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Host Suitability of Graminaceous Crop Cultivars for Isolates of *Meloidogyne arenaria* and *M. incognita*

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Abstract: Twenty-two graminaceous plant cultivars were evaluated in the greenhouse for host suitability for three South Carolina isolates of *Meloidogyne arenaria* race 2 (Ma-R2) designated as Florence, Govan, and Pelion, a Florida isolate of *M. arenaria* race 1 (Ma-R1), and a South Carolina *M. incognita* race 3. Host suitability was determined by calculating egg mass index (EMI), reproduction factor (RF) (final egg numbers/initial egg numbers), and number of eggs per gram fresh root. Corn hybrids Pioneer 3147 and Northrup King 508 and oat cv. Florida 502 were nonhosts to all nematode isolates, as no egg masses or eggs were found in roots grown in infested soils. Oat cv. Coker 716 and grain sorghum cvs. Cherokee, Northrup King 2660, and Pioneer 8333 were poor hosts (RF < 1). Good (RF = 1.1–5.0) or excellent (RF > 5.0) hosts for both Ma-R1 and three Ma-R2 isolates included the following: barley cvs. Boone, Keowee, and Redhill; corn hybrid Pioneer 3389; oat cvs. Brooks and Coker 820; rye cvs. Bonel, Florida 401, and Wrens Abruzzi; triticale cvs. Beagle 82 and Florida 201; and wheat cvs. Coker 983, Florida 302, and Williams. All cultivars except Coker 716 oat were good or excellent hosts of *M. incognita*.

Key words: barley, corn, host, *Meloidogyne arenaria, Meloidogyne incognita,* nematode, oat, resistance, root-knot, rye, sorghum, triticale, wheat.

Graminaceous crops such as barley (*Hordeum vulgare*), corn (*Zea mays*), oat (*Avena sativa*), and wheat (*Triticum aestivum*) are hosts for several species of root-knot nematodes (*Meloidogyne* spp.) (1,5,10,11). There are conflicting reports on the host status of sorghum (2,5,7). These crops are among important crops rotated with soybean and tobacco in the southeastern United States. Resistant graminaceous plant cultivars are needed in rotations or double cropping sequences to manage root-knot nematode populations effectively. Variability in root-knot resistance exists within crop species (1,2,21,22) and complicates cultivar selection. In addition, limited information is available on the host status of winter crops such as rye, wheat, and oat.

Meloidogyne arenaria is widespread and adversely affects soybean and tobacco production in South Carolina (3,6). Although *M. arenaria* parasitizes some graminaceous crops (11), investigations into the relative host suitability of these crops to different nematode races and isolates of *M. arenaria* have been limited. The objective of this study was to evaluate the host suitability of 21 graminaceous plant cultivars to four isolates of *M. arenaria* and to compare the same cultivars, plus an inbred corn, for host suitability for a race 3 *M. incognita* isolate.

Materials and Methods

Three isolates of *M. arenaria* race 2 (Ma-R2), one of race 1 (Ma-R1), and one of *M. incognita* race 3 were used. The *M. arenaria* race 1, selected from peanut, was obtained from D. W. Dickson (University of Florida, Gainesville). Isolates of Ma-R2 were obtained from infected tobacco grown near Florence, and soybean near Govan and Pelion, South Carolina. An isolate of *M. incognita* race 3 was obtained near Clemson, South Carolina, on field-grown tomato. All nematodes were increased on tomato (*Lycopersicon esculentum* cv. Rutgers) in the greenhouse for 7–8 weeks, and then eggs were collected from roots (9).

Seeds of each of 21 or 22 graminaceous cultivars, depending on nematode species, were sown in 15-cm-d plastic pots (1.5 liter) filled with equal portions of sterilized river bottom sand and Varina sandy loam soil. Organic matter was less than 0.3%.

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Seven days after emergence, corn seedlings were thinned to three per pot and other seedlings were thinned to four per pot. Soil was infested with 8,000 eggs per pot pipetted into the root zone. Pots were arranged in a randomized complete block design with five replications in a greenhouse maintained at 20–26 C.

Experiments were terminated 6 weeks after soil infestation. Roots were washed free of soil, and egg masses were stained in aqueous phloxine B (4). Galls and egg masses were rated on a 0–5 scale: 0 = 0, 1 = 1–2, 2 = 3–10, 3 = 11–30, 4 = 31–100, and 5 = >100 galls and egg masses per pot. Root and shoot fresh weights were recorded. Eggs were extracted from each root system (9) and counted. Oöstenbrink's (14) reproduction factor (RF) (final egg number/initial egg number) and the numbers of eggs per gram fresh root were determined for each cultivar–nematode combination.

Results

The cultivars differed in ability to support Ma-R1 and Ma-R2 populations (Tables 1,2). Generally, barley (*Secale cereale*), rye, triticale (× *Triticosecale*), and wheat were good (RF = 1.1–5.0) or excellent (RF > 5.0) hosts of *M. arenaria*. Three corn hybrids were not suitable hosts, but Pioneer 3389 was a good host, although eggs per gram root were low. Sorghum (*Sorghum bicolor*) was a poor (RF < 1.0) host for all *M. arenaria* isolates. Oat cultivars varied the most in host suitability, with Coker 716 and Florida 502 as non-hosts or very poor hosts, and Brooks and Coker 820 as good or excellent hosts.

The four *M. arenaria* isolates were quite similar in aggressiveness on the different cultivars (Tables 1,2), although Ma-R2 Govan was slightly more aggressive on barley and Pioneer 3389 corn (Table 2).

With the exception of Coker 716 oat, the graminaceous plants were good or excellent hosts of *M. incognita* (Table 1). Generally, the number of eggs per gram root was greater for *M. incognita* race 3 than for the *M. arenaria* isolates. Barley was the most suitable host of *M. incognita*, and triticale was generally so for *M. arenaria*.

Discussion

Corn hybrids Pioneer 3147 and Northrup King 508, all tested sorghum varieties, and oat cv. Florida 502 were poor hosts to our *M. arenaria* isolates. Similarly, Pioneer 3147 and Northrup King 508 corn hybrids were considered poor hosts for *M. arenaria* (1,21). Sorghum was a poor host for *M. incognita* race 3, *M. javanica*, and *M. arenaria* races 1 and 2 (5). Corn hybrids Pioneer 3147 and Northrup King 508 were good hosts and hybrid Pioneer 3389 and inbred South Carolina 60 were excellent hosts for *M. javanica* (22), which reflects nematode species differences in host ranges. Grain sorghum cvs. Coker 7675, Pioneer 8222, and Pioneer 8272 were resistant to *M. arenaria* race 2 (5), as were the cultivars in our experiments. However, in a field study, a sorghum–soybean rotation resulted in slightly higher numbers of *M. arenaria* juveniles than a soybean–corn rotation or soybean monoculture (18).

Egg production may be preferable to root gall ratings as a measure of resistance of graminaceous plants to *Meloidogyne* spp. Root-knot galls on graminaceous plants are small, and some plants with low gall ratings may actually be good hosts (1). However, variation in the number of eggs among replicates is high.

The four *M. arenaria* isolates reproduced at similar levels on the 21 graminaceous plant cultivars. Generally, the host status to *M. arenaria* across species and varieties of the Gramineae in this test indicates the following descending order of host suitability: triticale > barley > wheat > rye > oat > corn > sorghum. For *M. incognita*, the order is as follows: barley > corn > sorghum ≥ triticale ≥ wheat > rye ≥ oat. Corn and oat cultivars vary substantially in suitability as hosts of *M. arenaria* and *M. incognita* (1,11,15), thereby offering management options for these two nematode species. Because oat cultivars

TABLE 1. Egg mass index (EMI), reproduction factor (RF), and number of eggs per gram fresh root weight (EGR) for graminaceous cultivars grown 6 weeks in soil infested with 8,000 eggs of *Meloidogyne arenaria* race 1 (Ma-R1) or *M. incognita* race 3 (Mi-R3).

	Ma-R1			Mi-R3		
Cultivar	EMI†	RF‡	EGR	EMI	RF	EGR
Barley						
Boone	2.4	7.5	3,518	4.2	16.4	23,522
Keowee	2.6	3.2	4,839	4.2	13.6	18,288
Redhill	2.6	6.1	4,477	4.2	13.8	18,231
Corn hybrid						
Pioneer 3147	0	0	0	2.8	5.1	1,897
Pioneer 3389	1.8	2.7	406	3.6	13.7	7,859
Northrup King 508	0	0	0	3.4	5.8	2,594
Corn inbred						
South Carolina 60				3.4	6.6	3,541
Oat						
Brooks	1.8	1.7	1,895	3.4	2.0	3,103
Coker 716	0.2	0.1	56	0	0	0
Coker 820	3.6	5.7	6,954	4.2	10.6	39,480
Florida 502	0	0	0	3.2	2.5	3,219
Rye						
Bonel	2.8	2.5	4,276	2.2	1.7	2,139
Florida 401	2.0	1.9	3,376	3.2	5.5	18,102
Wrens Abruzzi	2.0	2.2	5,576	2.6	2.7	4,280
Sorghum						
Cherokee	0.4	0.1	24	3.6	6.6	5,930
Northrup King 2660	0.4	0	8	3.6	4.2	3,364
Pioneer 8333	0.6	0.3	93	3.8	4.1	3,562
Triticale						
Beagle 82	2.8	5.9	7,730	3.8	4.9	12,660
Florida 201	3.4	21.6	28,282	3.6	4.0	9,083
Wheat						
Coker 983	2.6	4.7	4,253	3.4	5.2	9,575
Florida 302	3.0	7.7	7,213	3.0	5.0	6,587
Williams	2.2	6.5	3,760	3.0	2.1	3,383
LSD (P = 0.05)	0.7	4.5	4,071	0.6	4.5	6,471

† Egg mass index (EMI) was based on a 0–5 scale: 0 = 0, 1 = 1–2, 2 = 3–10, 3 = 11–30, 4 = 31–100, and 5 = >100 galls and egg masses per pot.
‡ Reproduction factor (RF) was calculated by dividing the final number of eggs by the initial number of 8,000 eggs.

differ in host suitability for *Meloidogyne incognita* (15), screening of a larger array of germplasm, as with corn (20), may demonstrate some with greater potential in managing *M. arenaria.* Coker 820 was more suitable than other oat cultivars as a host of *M. arenaria* and *M. incognita* in this and another study (15), and two oat cultivars were less suitable hosts for *M. arenaria* and *M. javanica* than barley, wheat, or rye (11). Rotations can be effective in minimizing tobacco losses due to *Meloidogyne* (8), and sorghum, corn, and oat are generally less suitable as hosts for *M. arenaria* than the other crops tested and offer important options for management of this species. However, *M. incognita* reproduced well on sorghum and corn in these and other (1,5, 12,21) experiments.

Any of the tested oat cultivars except Coker 820 would inhibit rapid increase of *M. arenaria* or *M. incognita,* and Pioneer 3147 and Northrup King 508 corn hybrids suppress *M. arenaria.* These, along with sorghum, have potential as rotation or double-planting crops for suppression of one or both of these nematode species. In field trials, sorghum has shown promise in reducing *M. arenaria* and *M. incognita* (5,7, 17), but not in all cases (18).

Although a host for these *Meloidogyne* spp., rye may have a role in reducing pop-

TABLE 2. Egg mass index (EMI), reproduction factor (RF), and number of eggs per gram fresh root weight (EGR) from graminaceous cultivars grown 6 weeks in soil infected with 8,000 eggs of *Meloidogyne arenaria* race 2 (Ma-R2), Govan, Florence, or Pelion isolate.

	Ma-R2 Govan			Ma-R2 Florence			Ma-R2 Pelion		
Cultivar	EMI†	RF‡	EGR	EMI	RF	EGR	EMI	RF	EGR
Barley									
Boone	3.0	13.3	6,204	3.8	11.6	8,741	3.0	6.1	3,050
Keowee	4.6	8.3	9,277	3.6	5.8	11,339	3.4	5.5	5,977
Redhill	2.8	7.3	6,513	2.4	5.7	4,932	2.4	5.1	3,189
Corn hybrid									
Pioneer 3147	0	0	0	0	0	0	0	0	0
Pioneer 3389	4.0	11.4	2,981	2.4	1.6	294	3.2	2.6	659
Northrup King 508	0	0	0	0	0	0	0	0	0
Oat									
Brooks	1.6	1.1	1,311	1.6	1.5	2,016	1.4	1.2	1,413
Coker 716	0.4	0	32	0.6	0.2	317	0.2	0	17
Coker 820	2.6	3.5	4,424	3.2	7.0	8,526	3.4	4.8	6,367
Florida 502	0	0	0	0	0	0	0	0	0
Rye									
Bonel	3.4	5.6	9,056	3.6	4.7	9,117	2.2	1.8	3,195
Florida 401	3.0	3.8	7,493	3.8	5.9	10,543	1.4	2.2	5,051
Wrens Abruzzi	3.4	4.4	8,222	3.6	4.3	10,830	1.2	1.5	2,182
Sorghum									
Cherokee	0.8	0.6	219	0.8	0.3	104	0.8	0.1	47
Northrup King 2660	0.8	0.1	35	1.0	0.1	25	0.6	0.1	13
Pioneer 8333	0.4	0.1	40	0.8	0.6	235	0	0	7
Triticale									
Beagle 82	4.0	10.6	16,553	4.0	14.9	20,958	4.0	5.6	10,539
Florida 201	3.8	18.8	21,203	1.2	2.2	1,798	4.0	16.6	17,744
Wheat									
Coker 983	2.2	3.4	2,739	3.2	6.3	6,139	2.0	3.3	2,710
Florida 302	3.0	5.8	5,426	3.0	5.1	5,173	2.4	3.6	5,115
Williams	3.4	8.0	5,488	3.4	10.3	7,962	2.8	4.8	3,713
LSD (P = 0.05)	0.6	4.4	4,622	0.7	3.9	4,308	0.5	3.4	3,741

† Egg mass index (EMI) was based on a 0–5 scale: 0 = 0, 1 = 1–2, 2 = 3–10, 3 = 11–30, 4 = 31–100, and 5 = >100 galls and egg masses per pot.
‡ Reproduction factor (RF) = final ÷ initial number of eggs (8,000) per pot.

ulations (13), possibly due to toxic decomposition products (19). Moreover, planting small grains in winter after the nematode activity threshold of 18 C (16) soil temperature is reached should inhibit nematode invasion, even though in these greenhouse tests optimum temperatures encouraged reproduction.

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