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List of Plant-Parasitic Nematodes Found in North Carolina

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North Carolina's agricultural industry, including food, fiber, ornamentals and forestry, contributes \$84 billion to the state's annual economy, accounts for more than 17 percent of the state's income, and employs 17 percent of the work force. North Carolina is one of the most diversified agricultural states in the nation. Approximately, 50,000 farmers grow over 80 different commodities in North Carolina utilizing 8.2 million of the state's 12.5 million hectares to furnish consumers a dependable and affordable supply of food and fiber. North Carolina produces more tobacco and sweet potatoes than any other state, ranks second in Christmas tree and third in tomato production. The state ranks ninth nationally in farm cash receipts of over \$10.8 billion (NCDA&CS Agricultural Statistics, 2017).

Plant-parasitic nematodes are recognized as one of the greatest threat to crops throughout the world. Nematodes alone or in combination with other soil microorganisms have been found to attack almost every part of the plant including roots, stems, leaves, fruits and seeds. Crop damage caused worldwide by plant nematodes has been estimated at \$US80 billion per year (Nicol et al., 2011). All crops are damaged by at least one species of nematode. Most plant-parasitic nematodes live in soil and damage plants by feeding in large numbers on roots, impairing the plant's ability to take up water and nutrients. Severe root damage caused by nematodes typically results in aboveground symptoms that may include stunting, yellowing of leaves, incipient wilt, loss of plant vigor and/or an overall general decline in plant performance. Damage is often more pronounced when plants are under stress from lack of water or nutrients or when damaged by other diseases or insects. Although nematodes rarely kill plants, they can drastically limit plant growth and yields. Plant-parasitic nematodes are usually confined to localized areas in soil and spread very slowly by their own power. However, they may be dispersed more rapidly by movement of infested soil through cultivation, on soil clinging to farming tools and tillers, in water, wind or on roots of transplants.

In the state of North Carolina, nematodes are a major threat to most crops. About 94 plant-parasitic nematode species have been recorded. Among them, root knot, soybean cyst, reniform, sting, lesion, lance, stubby root, tobacco cyst, ring, and foliar nematodes are considered the most important. The list of plant-parasitic nematodes in Table 1 is based in part on the nematode section of the North Carolina Plant Disease Index by K. R. Barker (Grand, 1985) and includes all recent research findings (Ye et al., 2012, 2013, 2015a, b; Ye, 2017; Zeng et al., 2012b, 2015; Holguin et al, 2015a, 2016) and nematode assay services provided by the NCDA&CS. Nematode entries in this list do not necessarily indicate that all nematodes associated with a given plant species are pathogenic to that plant species. Although all of these nematodes are obligate parasites, some of them often cause little or no damage. Furthermore, nematodes are primarily soil inhabitants and may feed on associated weeds and grasses. In a few instances, the nematodes included under a given plant species probably were feeding primarily on these associated plants/weeds or had fed on previous crops.

Table 1. The plant-parasitic nematodes in North Carolina.

No.	Nematode species	Crop or plant	References
1	<i>Anguina tritici</i>	Rye, wheat	Grand, 1985
2	<i>Aorolaimus</i> ♂♂	Camellia	Grand, 1985
3	<i>Aphelenchoides fragariae</i>	Ornamentals, strawberry	McCuiston et al., 2007; Kohl et al., 2010
4	<i>A. myceliophagus</i>	Mushrooms, turfgrass	Zeng et al., 2012b
5	<i>A. parietinus</i>	Cotton	Steiner, 1938; Society of Nematologists, 1984
6	<i>A. ritzemabosi</i>	Florist's daisy	Strider, 1979; Grand, 1985
7	<i>A. subtenuis</i>	Unknown	Society of Nematologists, 1984
8	<i>Belonolaimus gracilis</i>	Corn, cotton	Ruehle and Sasser, 1962
9	<i>B. longicaudatus</i>	Bermuda grass, common bean, corn, cotton, creeping grasses, peanut, soybean, tomato	Zeng et al., 2012b
10	<i>B. maritimus</i>	American beachgrass	Grand, 1985
11	<i>Bursaphelenchus xylophilus</i>	Black pine, loblolly pine, longleaf pine, pond pine, shortleaf pine, slash pine, Virginia pine	Ye & Giblin-Davis, 2013
12	<i>Cactodera weissi</i>	Bermuda grass, knotweed, tobacco	Grand, 1985; Ye, 2012
13	<i>C. sphagni</i>	Trees	Ruehle, 1968
15	<i>Ditylenchus dipsaci</i>	Alfalfa, ornamentals, white clover, wild onion	Barker and Sasser, 1959; Grand, 1985
16	<i>D. triformis</i>	Iris	Hirschmann and Sasser, 1955
17	<i>Dolichodorus heterocephalus</i>	Bermuda grass, camellia	Zeng et al., 2012b
18	<i>D. marylandicus</i>	Pine	Lewis and Golden, 1981
20	<i>Globodera tabacum solanacearum</i>	Carolina horsenettle, tobacco	Melton et al., 1991
21	<i>HHLRHQX</i> <i>dihystera</i>	Bermuda grass, common bean, corn, cotton, creeping grasses, loblolly pine, peach, peanut, slash pine, soybean	Aycock et al., 1976; Schmitt and Barker, 1988; Zeng et al., 2012b
22	<i>H. erythrae</i>	Grass	Ruehle & Sasser, 1962
23	<i>H. nannus</i>	Loblolly pine, slash pine	Ruehle and Sasser, 1962
24	<i>Hemicaloosia graminis</i>	Turfgrass	Zeng et al., 2012a

25	<i>Hemicriconemoides chitwoodi</i>	Camellia, turfgrass	Ye and Robbins, 2000; López et al., 2012a; Zeng et al., 2012b
26	<i>H. wessoni</i>	Bermuda grass	Ye and Robbins, 2000; Zeng et al., 2012b
27	<i>Hemicycliophora conida</i>	Creeping bentgrass	Zeng et al., 2012b
28	<i>H. gigas</i>	Forest soil	Thorne, 1955
29	<i>H. gracilis</i>	Grass	Thorne, 1955
30	<i>H. mettleri</i>	Trees	Brzeski, 1974
31	<i>H. parvana</i>	Turfgrass	López et al., 2013; van den Berg et al., 2018
32	<i>H. robbinsi</i>	Turfgrass	López et al., 2013; Subbotin et al., 2014; van den Berg et al., 2018
33	<i>H. sheri</i>	Grass	Society of Nematologists, 1984
35	<i>Heterodera cyperi</i>	Ornamentals	Golden, et al., 1962
36	<i>H. glycines</i>	Common bean, soybean	Schmitt and Barker, 1988; Koenning, 2004
37	<i>H. lespedezae</i>	Bush clover	Golden & Cobb, 1963
38	<i>H. trifolii</i>	Daylilly, white clover	Grand, 1985; Ye, 2012
39	<i>Hoplolaimus columbus</i>	Cotton, soybean	Sher, 1963; Schmitt and Barker, 1988; Holguin et al., 2015a, b, 2016
40	<i>H. coronatus</i>	Loblolly pine, slash pine	Ruehle and Sasser, 1962
41	<i>H. galeatus</i>	Bermuda grass, boxwood, Chinese holly, corn, cotton, creeping bentgrass, creeping grasses, slash pine, soybean, tall fescue, white clover	Schmitt and Barker, 1988; Zeng et al., 2012b; Holguin et al., 2015a
42	<i>H. stephanus</i>	Soybean	Sher, 1963; Holguin et al., 2015a
43	<i>Longidorus breviannulatus</i>	Turfgrass	Society of Nematologists, 1984
48	<i>Meloidodera floridensis</i>	Azalea, grass, loblolly pine, slash pine	Ruehle and Sasser, 1962; Triantaphyllou and Hirschmann, 1973; Ye, 2012
49	<i>Meloidogyne arenaria</i>	Asparagus, azalea, carrot, daylily, peanut, corn, sweet potato, tobacco, soybean, tomato	Winstead & Sasser, 1956
50	<i>M. carolinensis</i>	Blueberry	Eisenback, 1982
51	<i>M. enterolobii</i>	Cotton, horseweed, morning glory, sicklepod, soybean, sweet potato, tobacco	Ye et al., 2013
52	<i>M. graminis</i>	Bermuda grass, blue oat grass, centipede grass, creeping bentgrass, creeping grasses, meadow fescue, St. Augustine grass	Ye et al., 2015b; Zeng et al., 2012b
53	<i>M. hapla</i>	Boxwood, cabbage, cantaloupe, common bean, cotton, ginseng, Irish potato, pea, peanut, peony, sage, soybean, strawberry, sweet potato, tobacco, tomato, watermelon, wheat	Schmitt and Barker, 1988; Society of Nematologists, 1984

54	<i>M. incognita</i>	Alfalfa, asparagus, azalea, bean, begonia, bentgrass, bermuda grass, boxwood, Buddleja, butterbean, cabbage, camellia, cantaloupe, carrot, collards, common bean, corn, cotton, creeping bentgrass, creeping grasses, cucumber, daylily, dogwood, eggplant, English oak, fig, forsythia, gardenia, green bean, holly, hyacinth bean, hydrangea, kiwifruit, Korean boxwood, lantana, lirioppe, lima bean, mondo grass, milo, muskmelon, oak, okra, ornamentals, peach, pepper, peony, potato, pumpkin, sage, snap bean, soybean, spinach, squash, St. Augustine grass, strawberry, sweet potato, tobacco, tomato, tube rose, watermelon, white clover, zoysiagrass	Schmitt and Barker, 1988
55	<i>M. javanica</i>	Boxwood, southern peas, soybean, sweet potato, tobacco, tomato	Schmitt and Barker, 1988
56	<i>M. marylandi</i>	Bermuda grass, creeping bentgrass, creeping grasses	Ye et al., 2015b
57	<i>M. megatyla</i>	Loblolly pine	Baldwin and Sasser, 1979
58	<i>M. naasi</i>	Bermuda grass, creeping bentgrass, creeping grasses	Zeng et al., 2012b; Ye et al., 2015b
60	<i>M. spatinae</i>	Smooth cordgrass	Rau and Fassuliotis, 1965
61	<i>Mesoanguina plantaginis</i>	Bracted plantain	Vargas and Sasser, 1976
62	<i>Mesocriconema curvatum</i>	Bermuda grass, creeping bentgrass, creeping grasses, soybean	Zeng et al., 2012b
63	<i>M. ornatum</i>	Corn, blueberry, grasses, ornamentals, peanut	Ratanaworabhan and Smart, 1970; Barker et al., 1982; Schmitt and Barker, 1988; Powers et al., 2004; Jagdale et al., 2013
64	<i>M. sphaerocephalum</i>	Corn, peanut	López et al., 2012; Zeng et al., 2012b
65	<i>M. xenoplax</i>	Bermuda grass, Chinese holly, creeping bentgrass, ornamentals, peach	Aycock et al., 1976; Zeng et al., 2012b; Powers et al., 2004
66	<i>Nanidorus minor</i>	American holly, azalea, bentgrass, bermuda grass, boxwood, camellia, centipede grass, Chinese holly, corn, cotton, creeping bentgrass, holly, loblolly pine, longleaf pine, ornamentals, peach, peanut, slash pine, soybean, tall fescue, tobacco, white clover	Schmitt and Barker, 1988; Zeng et al., 2012b; Huang et al., 2018
67	<i>Ogma floridense</i>	Bermuda grass	Zeng et al., 2012b
68	<i>Paratrichodorus allius</i>	Creeping bentgrass	Zeng et al., 2012b
69	<i>P. porosus</i>	Camellia, corn, sorghum, soybean	Huang et al., 2018
70	<i>Paratylenchus goldeni</i>	Boxwood, centipede grass	Raski, 1975; Zeng et al., 2012b
71	<i>Pratylenchus brachyurus</i>	Cotton, peach, peanut, soybean, tobacco	Schmitt and Barker, 1988
72	<i>P. coffeae</i>	Peach	Grand, 1985
73	<i>P. macrostylus</i>	Fraser fir, red spruce	Hartman and Eisenback, 1991

74	<i>P. penetrans</i>	Bermuda grass, boxwood, peach, potato, soybean, tobacco	Grand, 1985; Zeng et al., 2012b
75	<i>P. pratensis</i>	Cotton, ornamentals, potato, tobacco	Steiner, 1938; Grand, 1985
76	<i>P. scribneri</i>	Common bean, peach, soybean, tobacco	Grand, 1985
77	<i>P. vulnus</i>	Boxwood, Chinese holly, peach	Society of Nematologists, 1984; Grand, 1985
78	<i>P. zaeae</i>	Corn, peach, tall fescue	Grand, 1985; Schmitt and Barker, 1988
79	<i>Quinisulcius capitatus</i>	Unknown	Society of Nematologists, 1984
80	<i>Rotylenchulus reniformis</i>	Cotton, sweet potato	Grand, 1985; Koenning et al., 2004
81	<i>Rotylenchus buxophilus</i>	Azalea, boxwood	Grand, 1985
82	<i>R. pumilus</i>	Trees	Ruehle, 1968
83	<i>Scutellonema brachyurus</i>	Bermuda grass, corn, cotton, tobacco	Zeng et al., 2012b
84	<i>Trichodorus elefjohnsoni</i>	Tulip poplar	Bernard, 1992
85	<i>T. obtusus</i>	Bermuda grass, St. Augustine grass, zoysiagrass	Ye et al., 2015; Huang et al., 2018
86	<i>Trophurus spp.</i>	Azalea	Grand, 1985
87	<i>Tylenchorhynchus claytoni</i>	American holly, azalea, bermuda grass, camellia, centipede grass, Chinese holly, common bean, corn, cotton, creeping bentgrass, lima bean, loblolly pine, longleaf pine, ornamentals, peach, peanut, potato, slash pine, soybean, strawberry, tall fescue, tobacco, tomato, white clover	Steiner, 1937; Ruehle and Sasser, 1962; Aycock et al., 1976; Schmitt and Barker, 1988; Zeng et al., 2012b
88	<i>T. maximus</i>	Grasses, tomato	Grand, 1985
90	<i>Xenocriconemella macrodora</i>	Boxelder maple	López et al., 2012
91	<i>Xiphinema americanum sensu lato</i>	American holly, azalea, bermuda grass, boxwood, centipede grass, Chinese holly, corn, cotton, loblolly pine, ornamentals, peach, peanut, slash pine, soybean, strawberry, sweet potato, tall fescue, tobacco, tomato	Ruehle and Sasser, 1962; Zeng et al., 2012b
92	<i>Xiphinema bakeri</i>	Bermuda grass	Zeng et al., 2012b
93	<i>Xiphinema chambersi</i>	Azalea, bermuda grass, centipede grass, ornamentals, rose, soybean	Ye, 2012; Zeng et al., 2012b
94	<i>Xiphinema krugi</i>	Bermuda grass, boxwood, cotton, ornamentals, soybean, tomato	Ye and Robbins, 2010

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