Supplement to the Journal of Nematology 30(4S):611–615. 1998.

Response of *Sesamum indicum* and *S. radiatum* Accessions to Root-knot Nematode, *Meloidogyne Incognita*

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Abstract: Twenty *Sesame indicum* and four *S. radiatum* accessions in the USDA Plant Introduction collection were evaluated for reaction to the root-knot nematode, *Meloidogyne incognita* race 3, at two initial egg densities under greenhouse conditions. All sesame accessions produced considerably fewer root galls than the tomato cultivar Rutgers. Gall numbers varied slightly among accessions at the higher infestation density with even less variation at the lower density. Egg mass indices indicated little reproduction. Seventy percent of the accessions weighed less at the higher egg density than at the lower egg density. All the sesame accessions tested are resistant to *M. incognita* and have the potential for use as rotational crops for suppressing this nematode.
Key words: germplasm, host reaction, *Meloidogyne incognita,* nematode, plant breeding, resistance, sesame, southern root-knot nematode.

Sesame is grown commercially in tropical, subtropical, and southern temperate regions of the world as an oilseed crop, providing an important source of food supplements and income for farmers in certain countries of the Middle East, India, and Tanzania (Mponda et al., 1997). The United States annually imports approximately 40,000 metric tons of sesame seed (U.S. Department of Agriculture, 1997), principally for cooking oil. Occasionally, sesame is planted in gardens of the southern United States for culinary purposes or as a source of bird feed (Colditz et al., 1982).

Sesamum orientale L. (syn. *S. indicum* L.) is known to suppress populations of *Meloidogyne incognita* (Kofoid & White) Chitwood (Tanda et al., 1988, 1989) by the presence of aspartic acid, glutamic acid, glycine, leucine, proline, serine, and valine in root exudates or extracts. *S. indicum* did not support development of *Meloidogyne arenaria* (Neal) Chitwood in Alabama fields (Rodríguez-Kábana et al., 1988) and only moderate reproduction of *Meloidogyne javanica* Treub under greenhouse conditions (Starr and Black, 1995). Of 101 samples of *S. indicum* in Venezuela, the second-stage juvenile of *Meloidogyne* was found in only one sample (Meredith and Perez, 1975). In India only light infection by root-knot nematode occurred on *S. orientale* roots planted between rows of susceptible okra (Varma et al., 1978).

The purpose of this research was to examine a collection of sesame accessions, originating from 15 countries in several geographical regions of the world, for their susceptibility to *M. incognita* race 3. Susceptible tomato was included as an indicator of nematode infectivity. If accessions proved to be consistently resistant to root-knot nematodes, rotational schemes similar to those recently described for field crops (McSorley et al., 1994; Rodriguez-Kábana et al., 1989) could be devised to reduce root-knot nematode populations.

MATERIALS AND METHODS

Seed of 20 accessions of *S. indicum* and four of *S. radiatum* were obtained from the Plant Genetic Resources Conservation Unit, formerly Southern Regional Plant Introduction Station, USDA ARS, Griffin, Georgia, and the National Seed Storage Laboratory, USDA ARS, Fort Collins, Colorado. Seeds were planted in a 2:1 mixture of steamed pasteurized soil and Pro-Mix A (Premier Branch, Stamford, CT) in 10-cm-diam (360-cm^3) plastic pots and thinned 3 to 4 weeks after planting to approximately 10 seedlings/pot. Pots were arranged in a random

Received for publication 10 December 1997.
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The authors thank J. Demski, G. Lovell, and J. Starr for reviewing the manuscript, B. Purser for typing, and M. Spinks for obtaining seed.

design on a greenhouse bench within three blocks according to infestation density. There were six replications at each infestation level for every entry. The experiment was repeated.

After the seeds had germinated, plants were watered daily and drenched twice during the 9-week growth period with 35 ml of Peters Fertilizer (Grace-Sierra Horticultural Products, Milpitas, CA) solution (20N-4. 3P-16.6K), containing 2.6 g/liter water. Banrot, 40% wp (ethazol + thiophanate methyl), mixed at 0.45 g/liter water, was applied once as a drench soon after seedling emergence, and Dithane M45 (mancozeb) at 2.0 g/liter water was sprayed twice on the plant foliage to control *Alternaria* spp.

Soil was infested with nematodes 18 to 21 days after seeds were planted. Eggs of *M. incognita* were obtained from infected eggplant (*Solanum melongena* L.) roots using the method of Hussey and Barker (1973). Egg suspensions were pipetted into holes in the center of each pot at 0, 1,800, or 5,400 eggs/pot.

The reaction of sesame to infection by *M. incognita* was determined 32 to 42 days following infestation. Plants were removed from the pots, and the root systems were washed and then blotted with paper towels. Plant height, number of plants, and number of root galls per replicate were recorded. The number of galls on tomato transplants was counted. Roots in the first experiment were dipped in a 0.2 g/liter phloxine B solution to facilitate the counting of nematode egg masses. An egg mass index, patterned after a gall index (Sasser et al., 1984), was assigned to each replicate. Shoot and root dry weights were measured after drying plants for 2 weeks at 90 °C.

Data were subjected to analysis of variance

TABLE 1. Average number of root-galls on sesame accessions and Rutgers tomato in two experiments (1, 2) after exposure to two egg densities of *Meloidogyne incognita* race 3.

			Galls[a] per plant			
			1,800 eggs		5,400 eggs	
Species	Accession	Origin	1	2	1	2
Sesamum indicum	157156	India	0.1 abc[b]	0.0 b	0.8 bc	0.1 ef
	229673	Argentina	0.3 ab	0.0 b	0.7 bc	0.9 cde
	234424	Taiwan	0.0 c	0.0 b	0.2 c	0.0 f
	238416	Turkey	0.0 c	0.1 b	3.3 a	1.5 bc
	238992	Greece	0.1 abc	0.0 b	1.6 b	0.2 ef
	246386	Zaire	0.1 abc	0.0 b	0.8 bc	0.1 f
	248988	India	0.3 ab	0.2 b	1.2 bc	2.7 a
	250748	Iran	0.0 c	0.0 b	0.9 bc	0.5 ef
	250887	Iran	0.2 abc	0.5 a	1.0 bc	1.5 bcd
	250945	Iran	0.1 abc	0.0 b	0.6 bc	0.1 f
	251704	Russia	0.1 abc	0.0 b	2.9 a	0.5 ef
	253424	Israel	0.0 c	0.0 b	1.6 b	0.8 def
	254698	S. America	0.3 a	0.0 b	0.8 bc	0.4 ef
	254699	Nicaragua	0.1 abc	0.1 b	1.0 bc	0.5 ef
	254700	USA (Texas)	0.0 c	0.1 b	1.4 b	1.7 b
	263470	Russia	0.1 abc	0.0 b	0.6 bc	0.9 cde
	276700	Russia	0.1 abc	0.0 b	0.8 bc	0.0 f
	278161	Angola	0.0 c	0.1 b	0.6 bc	0.1 f
	490024	Thailand	0.1 abc	0.0 b	0.2 c	0.1 f
	490030	Korea	0.1 abc	0.0 b	0.6 bc	0.3 ef
Sesamum radiatum	275362	India	0.1 a	0.0 a	0.5 b	0.0 b
	278164	Angola	0.0 a	0.2 a	0.6 b	2.0 a
	278165	Angola	0.0 a	0.0 a	1.0 b	0.3 b
	278166	Angola	0.2 a	0.2 a	2.0 a	0.6 b
Lycopersicon esculentum 'Rutgers'			24.5	72.2	13.3	182.5

[a] Average of six replications.
[b] Dissimilar letters within columns indicate the means are significantly different according to a *t*-test (LSD) at $P = 0.05$.

with the GLM procedure (SAS Institute, Cary, NC), and the mean values were separated by *t*-tests ($P = 0.05$) to determine if the accessions varied in their sensitivity to the two egg population densities of root-knot nematode.

Results and Discussion

Galling and egg mass index on Rutgers tomato indicated sufficient infectivity of the nematode inoculum (Tables 1, 2).

The statistical analysis of all data indicated a significant plant by nematode density interaction; therefore, the data from each nematode population level for both sesame species were analyzed separately to measure significant differences within each dependent variable. The mean number of galls on all sesame accessions was lower than on tomato (Table 1). At the lower inoculum level, the number of galls on *S. indicum* varied from 0.0 to 0.5 gall per plant. At the higher inoculum density (5,400 eggs) gall numbers increased slightly, ranging from 0.0 to 3.3, with 58–79% of the accessions having fewer than 1.0 gall per plant. PI 490024, originally obtained from Thailand, had fewer galls than five and six other lines in experiments 1 and 2, respectively. PI 238416, originating in Turkey, had more galls than the majority of accessions. The four *S. radiatum* accessions were similar to each other in gall numbers. Small quantitative differences in numbers of galls may have little biological significance since all lines evaluated had significantly fewer galls than Rutgers tomato.

TABLE 2. Average egg mass indices for sesame accessions and Rutgers tomato exposed to 5,400 eggs per pot of *Meloidogyne incognita* race 3 (Experiment 1).

Species, accession	Egg mass index[a]
Sesamum indicum	
157156	0.17 e[b]
229673	0.25 de
234424	0.17 e
238416	1.67 a
238992	0.83 abcde
246386	1.60 ab
248988	1.67 a
250748	1.00 abcde
250887	1.60 ab
250945	1.20 abcde
251704	1.33 abcd
253424	0.83 abcde
254698	0.50 bcde
254699	0.50 bcde
254700	0.83 abcde
263470	0.33 de
276700	0.60 abcde
278161	0.40 cde
490024	0.50 bcde
490030	1.5 abc
Sesamum radiatum	
275362	0.67 b
278164	1.00 ab
278165	1.67 a
278166	1.33 ab
Lycopersicon esculentum 'Rutgers'	2.08

[a] Average of six replications. Indices based on 0 = no egg masses, 1 = 1–2, 2 = 3–10, 3 = 11–30, 4 = 31–100, and 5 = >100 egg masses per replication.
[b] Dissimilar letters indicate means are significantly different according to a *t*-test (LSD) at $P = 0.05$.

The full model ANOVA of the data gave significant F values ($P = 0.01$) for egg mass index for the variables of sesame entry and nematode population, with no two-way interactions (Table 2). Twenty-three sesame accessions had a lower egg mass index than tomato. PI 238416 had an index that was not statistically different than tomato. PI 157156 and 234424 had lower indices than six other *S. indicum*, and these may be useful in developing cultivars that are resistant to root-knot nematodes. The indices of all other accessions did not differ from each other and ranged from 0.17 to 1.67.

The total shoot and root dry weights of infested sesame were generally lower than the weights of control plants in both experiments (Table 3). In the second experiment, 22 of 24 accessions at the higher egg density, and 16 of 24 at the lower egg density, weighed less than the control plants. There was no correlation between number of galls and plant weight at either inoculum densities. Correlation values of plant weight and number of galls at the low egg density were $r = 0.10$, $P = 0.23$, and at the higher egg density, $r = 0.041$, $P = 0.628$.

Although sesame has been reported as a nonhost for root-knot nematode (Rodríguez-Kábana et al., 1988), our results indicate that several accessions may be poor hosts for *M. incognita*. If sesame supports only limited reproduction or is not a host of

TABLE 3. Dry weights of sesame accessions inoculated with *Meloidogyne incognita* race 3 at two egg densities in experiments 1 and 2.

		Milligrams per plant[a]					
		Experiment 1			Experiment 2		
Species	Accession	0 eggs	1,800 eggs	5,400 eggs	0 eggs	1,800 eggs	5,400 eggs
Sesamum indicum	157156	527 ef[b]	364 cdefg	637 bcde	189 c	151 a[a]	167 ef
	229673	1,464 a	456 cde	839 abc	1,155 a	358 b	333 bcd
	234424	1,292 ab	436 cdef	586 bcde	385 c	238 bcd	318 bcde
	238416	1,196 abc	774 a	835 abcd	935 ab	556 a	561 a
	238992	520 ef	253 fg	699 bcde	166 c	169 d	170 ef
	246386	650 cdef	470 cd	544 bcde	222 c	221 bcd	166 ef
	248988	864 bcdef	545 bc	609 bcde	311 c	216 cd	241 def
	250748	498 ef	296 defg	572 bcde	272 c	319 bc	196 def
	250887	549 def	528 c	438 de	931 ab	500 a	408 abc
	250945	847 bcdef	389 cdefg	470 cde	284 c	250 bcd	268 cde
	251704	838 bcdef	728 ab	1,099 a	825 b	538 a	454 ab
	253424	883 bcde	423 cdefg	921 ab	1,136 a	498 a	316 bcde
	254698	735 bcdef	553 bc	756 abcde	356 c	214 cd	303 bcde
	254699	929 abcde	466 cd	861 abc	342 c	329 bc	212 def
	254700	1,117 abcd	482 cd	797 abcd	430 c	336 bc	258 cdef
	263470	472 ef	322 defg	475 cde	225 c	227 bcd	164 ef
	276700	402 ef	428 cdef	464 cde	179 c	221 bcd	196 def
	278161	453 ef	263 efg	546 bcde	192 c	275 bcd	181 def
	490024	512 ef	315 defg	644 bcde	174 c	202 cd	102 f
	490030	289 f	228 g	377 e	429 c	315 bc	274 cde
Sesamum radiatum	275362	347 b	337 b	498 b	286 b	712 a	189 b
	278164	699 b	369 b	461 b	1,303 a	717 a	521 a
	278165	549 b	733 a	570 b	329 b	277 b	242 b
	278166	1,674 a	300 b	1,545 a	658 b	584 a	406 a

[a] Average of six replications.
[b] Different letters within columns indicate the significant differences according to a *t*-test (LSD) at $P = 0.05$.

M. javanica (Araya and Caswell-Chen, 1994; Starr and Black, 1995), *M. incognita*, or *M. arenaria* (Rodríguez-Kábana et al., 1988, 1989), it seems prudent to evaluate the crop for its resistance (Cook and Evans, 1987) to other plant-parasitic nematodes that commonly occur in the southern United States. Sufficient information has accumulated on the resistance of sesame that more field studies establishing its usefulness as a cover or rotational crop for management of root-knot nematode need to be undertaken.

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