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Biological control of bacterial spot of tomato using *hrp* mutants of *Xanthomonas campestris* pv. *vesicatoria*

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Abstract

Xanthomonas campestris pv. *vesicatoria* strain 75-3 *hrpG*, *hrpX*, *hrpF* and *hrpE1* mutants were evaluated for control of bacterial spot of tomato under both greenhouse and field conditions. In greenhouse studies, the 75-3 *hrp* mutants were spray-inoculated onto tomato foliage 48 h prior to inoculation of the wild-type pathogen, *X. campestris* pv. *vesicatoria* 75-3, and bacterial spot severity was assessed 10 days after pathogen inoculation. Statistically significant reductions in disease severity relative to the buffer treatment were provided by all four 75-3 *hrp* mutants. Unexpectedly, however, disease reductions differed significantly among the mutants with the 75-3S *hrpG* mutant consistently providing the greatest disease suppression (mean reduction in disease severity compared to the buffer treatment of ~58%), followed by the *hrpX* mutant (mean ~40%), the *hrpF* mutant (mean ~30%), and the *hrpE1* mutant, which provided the least control (mean ~21%). Disease control efficacy of these mutants was evaluated under field conditions in Alabama (AL) and Florida (FL). Only the 75-3S *hrpG* mutant and the 75-3 *hrpF* mutant provided statistically significant reductions in disease severity compared to the pathogen-only control in all three field trials. In the two AL trials, the 75-3S *hrpG* mutant was significantly more effective in reducing bacterial spot severity than the previously most effective biological control agents *Pseudomonas syringae* Cit7 and *Pseudomonas putida* B56. In the two AL trials, the 75-3S *hrpG* was as effective as the plant activator acibenzolar-*S*-methyl in one experiment but less effective in the other experiment. Averaged across all three field trials the 75-3S *hrpG* mutant provided a mean reduction in foliar disease severity of ~76%, compared to the mean of ~29% for *P. syringae* Cit7 averaged across all previous field trials. This study is significant not only for the selection of a biological control agent superior to previously selected strains and comparable in efficacy to the plant activator acibenzolar-*S*-methyl, but also for the finding that not all *hrp* mutants of a given bacterial strain are equally effective as biological control agents of that pathogen.
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1. Introduction

Bacterial spot of tomato (*Lycopersicon esculentum*), a serious disease affecting both foliage and fruit (Jones, 1991), is caused by *Xanthomonas campestris* pv. *vesicatoria* (syn. *Xanthomonas euvesicatoria* Jones et al., 2004). The disease is particularly important in the southeastern United States (Davis et al., 1998). Although bacterial spot may not reduce the total number of fruit, economic losses result from unmarketable infected fruit, sun scalded fruit due to defoliation, and reduced numbers of fruit in the USDA large size category which brings the highest return to growers (Pohronezny and Volin, 1983). Traditional control measures for bacterial spot include the application of bactericides, such as copper hydroxide, in combination with ethylene *bis*-dithiocarbamate (EBDC). Inadequate efficacy of the conventional chemical agents, particularly when copper-resistant pathogen strains are prevalent, make

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