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Sequential Application of Antagonists for the Biological Control of the Burrowing Nematode *Radopholus similis* in Banana

ALEXANDER R. MENDOZA LUNA, RICHARD A. SIKORA

University of Bonn, Institute of Crop Science and Resource Conservation-Plant Pathology, Germany

Abstract

Recent work suggests that the combination of different biocontrol agents with different modes of action could be more effective for the control of nematodes than individual application. The aim of this work was to determine the biocontrol effects of single or sequential applications of the mutualistic endophyte *Fusarium oxysporum* strain 162 (5×10^6 and 1×10^7 spores per plant), the eggs pathogen *Paecilomyces lilacinus* strain 251 (1.8×10^7 conidia g^{-1} soil) and the antagonistic bacteria *Bacillus firmus* (2 g of product/plant) toward *Radopholus similis* in banana in pot trials under greenhouse conditions. The single or combined application of fungus-fungus or fungus-bacteria was shown to reduce *R. similis* penetration and reproduction. The combination of *F. oxysporum* and *P. lilacinus* caused a 68.5% reduction in nematode density in the root system, whereas the individual applications reduced the density by 27.8% and 54.8% over the control, respectively. Satisfactory results were also obtained with sequential application of *F. oxysporum* and *B. firmus*. The combined treatments reduced the density of *R. similis* up to 86.2%, followed by 63.74% and 32.7%, with a single application of *B. firmus* or *P. lilacinus*, respectively. The combination of *P. lilacinus* and *B. firmus* increased significantly the biocontrol of *R. similis*, compared with the single applications of the agents and the absolute control. The density of nematode in the root system was reduced to 91% with mixed inoculations of both biocontrol agents. Meanwhile, the single applications of *P. lilacinus* or *B. firmus* reduced *R. similis* population up to 58% and 67%, respectively. The compatibility of the biocontrol agents, as well the capacity of *F. oxysporum* to colonize banana roots in absence and presence of *P. lilacinus* or *B. firmus* was also investigated. *P. lilacinus* or *B. firmus* did not adversely affect endophytic colonisation by *F. oxysporum*. It can be concluded that biological control of *R. similis* in banana can be enhanced via sequential application of antagonist with different modes of action that target different stages in the infection process.

Keywords: *Bacillus firmus*, bacteria, combined applications, endophytic, fungi, *Fusarium oxysporum*, *Musa*, *Paecilomyces lilacinus*