Biocontrol of *Rhizoctonia solani* using volatile organic compounds of solanaceae seed-borne endophytic bacteria

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Abstract

Rhizoctonia solani is a broad spectrum fungal pathogen that infects crops in greenhouse and field conditions causing plants damping-off and fruit rot which provoke serious yield losses. This study prospected the use of bacterial volatile organic compounds (VOCs) to control *R. solani* infection on tomato seedlings and fruit in order to search for an alternative to the use of chemical pesticides. Seed-born bacterial endophytes were isolated from the cultivated *Solanum lycopersicum* and the wild *Solanum linnaeanum* species. This study showed a host- and organ-specific colonization of endophytic bacteria at early seedling stage with most of them colonizes the cotyledons in comparison to stems and roots. Overall, 51% and 11 % of isolated endophytic bacteria produce antifungal VOCs against *R. solani* at 7 d and 14 d of dual culture, respectively. The majority (about 78%) of the antagonistic bacterial endophytes showed promoting activity on tomato seedling growth. For the bioprotection tests the strains TRC7 and TRC10 of *Bacillus subtilis* and TRT11 of *B. megaterium*were selected as the most antagonistic and PGP endophytic bacteria and a non-antagonistic strain SMLR7 of *Paenibacillus* sp., with this later strain reported for the first time colonizing internal seed tissues of *S. linnaeanum.* The VOCs of the strain TRC7 showed the best pattern of decrease of *R. solani* rotting on tomato fruit, and increase the hypocotyl length, the radicle length, the fresh weight, and the vigor of tomato seedlings. The identification of the VOCs produced by the antagonistic *Bacillus* strains showed a core set of four compounds i.e. 2-Heptanone; Pyrazine, 2,5-dimethyl-; Naphthalene; and Benzenamine, N-ethyl- which was the most abundant. All the four VOCs showed antifungal activity against *R. solani* in vitro growth, and to our knowledge this activity is reported for the first time for Benzenamine, N-ethyl- and 2-Heptanone. The Benzenamine, N-ethyl- showed the best antifungal activity with an

IC50 about 0.09 mL L^{-1} headspace and proved to be effective in reducing *R. solani* rotting on tomato fruit at the same concentration. So, this work provides evidence about VOCs-mediated biocontrol ability of *Bacillus* strains to reduce *R. solani* seedling damping-off and fruit rot of tomato making them valuable agents for pre- and postharvest control of this disease.