. They are *Lysobacter* sp., *Kitasatospora* sp., and *Bacillus* sp. To quickly evaluate the disease severity of the root system damaged by *Pythium* in nursery trays, a root surface area measurement was developed. By using this measurement, the control efficacy in nursery trays was evaluated, and the *Lysobacter* and *Bacillus* showed promising biocontrol activity against *Pythium* disease in nursery tray. In the field trial, the three endophytes exhibited significant disease control efficacy on rice brown spot disease caused by *Bipolaris oryzae* naturally occurring in a commercial nursery field. The three endophytes exhibited multiple enzymatic activities and broad-spectrum antagonistic activities against multiple rice pathogens. The three endophytes colonized the root surface and inside the root. Antibiosis is the major mechanism used by the *Lysobacter* and *Bacillus*, while a hyperparasitism-like phenomenon was found in the interaction of the *Kitasatospora* with *Pythium* and *Bipolaris* hyphae. Induced resistance was not found in rice seedlings colonized by the three strains. Pre-commercial production of the *Bacillus* was conducted using a pilot scale fermentater and applied through drenching in the automatic seeding system or applied through seed coating.

KEYWORDS:
Oryza sativa; endophytes, biocontrol, *Pythium, Bipolaris*.