Occurrence of Nematophagous Fungi in Cyst Nematode Populations

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ABSTRACT

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Females of the soybean cyst nematode and soil samples collected from several soybean-growing areas of Tennessee in July 1981 were examined for fungal pathogens with potential as biological control agents of the nematode. Females infected with *Nematophthora gynophila* were isolated at three sites from five samples of roots, and resting spores of the fungus were found at five sites in nine soil samples, including two sites where the nematode is declining. Females infected with *Catenaria auxiliaris* and resting spores of *Verticillium chlamydosporium* were also found. These fungi control populations of cereal cyst nematode in England.

In the last decade, U.S. production of soybean, *Glycine max* (L.) Merr., has doubled, and the soybean cyst nematode, *Heterodera glycines* Ichinohe (SCN), has become a major pest. It was first recorded in the United States in 1954 and has now been reported in 426 counties in 22 states. New or improved control measures would be helpful. The American Soybean Association predicts a need for tripling soybean production during the next 20 yr; with the control measures available at present, losses caused by SCN—already running in millions of dollars a year—are likely to increase.

In England, populations of the cereal cyst nematode *Heterodera avenae* Woll. often fail to increase, and may decline, when susceptible cereals are grown intensively (3). Numbers of the nematode are suppressed by soilborne fungi that parasitize and kill the females. *Nematophthora gynophila* Kerry & Crump is the most common parasite of the female cereal cyst nematode in England, where it has been found in most nematode-infested soils examined (6). Two other fungi have been found attacking cyst nematode females: *Catenaria auxiliaris* (Kühn) Tribe and an undescribed lagenidiaceous fungus (5). An egg-parasitic fungus, *Verticillium chlamydosporium* Goddard, is also considered important in some decline soils and is widespread in England (2).

Hartwig (4) reported a decline in SCN populations in microplots after 5 yr of continuous cropping with a susceptible soybean variety and suggested that a parasite could be reducing the nematode population. In a survey of fungi associated with SCN in an Alabama soil (8), several fungi were isolated from cysts and from eggs within the cysts. A limited survey was conducted for parasites of females of SCN in several soybean-growing areas of Tennessee, and the results are given here.

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MATERIALS AND METHODS

Root and soil samples were collected in several soybean-growing areas near Jackson, TN, from sites where the nematode had not increased as expected and where antagonists were thus most likely to occur. Three sites were at the West Tennessee Experiment Station, Jackson, the microplots referred to by Hartwig (4), and two additional locations within a 5-acre field. The other Tennessee sites were plots near Interstate Highway 40 north of Jackson, Ames Plantation near Grand Junction, Woodland Mills, and Obion County near Tiptonville. Additional samples were collected from declining SCN culture pots in a greenhouse at Beltsville (MD) Agriculture Research Center and from plots infested with corn cyst nematode (*H. zeae* Koshy, Swarup & Sethi) in Kent County near Kennedyville, MD.

The microplots surveyed were infested in 1976 with SCN race 4 and planted with the SCN-susceptible cultivar Lee. From 1977 onward, the microplots were planted with the susceptible soybean cultivars Essex or Forrest. Nematode populations were recorded each year. The SCN populations in these microplots declined from a mean of 244 cysts per 237 cm^3 (1/2 pt) of soil in March 1977 (range 205–320) to 6 cysts per 237 cm^3 of soil in December 1980 (range 2–11). The populations in September 1978 and August 1979 were 36 cysts per 237 cm^3 of soil (range 0–70) and 78/237 cm^3 of soil (range 20–160), respectively.

Females were washed from the roots, dissected, and examined for fungal pathogens. A 25-g soil sample was taken for extraction of fungal resting spores by filtration, followed by centrifugation in magnesium sulfate solution (2). This technique permits counts of resting spores of *N. gynophila* and chlamydospores of *V. chlamydosporium* in soil.

RESULTS

More than 7,000 females were examined from 45 samples taken from 10 sites (Table 1). Females of *H. glycines* infected with *N. gynophila* were recovered from five samples (three sites). Females infected with *C. auxiliaris* were found at two sites, one on *H. glycines* and the other on *H. zeae*, although with the latter only precursor sporangia of *C. auxiliaris* were found and not resting spores. Resting spores of *N. gynophila* were recovered from nine soil samples (five sites) and chlamydospores of *V. chlamydosporium* from 24 samples (10 sites).

DISCUSSION

This is the first record of *N. gynophila* in the United States and the first record of its attacking SCN in field conditions. *C. auxiliaris* has been recorded (9) from cysts of *H. schachtii* sent from California, but never before from *H. glycines*. Chlamydospores of *V. chlamydosporium* were found in several soil samples, but this fungus has been recorded before in the United States and has other hosts.

The females infected with *N. gynophila* were all at a similar stage of fungal development: full of vegetative mycelia but few with resting spores. Such synchronization of infection is often found in England (1). Infection by the motile infective zoospores is dependent on soil moisture (7), so it is likely that spore release is stimulated after rain and a new batch of females becomes infected simultaneously.

Compared with decline soils in England (2), the numbers of resting spores extracted from the soil samples were small. Residual spores probably germinate in the soil to initiate infection when females first appear on the root system. During the growing season, most

Table 1. Sites where *Nematophthora gynophila* (NG) and *Catenaria auxiliaris* (CA) were found parasitizing females of *Heterodera glycines* and where resting spores of NG and *Verticillium chlamydosporium* (VC) were recovered from soil samples

Sites	Site samples (no.)	Females examined (no.)	Females infected with NG (%)	Females infected with CA (%)	Resting spores (no./g of soil)[a] NG	Resting spores (no./g of soil)[a] VC
West Tenn. Exp. Stn.						
(microplots)	12	134	3.0	0.7	5.7	2.3
Field 1	3	670	0	0	1.5	4.7
Field 2	2	550	0	0	0	2
Jackson, TN	4	1,700	0	0	1.5	3.5
Grand Junction, TN	6	334	1.2	0	1.7	2.7
Woodland Mills, TN	6	2,730	0	0	0	4.3
Union City, TN	2	374	0	0	0	1
Tiptonville, TN	4	898	0	0	1.5	4
Beltsville, MD	3	200	5.5	0	0	3
Kennedyville, MD[b]	3	250	0	0.4	0	3

[a]Average number of spores observed per samples taken at each site.
[b]Sample from *Heterodera zeae*-infested soil.

of the infection is caused by the short-lived motile zoospores. Resting spores are then produced that overwinter in the soil to initiate infection in the following season. When the samples were taken (15–16 July 1981), most residual spores would have germinated, but not many new ones would have been produced. Any new spores that had been produced would still be clumped together because no cultivation would have taken place to disperse the spores; these factors would make sampling inconsistent.

Control of SCN in the microplots at Jackson by the nematophagous fungi has not been demonstrated. However, these fungi could have played a significant role because they have been associated with the decline of *H. avenae* in England. Further research into fungus-nematode relationships could determine the conditions that favor the buildup of the fungi in areas where they are already present and could evaluate their potential under natural conditions as biological control agents.

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