

SUMMARY

Plant diseases caused by soilborne pathogens, including fungi, pose a severe problem in agriculture. Commonly used chemical plant protection products, including fungicides, are not inert to the environment due to their low selectivity and toxic effects on organisms. Hence, microorganisms showing antagonistic interactions with phytopathogens are a welcome alternative to reduce the use of chemicals. Special attention is now being paid to naturally occurring endophytic bacteria, which can play an essential role in the biological protection of plants due to their antimicrobial activity, close interactions with plants and ability to support their systemic resistance.

The main objective of this study was to identify the mechanisms determining the high biological activity of the endophytic strains *Pseudomonas fluorescens* BRZ63 isolated from the roots of oilseed rape (*Brassica napus* L.) and *Serratia quinivorans* KP32 isolated from the roots of parsley (*Petroselinum crispum* L.). An attempt was made to explore and understand the basis of antagonistic interactions between these endophytes and taxonomically diverse fungal phytopathogens at the molecular level. In addition, the ability of the tested bacterial strains to colonise internal plant tissues and their effects on the growth and protection of oilseed rape against *Rhizoctonia solani* were determined.

The tested strains showed differential activity against *Rhizoctonia solani* W70, *Colletotrichum dematium* K, *Fusarium avenaceum* and *Sclerotinia sclerotiorum* K2291, and their ability to inhibit the growth of these phytopathogens was due to a wide range of traits determining antagonistic interactions. Analyses of the genomes of the bacterial strains studied allowed the identification of genes determining various biocontrol mechanisms, including competition for living space and nutrients, antibiotic production, production of pathogen cell wall-degrading enzymes and production of volatile compounds. In addition, genes encoding a wide range of mechanisms determining the ability to colonise and promote plant growth were identified in the genomes of both strains. Gene expression analysis in the BRZ63 strain in response to fungal filtrates showed significant changes in the transcript levels of genes involved in pyoverdine and viscosin production. In contrast, the KP32 strain showed significant changes in the transcription of genes encoding chitinases, as well as those involved in the biosynthesis of hydrogen cyanide, enterobactin and acetoin, indicating the involvement of different mechanisms in the growth inhibition of the phytopathogens tested. Biochemical tests carried out confirmed a range of activities in the bacterial strains tested for effective colonisation of

plant tissues, including the capacity for active motility, production of cellulases and antioxidant enzymes (catalase and superoxide dismutase), production of exopolysaccharides, autoaggregation and biofilm formation. The effective colonisation properties of strains BRZ63 and KP32 were confirmed by microscopic observations of EGFP protein-labelled bacterial cells colonising the surface and internal tissues of model plants *Arabidopsis thaliana* Col-0 and *Brassica napus* L. Moreover, soil inoculation with strains BRZ63 and KP32, which showed the ability to move freely from plant tissues to soil and soil to plant, was found to contribute to an increase in the weight of plant roots and shoots, even in the presence of *R. solani*.

The biological activity of the tested strains *P. fluorescens* BRZ63 and *S. quinivorans* KP32 and their ability to effectively colonise and survive in plant tissues and soil indicate that they may, according to the general principles of integrated pest management, find potential use as active agents of biopesticides.