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Effect of growing medium water content on the biological control of root pathogens in a closed soilless system

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SUMMARY

The water content of the growing medium and its interaction with a biocontrol agent was studied in a closed soilless culture system in order to identify factors that could increase the efficiency and decrease the variability of biocontrol agents. Pumice was chosen as the growing medium because of its high water-holding capacity and in view of the high water content required for the growth of the root pathogen. The commercial biocontrol agent Binab T (active strains *Trichoderma polysporum* and *T. harzianum*) was evaluated at 50% and 70% water content. Studies were carried out in a controlled environment, in a climate chamber, using tomato as the model plant and *Pythium ultimum* as the model pathogen. Pathogen levels were affected by the water content of the medium and the biocontrol treatment, while the amount of biocontrol agent was not affected by the water content of the growing medium. The *Trichoderma* strains in Binab T were able to reduce the amount of pathogen and the incidence of disease at both water contents tested. The biocontrol activity of Binab T against *P. ultimum*, as indicated by the level of glucanase production, was affected by variations in the water content of the growing medium. The pathogen, the biocontrol agent, and the water content of the growing medium, all had an impact on the microbial communities resident in the system.

Hydroponic and soilless greenhouse cultivation systems are used worldwide to grow fresh vegetables as well as ornamentals. These systems can be either open or closed, in terms of the type of recirculation of the nutrient solution. In closed hydroponic growing systems, the re-use of excess nutrient solution and better management of the water and nutrient supply reduces the release of nutrients into the environment, which confers an advantage from an environmental point of view. Conversely, the growth and spread of root pathogens is a particularly acute problem in such systems (Stanghellini and Rasmussen, 1994). The addition of fungicides is a questionable practice, due to environmental concerns, which has encouraged the use of other technical and biological methods to reduce the spread of root-borne pathogens within the circulating nutrient solution (Ehret *et al.*, 2001). However, even these methods do not prevent the spread of pathogens between plants that are interconnected through their root systems (i.e., plants within the same slab, or on the same irrigation board). In such cases, the addition of a biological control agent may be an effective and environmentally sound method to combat disease and prevent the spread of pathogens between such plants.

A number of microorganisms that are potentially antagonistic to root pathogens have been selected and tested in hydroponic systems (Rankin and Paulitz, 1994; McCullagh *et al.*, 1996; Paulitz, 1997; Utkhede *et al.*, 1999; Punja and Yip, 2003; Rose *et al.*, 2003). Among these are several species of *Trichoderma* which are well-known for their antagonistic activity in different ecosystems, including closed soilless systems (Khalil *et al.*, 2009). *Trichoderma* species also have properties that are directly related to the promotion of plant growth and have various beneficial secondary effects. Their use in substrate-based closed growing systems confirms the ability of such species to control root pathogens, but their performance has been shown to be affected by the type of substrate used and by the type of pathogen present in the growing system (Khalil *et al.*, 2009).

One drawback during the introduction of biocontrol microorganisms has been their inconsistent efficiency under commercial growing conditions. Optimising conditions in the environment to which biocontrol agents are applied, a process known as habitat management, could be an interesting strategy for improving the consistency of their performance. As indicated by Postma *et al.* (2000), and by van der Gaag and Wever (2005), abiotic and biotic factors in the growing medium play an important role in the suppression of disease. For a successful and consistent effect by any biocontrol agent in a closed substrate-based cultivation system, more knowledge is required on the interactions between these factors and the biocontrol agent. One key abiotic factor is the water content of the growing medium, which is crucial in substrate-based soilless culture due to the rapid variations that occur, from near-saturation levels immediately after irrigation, to near-dryness after several hours of evapo-transpiration.

Under commercial soilless culture conditions, pumice is commonly used to grow vegetables, especially tomato. This inert medium is known for its high waer-holding capacity. Previous investigations have also shown a high potential for disease control using this medium (Khalil *et al.*, 2009). The overall objective of the present study was to develop an irrigation strategy that promoted the

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