Research on the Rust Hyperparasite *Cladosporium tenuissimum*: Status and Prospects

S. Moricca[1, *], B. Ginetti[1], A. Ragazzi[1], A. Lupo[2], and G. Assante[3]

[1] *Università di Firenze, Dipartimento di Scienze delle Produzioni Agroalimentari e dell'Ambiente, Florence, Italy*

[2] *Università del Sannio, Dipartimento di Scienze Biologiche ed Ambientali, Facoltà di Scienze, Benevento, Italy*

[3] *Università di Milano, Dipartimento di Patologia Vegetale, Milan, Italy*

[*] *salvatore.moricca@unifi.it*

The use of biological agents to control plant diseases is an attractive approach, especially at a time when managers and other stakeholders seek to limit the impact of synthetic pesticides. Further, chemical pesticides cannot be used in natural habitats because of their expense and potential negative effects on ecosystems.

Mycoparasites are viewed as effective and environmentally friendly tools for the management and control of many important rust pathogens. Several species of the genus *Cladosporium* are mycoparasites of rust fungi. Of these, *C. tenuissimum* strongly inhibits important rust agents in the genera *Melampsora*, *Cronartium*, *Peridermium*, *Puccinia*, and *Uromyces*. It is also effective against nonrust fungal pathogens and oomycota. It suppresses disease by various means such as mechanical action, enzymatic action, and the production of metabolites that have antifungal properties. It reduces the number of rust propagules and their longevity, and hence curtails the diseases these rusts cause in a controlled environment (greenhouse).

Despite all these positive indications, several factors have so far made it difficult to use *C. tenuissimum* as a conventional biofungicide. Among these complicating factors are the complexity and variability of the habitat in which the mycoparasite occurs, the response of the other partners of the three-way interaction (the host and the parasite), the mode of application of the mycoparasite (its formulation and its combination with other control measures), and variations in mycoparasite virulence. In field tests the effectiveness of the fungus did not reach the level required to be commercially used for crop protection.

The situation might be completely different, however, in the prevention and control of human diseases. Here there are high hopes that a way will be found to use this mycoparasite, or the metabolites it produces, to protect human beings against disease. Cladosporols A–E, the family of metabolites that the fungus produces in vitro, strongly inhibited in vitro the growth of several *Candida* species, and it has recently been demonstrated that some of these metabolites are also effective antitumor agents, inhibiting the proliferation of cancer cells. The possible use of these molecules as therapeutic tools opens unexpected and promising avenues of research.

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