FUNGI ASSOCIATED WITH EGG MASSES OF *MELOIDOGYNE INCOGNITA* AND *M. JAVANICA* IN A FLORIDA TOBACCO FIELD[†]

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RESUMEN

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La colonización de hongos fue determinada por las masas de huevos colectadas en raíces de tabaco infectadas con una población mezclada de *Meloidogyne incognita* y *M. javanica* en un campo en Florida en 1991. De 467 masas de huevos examinadas, 48% fueron colonizadas y más de 15 especies de hongos fueron aislados. *Paecilomyces lilacinus* fue el hongo predominante y fue encontrado en 26% del total de masas de huevos y en un 54% de las masas de huevos colonizadas por hongos. *Fusarium oxysporum, Pyrenochaeta terristris* y un hongo estéril fueron también comunes en las masas de huevos. La comunidad de hongos en las masas de huevos de *Meloidogyne* spp. difirieron de aquellas de quistes de *Heterodera glycines* en un campo cercano a pesar de que la textura del suelo y las condiciones climáticas fueron similares.

Palabras clave: control biológico, Florida, hongos, índice de similaridad, *Meloidogyne incognita, M. javanica, Nicotiana tabacum, Paecilomyces lilacinus,* tabaco.

Interest in biological control of nematodes using fungal parasites of eggs has increased rapidly in recent years (Stirling, 1991). Many fungi have been isolated from females, cysts, eggs, and egg masses of Heteroderidae throughout the world (Crump, 1991; Rodríguez-Kábana and Morgan-Jones, 1988). In the United States, fungi have been isolated from eggs of *Meloidogyne incognita* (Kofoid & White) Chitwood on peach in California (Stirling and Mankau, 1978), soybean in Alabama (Morgan-Jones *et al.*, 1984), and tomato in California (Gaspard, 1990), and from eggs of *Meloidogyne arenaria* (Neal) Chitwood on peanut in Alabama (Godoy *et al.*, 1983) and Florida (Dickson *et al.*, 1994). The objective of our study was to investigate the species and frequencies of fungi colonizing egg masses in a mixed population of *M. incognita* and *Meloidogyne javanica* (Treub) Chitwood in a tobacco field near Gainesville, Florida.

The tobacco field was located at the University of Florida Agronomy Farm, Green Acres, Alachua County, Florida, U.S.A. The soil was an Arredondo fine sand (90% sand, 4% silt, 6% clay; 2.5% organic matter) (Weibelzahl-Fulton *et al.*, 1996). The site had been planted to flue-cured tobacco (*Nicotiana tabacum* L.) continuously for 6 years before 1991. In a

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related study, forty-eight plots were established in this field to determine the effects of nitrogen fertilizer (two inorganic nitrogen levels), autumn cover-crop treatments (hairy indigo, forage sorghum, and weeds), and tobacco cultivars (Coker 371 Gold and K-326) on population dynamics of *Meloidogyne* spp., their fungal antagonists, and the bacterial parasite, *Pasteuria penetrans* (Thorne) Sayre & Starr (Chen *et al.*, 1994b). Coker 371 Gold is susceptible to both *M. incognita* and *M. javanica*, and K-326 is resistant to *M. incognita* but susceptible to *M. javanica*. Fungi were isolated from egg masses collected from the 48 plots in 2 August 1991 as described previously (Chen *et al.*, 1994b). The overall percentage frequency of fungal colonization of egg masses was used to determine the effects of cultural practices on fungi and effects of fungi on nematode population densities (Chen *et al.*, 1994b). The fungi were identified by following a procedure described previously (Chen *et al.*, 1994a). The identity and frequency of each fungal species are reported herein.

The fungal community in the egg masses of *Meloidogyne* spp. was compared with the fungal community in cysts of *Heterodera glycines* Ichinohe collected from a soybean field located nearby (within 250 m) on the same farm. The soybean cyst nematode was introduced to the field in 1985 and the site was planted continuously to soybean, however, the nematode population developed poorly, indicating that the soil could be suppressive (Chen *et al.*, 1994a). The Bray and Curtis similarity index (Bray and Curtis, 1957) was used in this comparison with the percentage frequency data instead of density data. Similarity indices are used in ecology (Norton, 1978) to compare the composition of two communities on a numerical scale from 0 (dissimilar = no species in common) to 1 (identical = all species in common). The Bray and Curtis similarity index has been used to compare fungal species composition in cysts of *H. glycines* (Chen *et al.*, 1994a).

A total of 467 egg masses were examined and 224 (48%) were colonized by fungi. More than 15 species of fungi were isolated (Table 1). *Paecilomyces lilacinus* (Thom) Samson was the predominant fungus in the egg masses. This species colonized 26% of all egg masses and 54% of the egg masses that were colonized by fungi. *Paecilomyces lilacinus* parasitized a large proportion of the eggs once an egg mass was colonized by the fungus. An unidentified sterile fungus colonized 8% of the egg masses. *Pyrenochaeta terristris* (Hansen) Gorenz, Walker & Larson colonized 6% of the egg masses and *Fusarium oxysporum* Schlecht. colonized 3%. All other fungi were found at a low frequency.

The similarity index for fungi colonizing *Meloidogyne* egg masses and *H. glycines* cysts was low (Table 2). In contrast, the average similarity index between different sampling dates during 1991 and 1992 for fungi in brown cysts of *H. glycines* was 0.54, and the average similarity index between locations and sampling dates for fungi in cysts of *H. glycines* collected from different locations in the southeastern Unites States at different times was 0.48 (Chen *et al.*, 1994a). It is suggested that the mycoflora in egg masses of *Meloidogyne* spp. in the tobacco field differed from that in the brown cysts of *H. glycines* in the soybean field despite their similar soil texture, climatic conditions, and close proximity at the same farm site.

Although some fungi encountered in the cysts of *H. glycines* also were found in the egg masses of the *Meloidogyne* spp., the frequencies of most fungi in the egg masses differed from that in the cysts of *H. glycines*. *Paecilomyces lilacinus* colonized only one of 1 711 brown cysts of *H. glycines* (Chen *et al.*, 1994a), which was compared with 26% of

Table 1. Species and frequency of fungi isolated from egg masses of *Meloidogyne incognita* and *Meloidogyne javanica* collected from a Florida tobacco field in 1991.[z]

Fungal species	Egg masses colonized by fungi	
	Number	Percentage
Dictyochaeta coffeae (Maggi & Persiani) Cabello & Arambarri	2	0.4
Drechslera fugax (Wall.) Shoemaker	1	0.2
Fusarium oxysporum Schlecht.	15	3.2
Fusarium solani (Mart.) Sacc.	2	0.4
Gliocladium catenulatum Gilm. & Abbott	7	1.5
Gonytrichum macrocladum (Sacc.) Hughes	1	0.2
Myriococcum sp.	2	0.4
Nectria sp.	2	0.4
Neocosmospora vasinfecta Smith	2	0.4
Paecilomyces lilacinus (Thom) Samson	122	26.1
Penicillium janthinellum Biourge	2	0.4
Pyrenochaeta terristris (Hansen) Gorenz, Walker & Larson	27	5.8
Rhizoctonia solani Kühn	2	0.4
Verticillium chlamydosporium Goddard	1	0.2
A sterile species	35	7.5
Others	9	1.9

[z]A total of 467 egg masses were examined and 224 egg masses were colonized by fungi.

the egg masses of *Meloidogyne* spp. colonized by this fungus. *Paecilomyces lilacinus* also was a common fungus in egg masses of *M. arenaria* at another location in Florida (Dickson *et al.*, 1994) and in eggs of *M. arenaria* (Godoy *et al.*, 1983) and *M. incognita* (Morgan-Jones *et al.*, 1984) in Alabama. The fungus is a species with cosmopolitan distribution, particularly in the warmer regions of the world (Stirling, 1991).

Paecilomyces lilacinus has been successfully tested in some cases as a biological control agent for the suppression of root-knot and cyst nematodes (Jatala, 1986), whereas in another test the fungus provided no control or synergistic activity in combination with nematicides (Hewlett *et al.*, 1988). No suppressive effect of the fungus was observed on the population density of *Meloidogyne* spp. in spite of its high frequency in egg masses on tobacco in Florida (Chen *et al.*, 1994b). An isolate of *P. lilacinus* was shown to suppress *M. incognita* and *M. arenaria* populations but not *M. javanica* (Wu *et al.*, 1990). If the Florida isolate acted similarly by suppressing only one species of the mixed *Meloidogyne* population, its overall effects on the density of *Meloidogyne* spp. may be undetectable.

Verticillium chlamydosporium Goddard (synonym = *Diheterospora chlamydosporia* (Goddard) Barron & Onions) has been reported as a major fungal parasite of *Heterodera avenae* Woll. in Europe (Kerry,

Table 2. Similarity indices for fungi colonizing cysts of *Heterodera glycines* in soybean and egg masses of *Meloidogyne incognita* and *M. javanica* in tobacco.

H. glycines cysts sampling date[y]	*Meloidogyne* spp. egg masses[z]
3 July 1991	0.10
1 October 1991	0.18
20 July 1992	0.16
9 September 1992	0.16
3 October 1992	0.16

[y]Data cited from Chen *et al.* 1994a.
[z]Samples were taken from a Florida tobacco field site in 2 August 1991.

1988). It also was a common fungus in cysts of *H. glycines* in two soybean fields in Illinois, United States (Carris *et al.*, 1989). The first observation of this fungus on a root-knot nematode, *M. arenaria*, in the United States was reported by Morgan-Jones *et al.* (1981b). Gaspard *et al.* (1990) reported that *V. chlamydosporium* was common in soil infested with root-knot nematodes, but that it did not effectively suppress the nematode population. Although the fungus is worldwide in distribution (Domsch *et al.*, 1980), it was encountered with a low frequency in the egg masses of the *Meloidogyne* spp., and it was not found in cysts of *H. glycines* in Florida (Chen *et al.*, 1994a; Morgan-Jones *et al.*, 1981a) (Table 1).

Neocosmospora vasinfecta Smith is probably adapted to high temperatures of tropical or subtropical climates (Domsch *et al.*, 1980). It was encountered at a high frequency in cysts of *H. glycines* on soybean (Chen *et al.*, 1994a), but the fungus was encountered at a low frequency in egg masses of *Meloidogyne* spp. It is not clear whether the fungus is more adapted to cysts of *H. glycines* than to egg masses of *Meloidogyne* spp., or whether the soybean rhizosphere favors the fungus. Like *N. vasinfecta*, *Fusarium solani* (Mart.) Sacc. also was encountered at a high frequency in *H. glycines* cysts on soybean and at a low frequency in egg masses of *Meloidogyne* spp. on tobacco.

Fusarium oxysporum and *P. terristris* were common in both cysts of *H. glycines* on soybean (Chen *et al.*, 1994a) and egg masses of *Meloidogyne* spp. on tobacco. *Fusarium oxysporum* has been frequently isolated from cysts of *H. glycines* at other geographic locations (Carris *et al.*, 1989; Gintis *et al.*, 1982; Gintis *et al.*, 1983; Morgan-Jones and Rodríguez-Kábana, 1981) including Minnesota (Chen, unpubl. data) and in egg masses of *M. incognita* at other sites (Morgan-Jones *et al.*, 1984). This fungus is probably adapted to a wide range of substrates and environmental conditions (Domsch *et al.*, 1980).

The factors that were responsible for the differences between the mycoflora in cysts of *H. glycines* and egg masses of *Meloidogyne* spp. in these two nearby fields have not been determined. It is possible that the different cultural practices for the two crops affected the mycoflora in the rhizosphere. An alternative hypothesis is that different fungi may have a different degree of specialization toward certain nematode species. For example, *P. lilacinus* may be more adapted to root-knot nematodes than to cyst nematodes.

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