

Host Range of the Columbia Root-Knot Nematode

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ABSTRACT

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The Columbia root-knot nematode, *Meloidogyne chitwoodi*, a severe pest of potato in the Pacific Northwest, reproduced on 53 of 68 plant species tested under greenhouse conditions. Both monocotyledonous and dicotyledonous plant species were good hosts, indicating that *M. chitwoodi* has a wide host range. Principal crops used in rotation with potato in the Pacific Northwest include a poor host (alfalfa), but cereals such as barley, corn, and wheat were good hosts for this nematode.

An undescribed root-knot nematode was found attacking potato (*Solanum tuberosum* L.) in the Pacific Northwest in 1977-1978 (9). The new species was described as *Meloidogyne chitwoodi* Golden, O'Bannon, Santo, and Finley (4) and given the common name "Columbia root-knot nematode." It is presently known in Idaho, Oregon, Washington, northern California, and Nevada (6). Economically, potato is the major crop most severely damaged by *M. chitwoodi*, but it can reproduce and is pathogenic on oats (*Avena sativa* L.), barley (*Hordeum vulgare* L.), corn (*Zea mays* L.), and wheat (*Triticum aestivum* L.), crops that are used in rotation with potato (8,9).

The northern root-knot nematode, *M. hapla*, which also attacks potatoes, is limited to broad-leaf plants (2). Because of the need for effective rotation and weed control, a study was made to determine crop and weed hosts of *M. chitwoodi*.

MATERIALS AND METHODS

Several host range tests were conducted in a greenhouse for 2 yr. Four or five

seeds, later thinned to one or two seedlings or a single seed piece, were either pregerminated or planted directly into 10-cm plastic pots containing loamy sand (82.3% sand, 14.8% silt, 2.9% clay) fumigated with methyl bromide. Pots were randomized in five replicates on greenhouse benches, and plants were inoculated after 2- or 3-wk growth with 3,000-4,000 *M. chitwoodi* eggs in a 25-ml water suspension added to the roots of plants in each pot. Inoculum came from infected tomatoes (*Lycopersicon esculentum* Mill. 'Rutgers') maintained in a greenhouse. Eggs were extracted from roots by the sodium hypochlorite method (5).

Greenhouse temperatures were maintained at 20-25 C, which is favorable for nematode infection and reproduction (7). Plants were watered daily and fertilized with Hoagland's nutrient solution bimonthly. Tests were terminated after 50 days, and the roots were carefully removed and washed free of soil. To measure host susceptibility and nematode reproduction, roots were soaked (15 min) in a phloxine B solution (1) (150 mg/L) and examined with a dissecting microscope. After examination, nematode eggs were extracted (5) and brought to volume (100 ml), and a 1-ml aliquot sample was counted. Roots were oven-dried and weighed, and the number of eggs per gram of dry root was calculated. Plants were rated as to relative degree of nematode reproduction based on egg masses and eggs per gram of oven-dry root. Ratings were 0 = no reproduction, nonhost; 0.1-1 = trace reproduction,

<100 eggs per gram of root, very poor host; 1.1-2 = light reproduction, 100-1,000 eggs, poor host; 2.1-3 = moderate reproduction, >1,000-10,000 eggs, moderate host; 3.1-4 = high reproduction, >10,000-100,000 eggs, good host; 4+ = very high reproduction, >100,000 eggs, very good host.

Because several plants observed in our studies are grown in a rotation program, we tested several varieties within a species to ascertain the possible existence of resistant germ plasm or nematode-tolerant cultivars.

RESULTS AND DISCUSSION

M. chitwoodi was found to infect and reproduce on 53 of 68 plant species tested, indicating a wide host range (Table 1). Unlike *M. hapla* (2), many of the Gramineae as well as many dicotyledonous species were good host of *M. chitwoodi*. Because alfalfa is often used in the rotation, several *Medicago sativa* cultivars were tested and found to be either nonhosts or poor hosts. Most alfalfa varieties are susceptible to *M. hapla*, and several cereals susceptible to *M. chitwoodi* were also used in the rotation. Therefore, this information is of value to growers when practicing rotation with potatoes and alerts field and extension personnel to the necessity of species identification between *M. chitwoodi* and *M. hapla*.

In the field, galls and egg masses produced by *M. chitwoodi* are often difficult to see on roots of most host plants, even with the aid of a hand lens. To see egg masses better, roots should be stained with phloxine B, which stains the masses red for rapid identification (1). This can be done in the field and also serves as an excellent teaching example for the grower.

To aid interested persons in developing diagnostic evaluation for species separation of suspicious sites, specific hosts for *M. chitwoodi* or *M. hapla* should be used. Wheat cv. Nugaines, a host of *M. chitwoodi*, and pepper cv. California Wonder, a host of *M. hapla*,

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Table 1. Response of several plant species to *Meloidogyne chitwoodi*

Scientific name	Common name	Horticultural variety	Rating as host ^a
AMARANTHACEAE			
<i>Amaranthus graecizans</i>	Tumbleweed		0.0
<i>A. retroflexus</i>	Pigweed		0.0
ASCLEPIADACEAE			
<i>Asclepias syriaca</i>	Common milkweed		0.1
CANNABACEAE			
<i>Humulus lupulus</i>	Hop		0.0
CHENOPODIACEAE			
<i>Beta vulgaris</i>	Fodder beet		1.6
	Sugarbeet	U&I Hybrid No. 9	2.1
<i>Chenopodium album</i>	Lambsquarter		0.1
<i>Salsola kali</i>	Russian thistle		1.1
COMPOSITAE			
<i>Cirsium arvense</i>	Canada thistle		1.0
<i>C. vulgare</i>	Bull thistle		3.5
<i>Sonchus asper</i>	Spiny sowthistle		3.0
<i>Taraxacum officinale</i>	Dandelion		1.1
CRUCIFERAE			
<i>Brassica hirta</i>	Oil mustard	Kirby	2.3
<i>B. juncea</i>	Mustard weed		1.1
<i>B. napus</i>	Rape	Baraska	2.1
		Bar-Bn 1Va 814-5	1.4
<i>B. rapa</i>	Stubble turnip	Alander	2.4
		Endiviana	2.3
		Gelria	2.4
		Ponda	2.3
		Samson	2.4
		Vollenda	2.1
		Weseler	2.2
	Turnip	Barive	2.6
		Purpletop	2.5
<i>B. rapa</i> var. <i>rapa</i>	Stubble turnip × Chinese cabbage	Appin	1.6
<i>B. rapa</i> var. <i>silvestris</i>	Stubble turnip × Chinese cabbage	Daisy	2.2
<i>Capsella bursa-pastoris</i>	Shepherd purse		1.3
<i>Raphanus sativus</i>	Fodder radish	Nerus	0.0
CUCURBITACEAE			
<i>Citrullus vulgaris</i>	Watermelon	Charleston Grey	0.1
GRAMINEAE			
<i>Aegilops cylindrica</i>	Jointed goatgrass		0.7
<i>Agropyron repens</i>	Quackgrass		1.0
<i>Alopecurus pratensis</i>	Meadow foxtail		0.0
<i>Arrhenatherum elatius</i>	Tall oatgrass		0.0
<i>Avena sativa</i>	Oats	Appaloosa	4+
		Cayuse	4+
		Corbit	4+
		Markton	4+
		Menominee	4+
		Otana	4+
		Park	3.3
		Random	4+
		Terra	4+
<i>Bromus tectorum</i>	Downy brome		1.1
<i>Cenchrus incertus</i>	Field sandburr		0.0
<i>Cynodon dactylon</i>	Bermuda grass		0.5
<i>Dactylis glomerata</i>	Orchardgrass		2.1
<i>Echinochloa crus-galli</i>	Barnyardgrass		1.2
<i>Eragrostis orcuttiana</i>	Lovegrass		1.8
<i>Festuca arundinacea</i>	Meadow fescue		2.1
	Tall fescue		0.1
	Red fescue		1.8
<i>Hordeum vulgare</i>	Barley	Advance	3.9
		Boyer	3.2
		Hesk	3.1
		Kamiak	4+
<i>Hordeum vulgare</i>	Barley	Klages	3.3
		Mal	4+
		Morex	4+
		Piroline	4+
		Steptoe	3.4
		Vanguard	4+
<i>Panicum capillare</i>	Witchgrass		2.1
<i>Poa annua</i>	Annual bluegrass		1.6
<i>P. pratensis</i>	Kentucky bluegrass		0.5
<i>Setaria lutescens</i>	Yellow foxtail		1.2
<i>S. viridis</i>	Green foxtail		2.1
<i>Sorghum vulgare</i>	Sudangrass		0.1
<i>Triticum aestivum</i>	Wheat (spring)	Borah	4+
		Dirkwin	4+
		Fielder	4+
		Fieldwin	4+
		Owens	4+
		Sawtell	4+
		Sterling	4+
		Twin	4+
	Wheat (winter)	Barbee	3.4
		Faro	2.9

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TABLE 1. (continued from preceding page)

Scientific name	Common name	Horticultural variety	Rating as host ^a
<i>Triticum aestivum</i>	Wheat (winter)	Hyslop	3.3
		Luke	3.3
		Moro	3.1
		Neeley	3.3
		Nugaines	4+
		Palouse	3.3
		Prodax	4+
		Stephens	4+
		Tyee	3.4
		Wanser	3.5
<i>Zea mays</i>	Corn	Cenex 2119	2.4
		Funks G-4444 MF	3.2
		Funks G4574	2.1
		Idahybrid 216	3.1
		Idahybrid 303	0.9
		JX 122A	2.2
		JX 162	1.5
		JX 1153	2.3
		Northrup King 497	0.6
		Northrup King 589	3.2
	Sweet corn	Northrup King PX 46	2.3
		Jubilee	2.0
		Scotch	0.4
		Todd	0.3
LABIATAE	Spearment	Black	0.2
		Native	0.6
<i>Mentha cardiaca</i>	Peppermint		
<i>M. piperita</i>			
<i>M. spicata</i>	Spearment		
LEGUMINOSAE			
<i>Arachis hypogaea</i>	Peanut	Florrunner	0.0
<i>Medicago sativa</i>	Alfalfa	African	0.1
		DuPuit	0.0
		Lahanton	0.1
		Mn PL 9HF (Syn 2)	1.3
		Moapa	0.0
		Nevada Syn XX	0.4
		Nevada Syn VV	0.1
		I23	0.1
		Ranger	0.1
		Rhizoma	0.0
		Saranac	0.2
		Thor	0.1
		Vernal	0.1
		Vertus	0.1
		W9S ₂ R ₂ W ₁	0.1
		W12S ₂ R ₂ W ₁ Fu ₁	0.0
		Washoe	0.2
<i>Phaseolus limensis</i>	Lima bean	Henderson Baby Bush	0.0
<i>P. vulgaris</i>	Snap bean	Apollo	2.5
<i>Pisum sativum</i>	Edible podded pea	ARS 244219-B	3.1
	Garden pea	Alaska	2.1
		Dark Skin Perfection	2.1
		PH 14-119	1.7
		PI-189171	2.4
		PI-257593	2.4
<i>Trifolium pratense</i>	Red clover		2.8
<i>T. repens</i>	White clover		2.8
<i>Vigna sinensis</i>	Cowpea	California Black Eye No. 5	0.2
LILIACEAE			
<i>Allium cepa</i>	Onion	Rocket	0.3
<i>Asparagus officinalis</i>	Asparagus	Walla Walla Sweet	1.1
MALVACEAE		Mary Washington	0.0
<i>Gossypium hirsutum</i>	Cotton	Delta Pine 16	0.0
<i>Hibiscus esculentus</i>	Okra	Dwarf Green	1.1
ROSACEAE			
<i>Fragaria chiloensis</i>	Strawberry		0.1
<i>Malus sylvestris</i>	Apple	Golden Delicious	0.0
SOLANACEAE			
<i>Capsicum annuum</i>	Pepper	California Wonder	0.0
<i>Lycopersicon esculentum</i>	Tomato	Ace	3.5
		Beefsteak	2.7
		Big Boy	2.7
		Bonny Best	2.5
		Columbian	3.9
		Patriot	2.9
		Roza	4+
		Rutgers	3.7
		Saladmaster	3.4
		Sunray	3.1
		Tiny Tim	2.9
		Yellow Pear	3.2
<i>L. peruvianum</i>	Wild tomato		2.3
		PI 270435	1.1
<i>Nicotiana tabacum</i>	Tobacco		0.0
<i>Solanum nigrum</i>	Nightshade		1.5
<i>S. melongena</i>	Eggplant		0.9

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TABLE 1. (continued from preceding page)

Scientific name	Common name	Horticultural variety	Rating as host ^a
<i>S. tuberosum</i>	Potato	Bel-rus	2.5
		Lemhi	3.1
		Russet Burbank	3.5
		White Rose	2.5
UMBELLIFERAE			
<i>Daucus carota</i>	Carrot	Gold Pak	2.2
		Half Long	1.1
		Imperator	0.1
VITACEAE			
<i>Vitis labrusca</i> <i>V. vinifera</i>	Grape	Concord	0.2
	Wine grape	Semillon	0.4

^a0 = no reproduction, nonhost; 0.1-1 = trace reproduction, <100 eggs per gram of root (oven-dry), very poor host; 1.1-2 = light reproduction, 100-1,000 eggs, poor host; 2.1-3 = moderate reproduction, >1,000-10,000 eggs, moderate host; 3.1-4 = high reproduction, >10,000-100,000 eggs, good host; 4+ = very high reproduction, >100,000 eggs, very good host.

are good indicator hosts for the respective species. If soil, root, or tuber samples infested with root-knot nematodes are available, L₂ juveniles and eggs can be extracted and inoculated onto individual seedlings. After a given period of growth (55 days), plants can be harvested and the roots immersed in phloxine B. In conjunction with the indicator host test, female perineal patterns and tail shape of L₂ juveniles are of greater value to technical laboratories.

Even though certain plant species tested were poor hosts when used in rotation with potato, low populations of *M. chitwoodi* remaining from the previous crop can increase rapidly on potato and diminish the tuber quality, which is the major concern with potato

(3,8). This problem is also evident with several weed species examined that act as infection reservoirs for *M. chitwoodi*, thus necessitating a good weed control program.

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