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Resistance in Selected Corn Hybrids to *Meloidogyne arenaria* and *M. incognita*[1]

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Abstract: A total of 33 corn hybrids were evaluated in a series of greenhouse and field trials to determine if they differed in resistance to either *Meloidogyne incognita* race 3 or *M. arenaria* race 1. Reproduction of *M. incognita* race 3 and *M. arenaria* race 1 on the hybrids was also compared. Reproduction of *M. arenaria* differed among corn hybrids after 58 to 65 days in greenhouse experiments; however, reproduction was similar among hybrids in the field experiment. No hybrids were consistently resistant to *M. incognita*. Two isolates of *M. arenaria* and two of *M. incognita* were evaluated in the greenhouse trials, and no evidence of isolate-dependent resistance was observed. *Meloidogyne incognita* reproduced better than *M. arenaria* on the hybrids in this study. A survey of 102 corn fields from 11 counties throughout southern Georgia was conducted to determine the relative frequency of *M. incognita* and *M. arenaria*. *Meloidogyne* species were found in 34 of the fields surveyed, and 93.9% of these were identified as *M. incognita*. The frequency of occurrence of *M. incognita* was 99.6% if the previous crop was cotton and 84.6% if the previous crop was peanut. *Pratylenchus* spp. were extracted from all intact corn root systems examined.

Key words: corn, host suitability, *Meloidogyne arenaria* race 1, *M. incognita* race 3, peanut root-knot nematode, resistance, southern root-knot nematode, survey, *Zea mays*.

Corn (*Zea mays* L.) is planted on approximately 200,000 ha in Georgia, which is more than any crop except cotton (*Gossypium hirsutum* L.) and peanut (*Arachis hypogaea* L.) (Bass and Messer, 1999). *Meloidogyne* spp. are among the most damaging nematodes to all three of these crops in the southeastern United States (Koenning et al., 1999), and the crops are frequently grown in rotation with each other to suppress soilborne diseases and plant-parasitic nematodes. Rotations for nematode management generally include at least 1 year of a crop that is a poor or non-host for the *Meloidogyne* spp. or race present. Cotton is a non-host for *M. arenaria,* and peanut is a non-host for *M. incognita,* but corn is a host for both *M. incognita* (Baldwin and Barker, 1970; Ibrahim et al., 1993) and *M. arenaria* (Baldwin and Barker, 1970; Ibrahim et al., 1993). Substantial reproduction of *Meloidogyne* spp. on corn may reduce yields of subsequent susceptible crops such as cotton or peanut (Windham, 1998).

A wide range of reproduction of *M. incognita* race 4 and *M. arenaria* race 2 may occur on corn hybrids (Windham and Williams, 1987, 1994), although all hybrids screened were excellent hosts for *M. incognita* race 4. However, resistance to *Meloidogyne* spp. in corn may be affected by the isolate tested (Baldwin and Barker, 1970; Miller and Fox, 1973). The relative resistance of corn hybrids to *M. incognita* race 3, the dominant race where cotton has been grown, and *M. arenaria* race 1, the dominant race where peanut has been grown, has not been adequately evaluated. Moreover, the susceptibility of transgenic or value-added corn hybrids to *Meloidogyne* spp. is not known. Corn hybrids might be used as part of an integrated nematode management program in cotton and peanut if sufficient resistance to *M. incognita* race 3 and *M. arenaria* race 1 can be identified.

Meloidogyne spp. are commonly associated with corn in the southeastern United States (Gallaher et al., 1991; Koenning et al., 1999; Swarup and Sosa-Moss, 1990). *Meloidogyne* spp. were present in 41% of the 1,259 soil samples from corn submitted to the University of Georgia Extension Nematology Laboratory between 1992 and 1995 (Davis, unpubl.). Because the frequency of occurrence of *M. incognita* and *M. arenaria* in corn is not known, management decisions made for

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peanut or cotton crops following corn usually must be made without knowing which species is present.

The objectives of this study were to: (i) evaluate corn hybrids for resistance to two populations of *M. incognita* race 3 and two populations of *M. arenaria* race 1, (ii) compare the reproduction of *M. incognita* race 3 and *M. arenaria* race 1 on corn hybrids, and (iii) survey corn fields in Georgia to determine the relative frequency of *M. incognita* and *M. arenaria.*

Materials and Methods

Greenhouse experiments: Four greenhouse experiments were conducted to evaluate reproduction of *M. arenaria* race 1 and *M. incognita* race 3 on corn hybrids commonly grown in Georgia. Corn hybrids in experiments Ma1 and Ma2 were screened in Tifton, Georgia, for resistance to *M. arenaria,* and hybrids in experiments Mi1 and Mi2 were screened in Athens, Georgia, for resistance to *M. incognita.*

In experiments Ma1 and Ma2, approximately 1.5 liters of soil (85% sand, 11% silt, 4% clay; pH 5.3) was added to 15-cm-diam. pots. Soil was steam-heated at 100 °C for 6 hours prior to use. Three seeds of each corn hybrid were planted into a pot, and seedlings were thinned to one plant per pot after germination. Slow-release fertilizer (14-14-14 N-P-K) was applied soon after germination. Six to eight replicate pots per corn hybrid were arranged in a completely randomized design on a single greenhouse bench. Each experiment was conducted 4 times by running two trials with each of two isolates of *M. arenaria* race 1 (Gibbs isolate and GOP isolate). Both isolates were originally collected in Georgia.

Eggs of *M. arenaria* were extracted from roots of tomato (*Lycopersicon esculentum* Mill, 'Rutgers') with NaOCl (Hussey and Barker, 1973) within a few hours of inoculating an experiment. Eight to 10 days after planting the corn, 8,100 eggs were distributed in four holes around the base of the plant and covered with soil. Greenhouse temperatures during this study varied between 20 and 35 °C.

Nematode eggs were extracted from the corn roots 58 to 65 days after inoculation. The entire root system of a single plant was cut into ca. 5-cm pieces, placed in a 1-liter flask, and agitated for 4 minutes in a 1% NaOCl solution. Eggs were collected and rinsed with tap water on nested 150- and 25-µm-pore sieves. Egg counts were subjected to square root transformation prior to statistical analysis. A two-way analysis of variance followed by Tukey's HSD test was used to determine differences in nematode reproduction as affected by corn hybrid and experimental trial.

Materials and methods in experiments Mi1 and Mi2 were similar to those for Ma1 and Ma2 except as described here. The soil used in experiments Mi1 and Mi2 (88% sand, 8% silt, 4% clay; pH 6.4) was fumigated with methyl bromide (0.6 kg/m^3 for 36 hours) prior to use. Pots were arranged in six randomized complete blocks. Each experiment was conducted 4 times by running two trials with each of two isolates (Wrightsville isolate and Emanuel isolate) of *M. incognita* race 3. Pots were inoculated with 8,000 eggs per pot. Plants were fertilized every 14 days (20-10-20 N-P-K).

Prior to experiments Ma1 and Mi1, we did not know which hybrids were susceptible and could be used for *a priori* comparisons to classify hybrids as resistant. Consequently, hybrids that were different (Tukey's HSD, $P \leq 0.01$) from the most susceptible hybrid in all four trials of in experiments Ma1 and Mi1 were designated ''resistant,'' and those that were different in three of four trials were designated ''moderately resistant.'' Based on the results from experiments Ma1 and Mi1, Northrup King N79-L3 was selected as a susceptible control for experiments Ma2 and Mi2, and hybrids that were consistently different (Tukey's HSD, $P \leq 0.05$) from the susceptible control were designated ''resistant.''

Because nematode reproduction was always greater in Athens with *M. incognita* than in Tifton with *M. arenaria,* a third experiment (experiment 3) was conducted to determine if differences in reproduction were due to location or nematode species. Reproduction of *M. arenaria* (GOP isolate) and *M. incognita* (Emanuel isolate) was compared

on three hybrids identified in experiment Ma1 as susceptible (Northrup King N6330, AgriProAP 9707, Pioneer 3146) and three hybrids identified as resistant (Northrup King N4714, Northrup King N83-R7, DeKalb DK 683). One trial of experiment 3 was conducted in Tifton and another in Athens, Georgia. Pots were inoculated with 7,914 *M. arenaria* eggs (average Tifton and Athens) or 7,840 *M. incognita* eggs 8 to 10 days after planting. Each test had six replicate pots per hybrid × nematode species combination. A completely randomized design on a single greenhouse bench was used in both Tifton and Athens. The experimental methods and conditions were the same as described for the previous greenhouse experiments conducted at each location. A three-way analysis of variance was used to determine the effect of corn hybrid, nematode species, and location on nematode reproduction. Differences among hybrids for each nematode species were determined with Tukey's HSD, $P \leq 0.05$. All data were subjected to square root transformation prior to statistical analysis.

Field experiments: Two field experiments were conducted at the Coastal Plain experiment Station, Tifton, Georgia. Each experiment had six replications in a randomized complete-block design. Each 1.8-m-wide × 7.6-m-long plot was a single bed with two rows spaced 91 cm apart planted with 1 seed/20 cm of row.

In the 1998 experiment, the same corn hybrids used in experiment Ma1 (Table 1) and Mi1 were planted on a site with a Tifton loamy sand (fine, loamy, siliceous, thermic Plinthic Kandindult) infested with *M. incognita*. The site had been planted to cotton in 1997 followed by hairy vetch (*Vicia villosa* Roth) as a winter cover crop. In the spring,

TABLE 1. Reproduction and resistance rating of two populations of *Meloidogyne arenaria* race 1 (Gibbs and GOP) on selected corn hybrids in greenhouse trials.

Brand	Hybrid	Eggs/pot				Mean	Rating[a]
		Trial 1	Trial 2	Trial 3	Trial 4		
		Gibbs		GOP			
Northrup King	N4714	383**[b]	1,767**	457**	1,717**	1,081	R
Northrup King	N83-R7	175**	1,917**	614**	2,050**	1,189	R
DeKalb	DK 683	500**	1,440**	717**	2,117**	1,194	R
DeKalb	DK 706	517**	3,967**	864**	2,383**	1,933	R
DeKalb	DK 687	908**	3,400**	1,560**	4,192**	2,515	R
Pioneer	3163	1,458**	5,533**	640**	3,767**	2,850	R
Pioneer	3055	592**	6,900**	736**	3,850**	3,020	R
AgraTech	888	533**	5,500**	1,660**	5,460**	3,288	R
DeKalb	DK 714	1,100**	7,700**	1,200**	6,267**	4,067	R
Pioneer	3167	3,183	9,817**	262**	6,917**	5,045	MR
AgriPro	HS 9843	2,025**	8,017**	5,367**	7,383**	5,698	R
Mycogen	2815	567**	13,733	5,457**	3,067**	5,706	MR
Mycogen	2787	1,700**	9,750**	4,129**	13,633	7,303	MR
AgriPro	AP 9909	2,117**	11,017	3,120**	14,750	7,751	S
Pioneer	3245	2,658**	14,067	8,883	10,667	9,069	S
Northrup King	N8811	1,483**	10,300	10,160	19,617	10,390	S
Northrup King	N6330	1,700**	20,400	13,360	10,833	11,573	S
AgraTech	787	2,083**	15,733	9,517	22,567	12,475	S
AgriPro	AP 9707	5,550	6,917**	20,471	18,667	12,901	S
AgriTech	757	4,550	30,933	11,750	5,400**	13,158	S
Pioneer	3146	5,117	16,850	16,033	23,083	15,271	S
Northrup King	N79-L3	5,750	24,100	9,917	22,900	15,667	S
Pioneer	3223	1,300**	38,000	9,225	32,633	20,290	S
AgraTech	999	9,125	36,833	—	24,600	23,519	S

[a] Hybrids are designated as resistant (R) if they differed from the most susceptible hybrid in each of four trials, moderately resistant (MR) if they differed from the most susceptible hybrid in three of the four trials, and susceptible (S) if they did not differ from the most susceptible hybrid in two or more trials.

[b] Numbers are the means of six replicate pots. Means followed by ** differed ($P \leq 0.01$) from the most susceptible hybrid in that trial.

lime (4.5 tons/ha) was applied and the field was disk-harrowed, plowed to a depth of 25 to 30 cm, shaped into beds, and 4-8-24 N-P-K (1,121 kg/ha) was incorporated into the beds with a rototiller. The corn hybrids were planted on 21 April. A tank mix of atrazine, pendimethalin, and crop oil was applied at 1.7 kg a.i./ha, 1.1 kg a.i./ha, and 16% (v/v), respectively, in 234 liters of water for post-emergence weed control. Corn was side-dressed with ammonium nitrate (504 kg/ha) on 12 May and harvested on 10 September. Plot yields were not collected. Ten soil cores (2.5-cm diam. × 15-cm deep) were collected from each plot for extraction of *M. incognita* J2 on 22 April (at plant), 16 July (mid season), and 15 September. The 10 soil samples were combined, and the nematodes were extracted from a 150-cm^3 subsample by centrifugal flotation (Jenkins, 1964).

In the 1999 experiment, 21 corn hybrids (Table 2) selected from experiments Ma1 and Ma2 were planted on a site with an Ocilla loamy coarse sand (loamy, siliceous, thermic Aquic Arenic Paleudults) infested with *M. arenaria* race 1. The site had been planted to peanut in 1998 followed by hairy vetch as a winter cover crop. The field was disk-harrowed in the spring, fertilized with

TABLE 2. Final population densities of *Meloidogyne incognita* and *M. arenaria* and Pf/Pi in field trials.

		M. incognita		*M. arenaria*	
Brand	Hybrid	J2/150 cm^3 soil	Pf/Pi[b]	J2/150 cm^3 soil	Pf/Pi[b]
Northrup King	N4714	263*[a]	99	33	0.77
Northrup King	N83-R7	173*	65	25	0.25
DeKalb	DK 683	198*	46	83	0.62
DeKalb	DK 706	263	99	48	0.40
DeKalb	DK 687	718	269	—[c]	—
Pioneer	3163	435	73	27	0.36
Pioneer	3055	457	76	17	0.22
AgraTech	888	418	418	—	—
DeKalb	DK 714	352	352	—	—
Pioneer	3167	203*	27	—	—
AgriPro	HS 9843	307	115	—	—
Mycogen	2815	310	33	—	—
Mycogen	2787	225*	52	—	—
AgriPro	AP 9909	560	129	—	—
Pioneer	3245	340	340	—	—
Northrup King	N8811	518	120	28	0.61
Northrup King	N6330	327	43	62	0.38
AgraTech	787	898	207	—	—
AgriPro	AP 9707	573	573	30	0.18
AgriTech	757	308	71	—	—
Pioneer	3146	595	595	42	0.44
Northrup King	N79-L3	210*	35	47	0.93
Pioneer	3223	412	412	92	1.53
AgraTech	999	153*	58	—	—
Terra	T1147 RR	—	—	27	0.30
Pioneer	X304C	—	—	35	0.20
AgriPro	AP 9829 IMI	—	—	62	0.40
Southern States	SS 769 Bt	—	—	202	1.59
Pioneer	31B13	—	—	123	0.83
Pioneer	33V08	—	—	62	0.34
Pioneer	32 Z18	—	—	52	0.56
Garst	8300 IT	—	—	45	0.41
Pioneer	33Y09	—	—	180	1.05

[a] Mean of six replicate plots. Means followed by * are different ($P \leq 0.05$) from the most susceptible hybrid in that trial.

[b] Number of J2 at the end of season divided by the number (+1) at planting. Mean initial numbers of J2 per 150 cm^3 were 2.8 ± 0.6 ($\bar{x}$ ± SE) for *M. incognita* and 113 ± 36 for *M. arenaria.*

[c] Not examined.

1,009 kg/ha 5-10-15 N-P-K, plowed to a depth of 25 to 30 cm, and shaped into beds. A preplant herbicide, butylate + safener at 3.8 kg a.i./ha, was incorporated with a rototiller for weed control. The corn hybrids were planted on 7 April. A tank mix of atrazine, pendimethalin, and crop oil was applied at 1.7 kg a.i./ha, 1.1 kg a.i./ha, and 16% (v/v), respectively, in 234 liters/ha for post-emergence weed control. Plots were sidedressed with ammonium nitrate (504 kg/ha) on 20 May. Plot yields were not collected. Ten soil cores (2.5-cm diam. × 15-cm deep) were collected from each plot for extraction of *M. arenaria* J2 on 5 April (preplant), 24 June (mid season), and 7 October (after plant senescence). The soil samples were processed and the nematodes extracted as described above. For each field experiment, a one-way analysis of variance followed by Tukey's HSD test ($P \leq 0.05$) was used to determine differences in soil densities of J2 among corn hybrids. The mean Pf/Pi was calculated for each hybrid as the number of juveniles detected at harvest divided by the number at planting plus 1. All data were subjected to square root transformation prior to statistical analysis.

Survey of corn fields: A nematode survey of 102 corn fields was conducted in August 1998 and July to August 1999 in 11 counties in southern Georgia. Counties in which samples were collected included Appling, Bulloch, Burke, Coffee, Decatur, Early, Irwin, Randolph, Terrell, Thomas, and Tift. Approximately 15 soil cores (2.5-cm diam. × 15–20-cm deep) were collected from 1-ha sections of corn fields; all fields had been in cotton or peanut the year prior to sampling. *Meloidogyne* spp. juveniles extracted from soil (Jenkins, 1964) were transferred to tomato and allowed to mature; 12 females from each sample were identified to species by isozyme analysis (Esbenshade and Triantaphyllou, 1985; Janati et al., 1982) (Pharmacia LKB Biotechnology, Inc., Piscataway, NJ). A mist chamber was used in 1999 to extract nematodes from root fragments collected on sieves when processing soil samples and to extract nematodes from three intact corn root systems per field.

Results

Greenhouse experiments: The corn hybrids screened in the four replicate trials of experimental Ma1 differed ($P \leq 0.0001$) in their level of resistance to *M. arenaria* (Table 1). There were also differences among trials ($P \leq 0.0001$) and a hybrid × trial interaction ($P \leq 0.0001$). The range of reproduction was similar between isolates of *M. arenaria,* and final egg counts were 175 to 38,000 for the Gibbs isolate and 262 to 32,633 for the GOP isolate. Mean reproduction on the hybrids averaged across the four trials ranged from 1,081 for Northrup King N4714 to 23,519 for Agra Tech 999. Reproduction of *M. arenaria* on 10 hybrids was consistently lower ($P \leq 0.01$) than the most susceptible hybrid in each of the four trials, thereby meeting our criteria to be designated resistant. Three hybrids were designated moderately resistant because they supported less nematode reproduction than the most susceptible hybrid in three of the four trials.

In the four replicate trials of experiment Mi1, hybrids did not differ in their level of resistance to *M. incognita* (data not shown) and there was no hybrid × trial interaction. The range of reproduction was similar between isolates of *M. incognita,* and final egg counts ranged from 136,634 to 360,504 for the Wrightsville isolate and 118,109 to 364,852 for the Emanuel isolate. Mean reproduction on the hybrids averaged across the four trials ranged from 203,076 for Northrup King N79-L3 to 299,515 for AgriPro HS 9843.

In experiment Ma2, less *M. arenaria* reproduction occurred on AgriPro AP 9829 IMI than on the susceptible control (Northrup King N79-L3) in one trial, but reproduction was similar to that of the control in the other three trials (Table 3). In experiment Mi2, the hybrid × trial interaction was not significant for the four replicate trials (data not shown). Reproduction of *M. incognita* was similar on all hybrids, resulting in final egg counts that ranged from 181,953 to 266,772.

In experiment 3, reproduction of *M. incognita* on all corn hybrids was greater than that for *M. arenaria* ($P < 0.0001$). There was

TABLE 3. Reproduction and resistance rating of two populations of *Meloidogyne arenaria* race 1 (Gibbs and GOP) on selected corn hybrids in greenhouse trials.

		Eggs/pot					
		Gibbs		GOP			
Brand	Hybrid	Trial 1	Trial 2	Trial 3	Trial 4	Mean	Rating[a]
Terra	T1147 RR	4,900[b]	5,267	3,700	3,800	4,417	S
Pioneer	X304C	9,600	4,700	7,883	3,850	6,508	S
AgriPro	AP 9829 IMI	9,033	9,383	6,083	1,711*	6,552	S
Southern States	SS 769 Bt	8,100	7,350	7,067	3,950	6,617	S
Northrup King	N79-L3	17,300	5,683	9,400	4,800	9,296	S
Pioneer	31B13	19,350	10,917	5,717	3,867	9,963	S
Pioneer	33V08	14,267	10,083	16,717	2,233	10,825	S
Pioneer	32 Z18	19,417	7,383	13,583	6,750	11,783	S
Garst	8300 IT	26,200	16,578	13,475	1,794	14,512	S
Pioneer	33Y09	21,483	18,133	12,633	9,433	15,420	S

[a] Hybrids are designated as susceptible (S) if they were not different from the most susceptible hybrid in two or more trials.
[b] Numbers are the means of six replicate pots. Means followed by * are different ($P \leq 0.05$) from Northrup King N79-L3, the susceptible control.

no effect of location (Tifton vs. Athens) on nematode reproduction, but there was a location × hybrid interaction ($P = 0.006$) and a hybrid × nematode species interaction ($P \leq 0.0001$). Only Dekalb DK 683 had lower *M. arenaria* reproduction than the most susceptible hybrid (Table 4). Four hybrids had lower *M. incognita* reproduction than for the most susceptible hybrid. The mean number of eggs per pot, averaged across locations and hybrids, was 19,138 for *M. arenaria* and 122,152 for *M. incognita*.

Field experiments: The number of *M. incognita* J2 per 150 cm^3 of soil differed among hybrids ($P \leq 0.0001$) at harvest. The hybrid AgraTech 757 had a mean population density that was higher than the densities in Northrup King 4714, Mycogen 2787, Dekalb 683, Pioneer 3167, Northrup King N79-L3, Northrup King N83-R7, and AgraTech 999 (Table 2). AgraTech 757 had nematode counts that were similar to all other hybrids in the test. The population densities in Northrup King 79-L3, the susceptible control used in experiments Ma2 and Mi2, was similar to those in all other hybrids except AgraTech 757. Nematode population levels ranged from 153 to 898 per 150 cm^3 of soil. The maximum mean Pf/Pi in the experiment was 595, and the minimum was 27.

TABLE 4. Reproduction of *M. arenaria* race 1 (GOP isolate) and *M. incognita* race 3 (Emanuel isolate) on selected corn hybrids in greenhouse trials.

		Eggs per pot	
Brand	Hybrid	*M. arenaria*	*M. incognita*
Northrup King	N6330	30,833[a]	119,333*
AgriPro	AP 9707	28,200	115,358*
Pioneer	3146	23,508	179,333
Northrup King	N4714	15,833	58,083*
Northrup King	N83-R7	9,223	89,025*
DeKalb	DK 683	7,233*	171,783
	Mean	19,138	122,152

[a] Numbers are the means of 12 replicate pots averaged across locations. Means followed by * differed ($P \leq 0.05$) from the hybrid most susceptible to that species.

At harvest, the number of *M. arenaria* J2 per 150 cm^3 of soil differed among hybrids at $P = 0.036$, although not at $P \leq 0.05$. Nematode population levels ranged from 17 to 202 per 150 cm^3 of soil (Table 2). The maximum mean Pf/Pi in the experiment was 1.59, and the minimum was 0.18. Only three hybrids had a mean Pf/Pi above 1.0.

Survey of corn fields: Nematodes detected from soil samples in the survey of corn fields included *Pratylenchus* spp. (74% of fields sampled), *Mesocriconema* spp. (58%), *Helicotylenchus* spp. (43%), *Paratrichodorus* spp. (31%), *M. incognita* (30%), *Tylenchorhynchus* spp. (3%), *M. javanica* (2%), *M. arenaria* (2%), and *Rotylenchulus reniformis* (2%). *Pratylenchus* spp. were recovered from 89% of the root samples collected during extraction

from soil and from 100% of the samples from intact corn root systems.

Meloidogyne spp. were detected in 13 of 40 soil samples from corn fields that had been planted in peanut the previous year, and in 21 of 62 samples from corn fields that had been planted in cotton the previous year. In fields that had previously been in cotton, 99.6% of the *Meloidogyne* spp. were *M. incognita* and 0.4% were *M. arenaria*. In fields that had previously been in peanut, 84.6% of the *Meloidogyne* spp. were *M. incognita,* 13.5% were *M. javanica,* and 1.9% were *M. arenaria*. Overall, 93.9% of the 408 *Meloidogyne* spp. extracted from soil samples and identified to species were *M. incognita*.

Discussion

Identifying corn hybrids with resistance to *M. incognita* race 3 and *M. arenaria* race 1 could be crucial to agriculture in Georgia and areas with similar nematode problems and cropping sequences. Surveys of cotton fields indicate that *M. incognita* is common in Georgia (Baird et al., 1996; Motsinger et al., 1976), with race 3 believed to be more common than race 4. Surveys of peanut fields indicate that *M. arenaria* race 1 is common in Georgia (Davis, unpubl.; Motsinger et al., 1976). *Meloidogyne incognita* and *M. arenaria* are also common in other states in the southern United States (Dickson, 1998; Koenning et al., 1999; Martin et al., 1994; Robbins et al., 1989; Sturgeon, 1986). Corn may or may not suffer significant damage from *Meloidogyne* spp., but yields of a susceptible crop following corn may be reduced (Windham, 1998).

Strict criteria were used in our study to identify nematode-resistant hybrids to minimize the chance of identifying hybrids with inconsistent performance as *Meloidogyne*-resistant. Because we did not initially have a hybrid that could be designated as a susceptible control, our criteria in experiments Ma1 and Mi1 were designed to identify hybrids on which the nematodes consistently reproduced poorly. After the initial screening in experiment Ma1, we had a basis for the designation of a consistently susceptible hybrid as a standard. A greater number of differences among hybrids were identified when statistical analyses used mean separation procedures less stringent than Tukey's HSD.

Most of the hybrids included in experiments Ma1 and Mi1 were non-transgenic hybrids, but all of the hybrids in experiments Ma2 and Mi2 were transgenic hybrids. Our studies did not compare nematode reproduction on transgenic and non-transgenic hybrids, but there were no obvious differences.

Windham and Williams (1987) screened 64 corn hybrids and found that, although hybrids differed in the amount of nematode reproduction, all hybrids were excellent hosts for *M. incognita* race 4, but many hybrids were poor hosts for *M. arenaria* race 2. They warned that the hybrids screened may react differently to other races or even isolates of these nematode species. Similarly, our study found little resistance to *M. incognita* and significant resistance to *M. arenaria,* although we used different races of the two species and did not test the same hybrids. Previous studies of *M. arenaria* resistance in corn differed from ours in that they used race 2 (Windham and Williams, 1987 and 1994) or they did not identify the race used (Miller, 1973).

Hybrids identified as resistant to *M. arenaria* in our study generally resulted in lower final than initial population densities, making them excellent candidates for use in crop rotation with peanuts for suppression of *M. arenaria*. Aung et al. (1990) caution that the results of greenhouse resistance screening need to be verified with field tests prior to selecting hybrids for nematode management in the field. In our study, the results from the field trial were similar to greenhouse trials in that *M. arenaria* population increases were less than three-fold on the most susceptible hybrids. When subsequent winter attrition is considered, corn may be useful as a rotation crop to reduce *M. arenaria* populations in the field, thereby giving peanut farmers a crop rotation alternative to cotton.

In experiment 3 and in the field trial, we

found differences in *M. incognita* reproduction among hybrids, although no differences were observed in the eight trials of experiments Mi1 and Mi2. Population increases on the least susceptible hybrids were seven-fold or greater, indicating that all corn hybrids are good hosts for *M. incognita* race 3. The race of *M. incognita* that was present in the field test was not identified, but reproduction appears to have been significant. This is consistent with our greenhouse trials and previous reports (Windham and Williams, 1987) that all hybrids are relatively susceptible to *M. incognita*.

Our survey of corn grown subsequent to cotton and peanut confirms the results of our greenhouse and field trials. *Meloidogyne incognita* populations increased readily on corn, but *M. arenaria* populations did not. In locations where potentially damaging populations of *Meloidogyne* spp. are present, corn hybrids may be a more suitable rotation crop for *M. arenaria* management in peanut than for *M. incognita* management in cotton.

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