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Bacillus spp. as Potential Biocontrol Agents to Multiple Diseases on *Panax ginseng*

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복합 인삼병해의 생물적 방제제로서 *Bacillus* spp.

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Objectives

The production of harvestable ginseng roots requires a 3~5 year cultivation period after transplanting of one-year-old roots in Korea. During this period, ginseng is susceptible to various diseases caused by soilborne and airborne pathogens which can reduce yield up to 30~60%. Therefore, successful production of ginseng roots depends on the control of diseases. The purpose of this study was to determine whether selected Bacillus spp. can simultaneously control ginseng root rot and Phytophthora leaf blight and to evaluate their biocontrol ability against above two pathogens.

Materials and Methods

ㅇ **Isolates:** *Bacillus* spp. were isolated from plant roots and maintained on tryptic soy agar. *Phytophthora cactorum* was isolated from naturally infected ginseng tissues and properly maintained on potato dextrose agar or V8 juice agar.

ㅇ **Biocontrol screens on ginseng seeds:** Ginseng seeds (10 seeds/isolate) socked in each bacterial suspension (1×10^8 cfu/ml) were sowed in the pot containing a field soil infested with *C. destructans*. All pots were placed in a greenhouse. Seedling stand and root length were evaluated 30 days after treatment at approx. 21℃.

ㅇ **Biocontrol of ginseng root rot:** A naturally infested soil with *C. destructans* was evenly mixed with peat-moss (1:3, w/w) and placed in round plastic pots. One-year-old ginseng (10 roots/treatment) socked in the suspension (1×10^8 cfu/ml) of each isolates or water as control was planted in the pots containing pathogen mixture or peat moss only. Shoot stand and healthy root were recorded after a month of cultivation. There were three replicates per treatment in a completely randomized design. The experiment was repeated at least twice.

ㅇ **Biocontrol of Phytophthora blight:** Five milliliter of each bacterial suspension (1×10^8 cfu/ml) or water as control was drenched around each 2 month old seedling of ginseng before 5 days of challenge with *P. cactorum* (approx. 3×10^4 zoospore/ml). The seedlings were incubated in a humid chamber for 12 hr to induce the disease. Disease incidence was recorded for 10 days.

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Results

Based on their performance in preliminary experiment, three isolates (B1141, B1142 and B1146) were selected for this experiment, which were identified as *B. pumilus, B. megaterium,* and *Paenibacillus lentimorbus* by MIDI analysis. Treatment of selected *Bacillus* isolates to one-year-old ginseng roots resulted in significantly higher healthy shoot and root than that of untreated control in infested peat moss with *C. destructans*. *P. cactorum* infected stem, petiole, and leaf of the seedlings resulting water-socked and wilted symptoms when inoculated with zoospores by spraying. Soil drenching of selected *Bacillus* isolates before challenging of the pathogen significantly reduced disease incidence. The results indicate the potential of *Bacillus* strain as biological control agents for multiple ginseng diseases including soilborne and airborne pathogens.

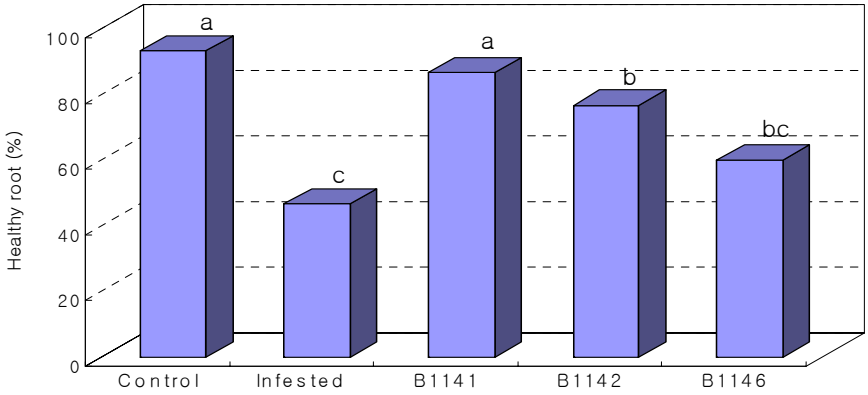

Fig. 1. Effect of *Bacillus* isolates on the control of root rot caused by *C. destructans*. Untreated or treated one-year-old ginseng roots with *Bacillus* isolates were planted in infested peat moss with *C. destructans* or peat moss for control.

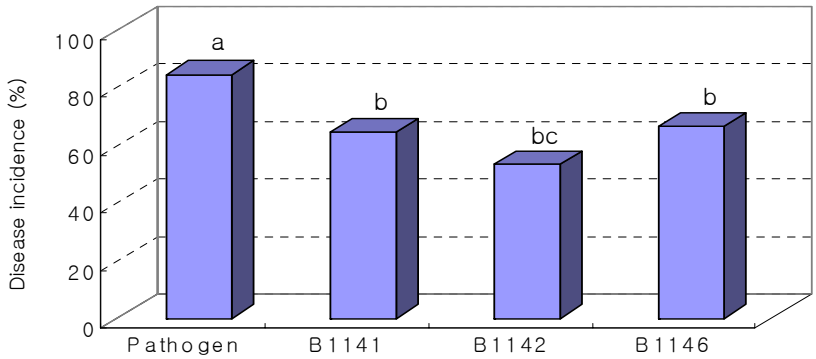

Fig. 2. Effect of selected *Bacillus* isolates on Phytophthora blight caused by *P. cactorum*. Disease incidence was recorded 10 days after challenging by spraying zoospore suspension (3×10^4 zoospore/ml) on ginseng seedlings.