Pedobiologia **50** (2006) 185—190

Available online at www.sciencedirect.com

SCIENCE DIRECT®

Pedobiologia

www.elsevier.de/pedobi

PROCEEDINGS OF THE XITH INTERNATIONAL COLLOQUIUM ON APTERYGOTA, ROUEN, FRANCE, 2004

Survival and feeding activity of *Protaphorura armata* in different composts

Maria Agnese Sabatini[a,*], Gloria Innocenti[b], Matteo Montanari[b], Sonia Ganassi[a]

[a]*Dipartimento di Biologia Animale, Università degli Studi di Modena e Reggio Emilia, via Campi, 213/D; I-41100 Modena, Italy*
[b]*Dipartimento di Protezione Valorizzazione Agroalimentare, Alma Mater Studiorum Università degli Studi di Bologna, viale Fanin, 46, 1-40127 Bologna, Italy*

Received 10 May 2005; accepted 21 December 2005

KEYWORDS
Springtail;
Compost;
Trichoderma atroviride;
Conidia viability;
Gut content analysis;
Ca-Lignosulphonate

Summary

Effects of compost products, enriched or not-enriched with a strain of the mycoparasitic fungus *Trichoderma atroviride*, on the survival of the collembolan *Protaphorura armata* and the viability of fungal conidia after the transit through the springtail gut were investigated. The effect of compost enriched with Ca-Lignosulphonate (Ca-Ls), a low cost by-product of the acid sulphite pulping process, with lignin-like structure, on *P. armata* was also evaluated. All compost products enriched or not with the mycoparasitic fungus or Ca-Ls did not affect *P. armata* survival. No statistical differences were found in animal survival for different types of product or in enriched and not-enriched products. In addition to adults, live juveniles were also observed in all compost products. The gut content of animals, collected at the end of the survival test from compost enriched with *T. atroviride*, was examined under the light microscope, and in a few cases observations revealed the presence of some *T. atroviride* conidia. Subsequent tests carried out to study the viability of conidia after the transit through the springtail gut showed that colonies of the fungus developed from all faecal pellets produced by adult and juveniles specimens of *P. armata* previously fed on conidia of *T. atroviride*. These results suggest compatibility between Collembola and *Trichoderma* or Ca-Ls in the composts.

Introduction

Composting in part solves the problem of disposal and reuse of wastes, and the use of compost is important in modern sustainable agriculture,

*Corresponding author. Tel.: 0592055550; fax: 0592055548.
E-mail address: sabatini@unimore.it (M.A. Sabatini).

0031-4056/$ - see front matter © 2006 Elsevier GmbH. All rights reserved.
doi:10.1016/j.pedobi.2005.12.005

particularly in southern Europe where soils have a poor organic content as well as in areas continuously used for arable production where organic matter levels are decreasing. Compost is a hygienic humus-rich product used as an amendment to improve soil structure and promote plant growth (Popkin 1995). Compost can also provide biological control against plant diseases (Hoitink and Fay 1986); the suppressive effect seems to be related to indigenous microbial consortia (Hoitink 1990; Postma et al. 2003) and depends on the origin and quality of the compost. In particular, the nature of organic matter, maturity level and salinity strongly influence the activity of microorganisms (Hoitink and Bohem 1999). To enhance suppressiveness to plant diseases, compost can be enriched with selected strains of microbial antagonists or with different products such as Ca-Lignosulphonate (Ca-Ls), a by-product of the pulping process, available in large amounts at low cost. Ca-Ls is used to improve chemical–physical parameters and microbial biocontrol activity of soil to enhance plant growth and health (Meier et al. 1993; Lazarovitis 2001; Soltani et al. 2002). Enrichment of compost with Ca-Ls and the mycoparasitic fungus *Trichoderma atroviride* improved its suppressiveness against melon *Fusarium* wilt disease (Montanari et al. 2004a).

In soils enriched or not-enriched composts come in contact with components of the soil community; however, the effects of composts on soil animals have been scarcely investigated (Mueller et al. 1993; Pfotzer and Schuler 1997; Crouau et al. 2002; Petersen et al. 2003).

It has been shown in microcosm studies that the collembolan *Protaphorura armata* may significantly control disease caused by *Gaeumannomyces graminis* var. *tritici* and *Fusarium culmorum*, two of the most important soil borne pathogenic fungi of cereals (Sabatini and Innocenti 2001). Previous studies also demonstrated the absence of negative interactions between springtails and *T. harzianum*, a fungus controlling fungal plant diseases, in tests carried out in Petri dishes or under controlled conditions in the glasshouse (Curl 1979; Wiggins and Curl 1979; Lartey et al. 1994; Innocenti et al. 2001; Sabatini et al. 2002).

The aim of this study was to investigate (i) the interactions between the collembolan *P. armata*, a species used also in ecotoxicological tests (Hopkin 1997), and compost products, enriched or not enriched with a strain of the mycoparasitic fungus *T. atroviride* or Ca-Ls and (ii) the effect of the feeding activity of this fungivorous collembolan species on the viability of conidia of *T. atroviride*.

Materials and methods

Test organisms

Collembola: The Collembola used belonged to the species *P. armata* (Tullberg, 1869) sensu Gisin, 1952. Springtails, derived from specimens collected in a cultivated cereal field of the University of Bologna located in the Po Valley near Carpi (Modena, Italy), were reared for several generations in the laboratory. They were maintained in glass jars containing clay saturated with distilled water and kept in a thermostatic chamber at 20 °C. Animals were fed on brewer's yeast.

Fungi: The benomyl-tolerant strain of *T. atroviride* Karsten 312 B2 (Ta 312 B2) was used. The fungus is kept in the collection of the "Dipartimento di Protezione Valorizzazione Agroalimentare," University of Bologna. Cultures were stored in tubes on PDA amended with 5 mg l^{-1} of benomyl at 5 °C. This fungus is characterised by a high antagonistic activity (Montanari et al. 2004a), and it is suitable for establishment in composts (Montanari et al. 2004b). The acquisition of benomyl tolerance did not affect the fitness of the fungus (data not shown).

To prepare sporal suspension, Ta 312 B2 was grown in Petri dishes on PDA (39 g PDA l^{-1} deionised water) for 5 days at 22 °C in the dark, and then it was incubated in the light at room temperature for two additional days to improve sporulation. Spores were suspended in sterile deionised water, gently scraped, sieved through cheese cloth and washed in deionised water by centrifugation at 6000*g*.

Organic products and enrichment with *T. atroviride* and Calcium-Lignosulphonate

The following compost products were used: (i) spent mushroom (*Agaricus bisporus*) compost (Fungo Spergola, Bologna, Italy) produced from wheat straw-bedded horse manure at two maturity levels: taken after steaming at the end of the mushroom production process (Young Spent Mushroom Compost – YSMC), and taken 3 months after steaming (Mature Spent Mushroom Compost – MSMC); (ii) green compost (GC) derived from fruit, vegetable and garden wastes taken 1 month after heat peaking, (Nuova Geovis, Bologna, Italy); (iii) commercial peat moss (PM), (Compo GmbH, Munster, Germany) and potting soil (PS), (Compo Agricoltura, Milano, Italy) were used as controls. Some physical and chemical properties were determined at the laboratory of "Chimica del Suolo," University of Bologna (Table 1).