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Weed Hosts of *Meloidogyne arenaria* and *M. incognita* Common in Tobacco Fields in South Carolina[1]

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Abstract: Thirty-two weed species common in South Carolina and one cultivar of tobacco were evaluated as hosts of *Meloidogyne arenaria* race 2 and *M. incognita* race 3 in the greenhouse. Egg mass production and galling differed ($P < 0.05$) among weed species. *Chenopodium album, Euphorbia maculata,* and *Vicia villosa* were good hosts of *M. arenaria. Amaranthus palmeri, Rumex crispus, Amaranthus hybridus, Ambrosia artemisiifolia, Ipomoea hederacea* var. *integriuscula, Setaria lutescens, Sida spinosa, Portulaca oleracea,* and *Rumex acetosella* were moderate hosts. *Taraxacum officinale, Ipomoea hederacea, Cyperus esculentus, Cynodon dactylon, Echinochloa crus-galli, Eleusine indica, Sorghum halepense, Setaria viridis, Digitaria sanguinalis,* and *Datura stramonium* were poor hosts for *M. arenaria. Amaranthus palmeri, Amaranthus hybridus, Chenopodium album, Euphorbia maculata, Setaria lutescens, Vicia villosa, Sida spinosa, Rumex crispus,* and *Portulaca oleracea* were moderate hosts and *Ipomoea hederacea* var. integriuscula, *Xanthium strumarium, Cyperus esculentus, Cynodon dactylon, Paspalum notatum, Eleusine indica, Setaria viridis,* and *Rumex acetosella* were poor hosts for *M. incognita.* None of the above were good hosts for *M. incognita.* Tobacco 'PD4' supported large numbers of both nematode species.

Key words: host suitability, *Meloidogyne arenaria, M. incognita, Nicotiana tabacum,* root-knot nematode, tobacco, weed.

An increase in the incidence of *Meloidogyne arenaria* (Neal) Chitwood race 2 in South Carolina tobacco (*Nicotiana tabacum* L.) fields was reported recently (6). *Meloidogyne arenaria* is more virulent than *M. incognita* (Kofoid & White) Chitwood on tobacco (1,2) and predisposes plants to secondary organisms (3). The increase in *M. arenaria* played a significant role in the epiphytotic of root-knot observed on flue-cured tobacco in 1982 (6).

Alternate hosts of *M. arenaria* that might influence its development need to be documented, thereby enabling management strategies to be developed. Weeds are present in many agricultural ecosystems and may influence nematode population development. The incidence of weed populations changes with use of different agricultural practices and herbicides, and certain weeds may favor *M. arenaria* or *M. incognita.* Our objective was to determine the suitability of weeds commonly found in tobacco fields in South Carolina as hosts of *M. arenaria* race 2 and *M. incognita* race 3.

Materials and Methods

Meloidogyne arenaria race 2 and *M. incognita* race 3 were isolated from tobacco in Florence County, South Carolina. Single egg-mass cultures were increased on tomato (*Lycopersicon esculentum* Mill. cv. Rutgers). Species confirmation and race identification were based on differential host tests, perineal patterns, and juvenile morphometrics (10).

The experimental design was a split plot with nematode species as whole plots and weed species as subplots. A randomized complete block design was used with five replicates, and the experiment was repeated once. Weed seeds were obtained from Valley Seed Service, Fresno, California.

A heat-pasteurized mixture of Varina sandy loam soil (75% sand, 17% silt, 8% clay, 0.8% organic matter; pH 6.1) was mixed two parts soil, two parts sand, and one part peat (v:v:v). The mixture was added to 15-cm-d plastic pots and seeded with either *Cynodon dactylon* (L.) Pers., *Digitaria sanguinalis* (L.) Scop., *Paspalum notatum* Fluegge., *Eremochloa ophiuroides*

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(Munro.) Hack., *Echinochloa crus-galli* (L.) Beauv., *Paspalum dilatatum* Poir, *Eleusine indica* (L.) Gaertn., or *Axonopus affinis* Chase. These grasses were maintained in the greenhouse until a dense carpet covered the surface layer in each pot. *Ipomoea hederacea* var. *integriuscula* (L.) Gray, *Ipomoea hederacea* (L.) Jacq., *Sorghum halepense* (L.) Pers., *Setaria viridis* (L.) Beauv., *Portulaca oleracea* L., *Crotalaria spectabilis* Roth., *Cassia obtusifolia* L., *Oenothera biennis* L., *Ambrosia artemisiifolia* L., *Amaranthus hybridus* L., *Cenchrus incertus* Curtis, *Taraxacum officinale* Weber., *Rumex crispus* L., *Datura stramonium* L., *Rumex acetosella* L., *Sida spinosa* L., *Amaranthus palmeri* S. Wats., *Setaria lutescens* (Weisel) Hubb., *Lespedeza stipulacea* Maxim., *Euphorbia maculata* L., *Xanthium strumarium* L., *Chenopodium album* L., *Cyperus esculentus* L., *Vicia villosa* Roth, and tobacco 'PD 4' seeds were germinated in plastic trays containing vermiculite, and single seedlings of each were transplanted into the centers of 15-cm-d plastic pots containing the soil mixture. All plants were fertilized with a 20:20:20 (N:P:K) fertilizer (1 g/pot) at 14-day intervals starting at transplanting. Weeds and tobacco seedlings were maintained in a greenhouse at 25 ± 5 C. Egg inoculum was extracted from 60-day-old tomato roots in 0.5% sodium hypochlorite and washed in tap water (9). Inocula were standardized to 1,000 eggs/ml suspension. Two weeks after transplanting, the seedlings were inoculated with 5,000 eggs of *M. arenaria* or *M. incognita*. Eggs were pipetted into two 5-cm-deep holes at the base of each seedling hypocotyl or into four 5-cm-deep holes in soil of the pots containing the grasses, and the holes were covered with soil. Control plants received a similar volume of water without eggs using a leachate from uninfected tomato roots.

Sixty days after inoculation, roots were washed free from soil and stained in Phloxine B (150 mg/liter) for 15 minutes and rinsed with tap water to enhance egg-mass visibility (5). Roots were rated for galling on a 0–10 scale where 0 = no galling and 10 = 100% of the root tissue galled (4). The following scale was used to index egg masses: 0 = no egg masses, 1 = 1–2, 2 = 3–10, 3 = 11–30, 4 = 31–100, and 5 = > 100 egg masses per root system (11).

A reproductive rating (R) was determined by dividing the average egg-mass index for each weed species by the average egg-mass index for PD 4 tobacco, which is a host of both nematode species. A suboptimal initial population (Pi) of root-knot nematodes (50% of the Pi used in a differential host test) was chosen to separate weed species that were better hosts than tobacco. Based on R values, hosts were rated as follows: R > 1 = good host, ≤ 1.0–> 0.5 = moderate host, ≤ 0.5–> 0.1 = poor host, and ≤ 0.1 = nonhost. Data from nematode egg masses and root galls for the various weeds were subjected to ANOVA and treatment means were compared by least-significant difference (12).

Results and Discussion

Differences ($P \leq 0.01$) in egg mass production and galling by *M. arenaria* and *M. incognita* were observed for the weeds tested (Table 1). At least one egg mass was observed on 31 of the 33 plant species inoculated with *M. incognita* or *M. arenaria* (Table 1). On the basis of R values, *C. album, E. maculata,* and *V. villosa* were good hosts; *A. palmeri, R. crispus, A. hybridus, A. artemisiifolia, I. hederacea* var. *integriuscula, S. lutescens, S. spinosa, P. oleracea,* and *R. acetosella* were moderate hosts; *T. officinale, I. hederacea, C. esculentus, C. dactylon, E. crus-galli, E. indica, S. halepense, S. viridis, D. sanguinalis,* and *D. stramonium* were poor hosts; and *X. strumarium, C. spectabilis, C. obtusifolia, C. incertus, A. affinis, P. notatum, E. ophiuroides, L. stipulacea, P. dilatatum,* and *O. biennis* were nonhosts for *M. arenaria.*

None of the weeds tested was a better host than tobacco PD 4 for *M. incognita* (Table 1). *Amaranthus palmeri, A. hybridus, C. album, E. maculata, S. lutescens, V. villosa, S. spinosa, R. crispus,* and *P. oleracea* were moderate hosts; *I. hederacea* var. *integriuscula, X. strumarium, C. esculentus, C. dactylon, P. notatum, E. indica, S. viridis,* and *R. acetosella* were poor hosts; and *D. sanguina-*

TABLE 1. Suitability of plants commonly found in tobacco fields in South Carolina as hosts of *Meloidogyne arenaria* (Ma) race 2 and *M. incognita* (Mi) race 3.

Plant species (common name)	Reproductive rating (R)†		Egg mass index‡		Root-gall index§	
	Ma	Mi	Ma	Mi	Ma	Mi
AMARANTHACEAE						
Amaranthus palmeri S. Wats. (palmer amaranth)	0.7	0.6	2.0	2.3	1.0	0.4
Amaranthus hybridus L. (smooth pigweed)	1.0	0.8	2.8	3.0	0.8	1.9
CHENOPODIACEAE						
Chenopodium album L. (common lambsquarters)	1.3	0.9	3.7	3.2	3.3	1.7
COMPOSITAE						
Ambrosia artemisiifolia L. (common ragweed)	0.8	0.1	0.6	0.4	0	0.1
Taraxacum officinale Weber. (dandelion)	0.2	0.1	0.5	0.4	0.8	0.4
Xanthium strumarium L. (common cocklebur)	0.1	0.2	0.2	0.7	0	0.4
CONVOLVULACEAE						
Ipomoea hederacea var. *integriuscula* (L.) Gray (entireleaf morning-glory)	0.8	0.5	2.3	2.0	0.3	0.3
Ipomoea hederacea (L.) Jacq. (ivyleaf morning-glory)	0.2	0.1	0.5	0.5	0	0
CYPERACEAE						
Cyperus esculentus L. (yellow nutsedge)	0.5	0.4	1.3	1.3	0	0.1
EUPHORBIACEAE						
Euphorbia maculata L. (spotted spurge)	1.2	0.8	3.3	2.8	0.5	0.2
GRAMINEAE						
Cynodon dactylon (L.) Pers. (bermudagrass)	0.4	0.3	1.2	1.2	0	0.1
Digitaria sanguinalis (L.) Scop. (large crabgrass)	0.2	0	0.5	0.2	0	0
Paspalum notatum Fluegge. (bahiagrass)	0.1	0.2	0.4	0.6	0	0
Eremochloa ophiuroides (Munro.) Hack. (centipedegrass)	0.1	0	0.2	0.2	0	0
Echinochloa crus-galli (L.) Beauv. (barnyardgrass)	0.3	0.1	1.0	0.3	0.1	0.1
Paspalum dilatatum Poir (dallisgrass)	0	0.1	0.1	0.3	0	0
Eleusine indica (L.) Gaertn. (goosegrass)	0.2	0.3	0.7	1.3	0.1	0
Axonopus affinis Chase (carpetgrass)	0.1	0.1	0.3	0.4	0	0.1
Sorghum halepense (L.) Pers. (johnsongrass)	0.2	0.1	0.5	0.5	0	0
Setaria viridis (L.) Beauv. (green foxtail)	0.2	0.4	0.5	1.3	0	0.1
Setaria lutescens (Weisel) Hubb. (yellow foxtail)	0.6	0.7	1.6	2.5	0.1	0.3
LEGUMINOSAE						
Crotalaria spectabilis Roth. (showy crotalaria)	0.1	0.1	0.4	0.5	0	0
Cassia obtusifolia L. (sicklepod)	0.1	0.1	0.3	0.5	0	0
Vicia villosa Roth (hairy vetch)	1.4	0.9	4.0	4.0	7.3	4.8
Lespedeza stipulacea Maxim. (Korean lespedeza)	0.1	0	0.2	0.1	0.2	0.3
Cenchrus incertus Curtis (field sandbur)	0.1	0.1	0.2	0.5	0	0.1
MALVACEAE						
Sida spinosa L. (prickly sida)	0.9	0.6	2.7	2.4	0.4	0.6
NAGRACEAE						
Oenothera biennis L. (common evening primrose)	0.1	0	0.2	0	0	0
POLYGONACEAE						
Rumex crispus L. (curly dock)	1.0	0.8	2.9	3.1	2.4	2.0
Rumex acetosella L. (red sorrel)	0.8	0.5	2.2	1.9	0.9	1.4
PORTULACEAE						
Portulaca oleracea L. (common purslane)	0.8	0.6	2.2	2.2	0.5	0.2
SOLANACEAE						
Datura stramonium L. (jimsonweed)	0.2	0.1	0.6	0.5	0.7	0.2
Nicotiana tabacum L. (tobacco 'PD 4')	1.00	1.00	2.9	3.8	2.4	2.4
LSD ($P = 0.05$)			0.6	1.5	0.7	1.0

lis, D. stramonium, C. incertus, C. spectabilis, C. obtusifolia, A. affinis, S. halepense, I. hederacea, A. artemisiifolia, T. officinale, E. ophiuroides, E. crus-galli, P. dilatatum, L. stipulacea, and *O. biennis* were nonhosts for *M. incognita. Meloidogyne incognita* and *M. arenaria* reproduced on several weed species from distinctly different plant families.

Meloidogyne arenaria reproduction was equal to or greater than *M. incognita* on most of the weeds tested. Fields infested with *A. artemisiifolia, C. album,* or *E. maculata* would be expected to favor the development of *M. arenaria.* Many of the weeds tested did not support large populations of either nematode species, but the potential could be great enough to enhance development on selected tobacco cultivars (8).

There have been numerous reports on weed hosts of *Meloidogyne* spp.; however, the majority of these reports failed to distinguish the nematode species or race under investigation. Host ranges for *M. arenaria* could be expected to differ depending on race. *Meloidogyne arenaria* (10) caused severe galling on sicklepod; however, our *M. arenaria* did not parasitize sicklepod. An Alabama study used a field soil that reportedly contained *M. arenaria* race 1 (Rodríguez-Kábana, pers. comm.), whereas race 2 was used in these experiments. It is possible the field soil contained a mixture of *Meloidogyne* species or both races of *M. arenaria.*

Griffin (7) observed differences in the response of certain weed host populations to *Heterodera schachtii* Schmidt in different geographic locations. Apparently weed host suitability is dependent on genetic differences in the nematode population as well as weed biotypes (7).

The capability of weeds, commonly found in tobacco production areas of South Carolina, to support reproduction of *M. incognita* and *M. arenaria* emphasizes the need for good weed management programs. Herbicides and cultivation used on tobacco provide reasonable control of weeds, but failure to manage weeds may enhance nematode problems on tobacco and succeeding crops.

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† Reproductive rating for each weed species was determined by dividing the egg-mass index of each weed species by the average egg-mass index for tobacco.

‡ Egg-mass index: 0 = no egg-masses, 1 = 1–2, 2 = 3–10, 3 = 11–30, 4 = 31–100, 5 = > 100 egg mass.

§ Root-gall index based on a 0–10 scale: 0 = no root galling and 10 = 100% of the root surface galled.