Reproduction of Root-Knot, Lesion, Spiral, and Soybean Cyst Nematodes on Sunflower

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ABSTRACT

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The ability of sunflower cultivars to support reproduction of *Meloidogyne arenaria, M. hapla, M. incognita, M. javanica, Helicotylenchus dihystera, Heterodera glycines,* and *Pratylenchus alleni* was investigated in greenhouse tests. All nematode species except *H. glycines* reproduced well on sunflower, although some variability occurred among the cultivars. Among *Meloidogyne* spp., reproduction of *M. javanica* was highest, followed by *M. arenaria, M. incognita,* and *M. hapla*. In the field, *P. scribneri* and *Helicotylenchus pseudorobustus* increased substantially in the sunflower rhizosphere.

Sunflower (*Helianthus annuus* L.) is the second most important oilseed crop in the world (after soybean) (2). Most sunflower hectarage in the United States is in the upper Midwest and Texas (2), but high-oil-type sunflower can be grown in other southern states (3,15). Sunflower also may be useful as a rotation crop with soybean when fields are heavily infested with the soybean cyst nematode (*Heterodera glycines* Ichinohe) (15), but its host status is unknown. Even if sunflower is a nonhost, its use to control *H. glycines* may cause an increase in other nematodes damaging to sunflower or to succeeding soybean crops.

The nematode parasites of sunflower are not well studied. *Belonolaimus longicaudatus* Rau (11), *Meloidogyne incognita* (Kofoid & White) Chitwood (4,11), *Pratylenchus brachyurus* (Godfrey) Filip. & Sch. Stek. (9,11), *P. penetrans* (Cobb) Filip & Sch. Stek. (6), *Rotylenchulus reniformis* Linford & Oliveira (13), and *Trichodorus* spp. (11,14) have been reported as associates or parasites of sunflower. Rich and Green (12) found that although nematicide applications increased growth of sunflower grown in soil infested by *M. javanica* (Treub) Chitwood, the nematode had no effect on dry plant weights at harvest. In addition, they noted some differences between two sunflower cultivars in their suitability as hosts for *M. incognita*.

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The purposes of this study were to assess the ability of some common plant-parasitic nematodes to reproduce on sunflower and to determine whether reproductive differences exist among some commercially available cultivars. A preliminary report has been published (8).

MATERIALS AND METHODS

Greenhouse studies. *M. arenaria* (Neal) Chitwood, *M. hapla* Chitwood, *M. incognita*, and *M. javanica* were increased in the greenhouse on tomato (*Lycopersicon esculentum* L. 'Rutgers'). Eggs were harvested 60 days after inoculation by a sodium hypochlorite method (5). Sunflower seed were germinated in vermiculite. Two 6- to 14-day-old seedlings of each of one confectionary or 10 oil-type cultivars or two 28-day-old Rutgers tomato plants were transplanted into 20-cm (3.4-L) pots filled with autoclaved sandy loam soil. Soil in each pot was infested with 20,000 eggs of each species by pouring a suspension into 12 holes made in the soil near the stems. Plants were inoculated 1–4 days after transplanting. Seedling ages and inoculation times were uniform for each species. Root systems were harvested, washed, and weighed 58–60 days after soil infestation, then eggs were extracted and counted. Eggs per plant and eggs per gram of fresh root were calculated for each root system.

Helicotylenchus dihystera (Cobb) Sher was increased on soybean (*Glycine max* (L.) Merr. 'Pickett-71') and extracted from soil by a centrifugal-flotation method. Two 23-day-old seedlings of one confectionary or six oil-type sunflower cultivars or two 14-day-old Pickett-71 soybean seedlings were transplanted as described previously. Seedlings in each pot were inoculated at transplanting with a suspension of 1,500 *H. dihystera* adults and juveniles. Plants were grown for 9 wk, then clipped at the soil line and replaced with fresh seedlings. Nine weeks later, the soil in each pot was thoroughly mixed and a 100-cm^3 sample removed for extraction of *H. dihystera*.

P. alleni Ferris was increased on Pickett-71 soybean and extracted from roots in a mist chamber. Nematodes were collected daily for 4 days and kept refrigerated at 12 C until inoculation. One 12-day-old seedling of one confectionary or six oil-type sunflower cultivars or one 14-day-old Pickett-71 soybean seedling was transplanted to 14-cm (1.5-L) clay pots filled with autoclaved, sandy loam soil. Seedlings were inoculated during transplanting by pouring a suspension of 1,000 *P. alleni* adults and juveniles onto the roots before covering them with soil. Roots were harvested, washed, and weighed 75 days after inoculation, then placed in a mist chamber. Extracted nematodes were counted for 10 days after root harvest. Nematodes were also extracted from 100-cm^3 soil samples. Nematodes per pot and nematodes per gram of root were calculated for each root system.

Table 1. Reproduction of *Meloidogyne* spp. on 11 cultivars of sunflower and one of tomato

	M. arenaria[w]		*M. hapla*		*M. incognita*		*M. javanica*	
Cultivar	**Eggs/pot**[x]	**Eggs/g root**[y]	**Eggs/pot**	**Eggs/g root**	**Eggs/pot**	**Eggs/g root**	**Eggs/pot**	**Eggs/g root**
Sunflower								
212	1.05 ab[z]	49.7 bc	0.21 b	5.7 a	0.56 c	12.4 b	1.90 ab	50.8 a
241A	0.84 ab	53.2 bc	0.17 b	6.4 a	0.62 bc	18.1 b	1.76 ab	65.9 a
454	0.93 ab	134.6 a	0.13 b	4.4 a	0.89 bc	22.5 b	1.73 ab	102.8 a
600	1.05 ab	51.2 bc	0.15 b	6.2 a	1.04 abc	27.8 b	1.37 ab	56.6 a
700	0.91 ab	99.5 b	0.30 b	15.6 a	1.06 ab	26.5 b	2.05 ab	58.3 a
800	0.94 ab	83.4 bc	0.30 b	14.5 a	0.90 bc	33.5 b	1.19 b	108.6 a
893	1.20 a	83.7 bc	0.21 b	5.5 a	0.81 bc	29.8 b	1.87 ab	90.8 a
898	0.60 b	65.3 bc	0.23 b	10.5 a	0.90 bc	28.5 b	1.93 ab	47.7 a
8903	0.74 ab	41.2 c	0.26 b	13.4 a	0.56 c	13.1 b	2.06 ab	58.8 a
903	0.86 ab	50.1 bc	0.16 b	5.4 a	0.85 bc	27.0 b	1.77 ab	46.8 a
Mammoth	1.14 ab	37.7 c	0.16 b	2.7 a	0.81 bc	18.6 b	2.33 a	64.5 a
Tomato								
Rutgers	1.00 ab	43.1 c	0.55 a	12.9 a	1.33 a	55.2 a	2.40 a	82.2 a

[w] P_i = 20,000 eggs per pot.
[x] Egg production per pot in millions.
[y] Eggs per gram of root in thousands.
[z] Each value is the mean of four replicates; column means followed by a common letter are not significantly ($P = 0.05$) different according to Duncan's multiple range test.

Table 2. Reproduction of *Helicotylenchus dihystera* and *Pratylenchus alleni* on seven cultivars of sunflower and one of soybean

	Nematodes per pot	
Cultivar	***H. dihystera***[x]	***P. alleni***[y]
Sunflower		
212	75,474 a[z]	4,443 a
454	34,473 bc	6,558 a
700	46,416 b	8,197 a
8903	29,990 bc	8,615 a
893	36,915 bc	7,845 a
898	47,213 b	6,012 a
Mammoth	37,309 bc	4,055 a
Soybean		
Pickett-71	15,514 c	1,981 a

[x] P_i = 1,500 nematodes per pot.
[y] P_i = 1,000 nematodes per pot.
[z] Each value is the mean of four replicates; column means followed by a common letter are not significantly ($P = 0.05$) different according to Duncan's mutiple range test.

Experiments with *Meloidogyne* spp., *H. dihystera*, and *P. alleni* were each arranged in randomized complete block designs with four replicates.

Heterodera glycines (race 3) was reared on Essex soybean. White females were harvested 40 days after inoculation and crushed to recover eggs. Soil in 14-cm pots was planted with Russian Mammoth sunflower (eight pots) or Essex soybean (eight pots) and infested with 2,000 eggs per pot. Root systems were harvested 35 days after inoculation, and nematodes within roots were stained with acid fuchsin (1).

Field sampling. Soils in two replicated sunflower variety trials in Haywood and Madison counties of Tennessee were sampled in June and August 1980. Twenty soil cores from the rhizosphere of each cultivar were bulked and mixed. Subsamples of 100 cm^3 were removed for nematode extraction. Because of non-significant differences among cultivars, a grand mean for each species in each field was determined.

RESULTS

All *Meloidogyne* spp. reproduced on all tested sunflower cultivars when measured as total egg production or eggs per gram of root (Table 1). Total egg production of *M. hapla* and egg production per gram of root for *M. incognita* were lower on sunflower than on the standard host, tomato. Reproduction of *M. arenaria* as eggs per gram of root on sunflower 454 was higher than on tomato or any other sunflower cultivar. Other differences that occurred in reproduction of *Meloidogyne* spp. were smaller.

H. dihystera and *P. alleni* reproduced on all tested sunflower cultivars (Table 2). Final densities of *H. dihystera* were 20–50 times higher than the initial inoculum. Some sunflower cultivars were more suitable hosts than the soybean reference host. Reproduction of *P. alleni* was not significantly different from that of the reference host. Final densities on sunflower were two to four times that of the initial inoculum.

Sunflower was a very poor host for *Heterodera glycines* compared with soybean. Only four females developed on all eight plants, although some twisted, nonswollen juveniles and a few sausage-shaped juveniles were seen in the roots. On soybean, 200–300 females were found on each root system or in the soil.

In the variety trial, *Helicotylenchus pseudorobustus* (Steiner) Golden increased from 576 (21 June 1980) to 1,462 per 100 cm^3 of soil (26 August 1980), and *P. scribneri* Steiner increased from 92 to 320 per 100 cm^3 of soil. Other species of plant parasites present in the soil in low numbers were *Paratylenchus projectus* Jenkins, *Xiphinema americanum* Cobb, and *Hoplolaimus galeatus* (Cobb) Filip. & Sch. Stek.

DISCUSSION

Reproduction of *Meloidogyne* spp. on sunflower cultivars may vary, but this variability appears to be of little practical use because all tested cultivars were suitable hosts for each species. The major hectarage of sunflower in the United States is in the Dakotas and Minnesota (2), where *M. hapla* is the dominant root-knot species. Although the extensive root system and drought tolerance of sunflower (2) may make it less susceptible to damage by *M. hapla*, the presence of this nematode should be examined on the northern production areas. Of other *Meloidogyne* spp., *M. incognita* (10) and *M. javanica* (10,12) have both been implicated through nematicide tests as possible reducers of sunflower growth and vigor, although *M. javanica* did not reduce dry plant weights at harvest. Apparent differences in reproduction of *M. incognita* on two sunflower cultivars were noted by Rich and Dunn (11). Further field research is necessary to determine the impact of *M. incognita* on sunflower growth and yield.

The role of *Pratylenchus* spp. as parasites of sunflower likewise is variable. Kaplan et al (6,7) reported lesion formation, severe stunting, and death of plants inoculated with very high initial densities of *P. penetrans*. In our study, root symptoms were not apparent on plants infected with *P. alleni*.

Species of spiral nematodes have rarely been considered significant plant pathogens despite their generally polyphagous habits. Sunflower is capable of supporting very high densities of *H. dihystera* and probably *H. pseudorobustus* and has proven to be an excellent host for greenhouse stock cultures.

The high resistance of sunflower to *Heterodera glycines* maturation establishes sunflower as a suitable rotation crop with soybean on infested land. The widespread use of sunflower as a rotation crop, however, depends more on the market values of sunflower oil and meal in relation to those of soybean, because soybean cultivars resistant to most cyst nematodes isolates are available. Sunflower also may increase densities of other plant-parasitic nematodes damaging to soybean.

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