

Title Improved postharvest disease control of *Penicillium digitatum* on citrus fruits by combined application of compatible biocontrol agents.

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Abstract

Ten *Pseudomonas* spp. and five *Trichoderma* spp. strains were tested *in vitro* and *in vivo* for their antagonistic properties against *P. digitatum*, the causal agent of green mould of citrus. Several bacterial and fungal strains, but not their culture filtrates, strongly inhibited the growth of the pathogen *in vitro* assays on different substrates. Spore germination in PDB was also greatly controlled by *Pseudomonas* spp. cell suspensions as well as by culture filtrates. Inhibition of *P. digitatum* growth was increased when *Pseudomonas* and *Trichoderma* strains were combined, showing synergic efficacy of the mixtures. Inhibitory effects of fungal growth and conidial germination were synergically increased by mixing *Trichoderma* culture filtrates and *Pseudomonas* cells. Combination of bacterial and fungal culture filtrates generated only an additive response, indicating that the presence of living bacterial cells was required for a synergistic effect. Incidence and severity of citrus decay *in vivo* were consistently reduced when strains were applied in wounds 24 h and 72 h before challenging *P. digitatum*. Even in “*in vivo*” biocontrol assays, the mixtures of bacterial and fungal biocontrol agents were more effective than either agent used alone. The development of decay was more effectively inhibited in small-scale dip-treatments, whereas the efficacy of the mixtures was not significantly different in either the dip treatments or in the wound inoculation. These experiments clearly indicate that *Pseudomonas* spp. and *Trichoderma* spp. strains could be considered interesting biocontrol agents for citrus green mould, supporting the concept that a more effective disease control is given by the combined action of the two agents.