Races of the Barley Root-Knot Nematode, Meloidogyne naasi. I. Characterization by Host Preference[1]

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Abstract: The host preferences of populations of *Meloidogyne naasi* from England, California, Illinois, Kentucky and Kansas were compared. Among 22 plant species tested, most were hosts for isolates of all five populations; crabgrass was added to the list of known hosts. Differential reactions of isolates on creeping bentgrass, curly dock, sorghum, and common chickweed demonstrated the existence of at least five physiological races within *M. naasi*. The known races are numerically designated and characterized.

The barley root-knot nematode, *Meloidogyne naasi* Franklin, has been reported from various locations in the British Isles (5), Belgium (3) and the United States (4, 6, 8, 9, 10, 13). In the field, it has been associated with stunted and chlorotic barley, sorghum and creeping bentgrass. Confirmation of its pathogenic effect on these hosts in greenhouse studies (1, 2, 11) demonstrated the potential importance of *M. naasi* on cereal crops and grasses.

Thirty-nine species of plants have been reported as hosts of *M. naasi* since its description in 1965. However, conflicting reports of host status suggest that populations of *M. naasi* from different geographical areas differ in their ability to reproduce on certain plant species and that physiological races of this nematode may exist. Races are known to occur in other species of *Meloidogyne* and in the closely related genus *Heterodera* (12). This intraspecific physiological variation has led to difficulties in control of these nematodes by cultural methods.

The most clear-cut basis for differentiation of phytoparasitic nematode races has been host range differences (12). Therefore, in the present study, the host preferences of isolates from five geographical populations of *M. naasi* were compared to determine the existence of physiological races within the species.

MATERIALS AND METHODS

A field population of *M. naasi* was obtained from quackgrass, *Agropyron repens* (L.) Beauv., Berkshire County, England; barley, *Hordeum vulgare* L., Siskiyou County, Cal.; creeping bentgrass, *Agrostis palustris* Huds., DuPage County, Ill.; *A. palustris*, Kenton County, Ken.; and sorghum, *Sorghum bicolor* Moench, Leavenworth County, Kans. An isolate was established from a single egg mass from each population, increased and subcultured at 8-week intervals in the greenhouse on a common host Traill barley. To assure a readily available supply of inoculum of all isolates for simultaneous use in comparative studies, heavily infected barley roots were stored in plastic freezer bags at 10 C for up to 6 weeks.

Twenty-one reported hosts of *M. naasi* and one untested species were assessed for their relative susceptibility to the five nematode isolates. Fifteen 10-cm clay pots for each plant species were filled with a steam-pasteurized mixture of sandy loam soil and quartz sand (2:1). The following species were established from seed: *Agropyron repens* (L.) Beauv., quackgrass; *Agrostis alba* L., redtop; *A. tenuis* Sibth. 'Astoria', colonial bentgrass; *Avena sativa* L. 'Wintok', oat; *Beta vulgaris* L. 'U.S. 75', sugarbeet; *Dactylis glomerata* L., orchard grass; *Digitaria sanguinalis* (L.) Scop., hairy crabgrass; *Festuca pratensis* Huds. 'N6-95', meadow fescue; *Hordeum vulgare* L. 'Traill', barley; *Lolium multiflorum* Lam., Italian ryegrass; *L. perenne* L., perennial ryegrass; *Oryzae sativa* L. 'Stripe 36', rice; *Plantago lanceolata* L., buckhorn; *Poa annua* L., annual bluegrass; *P.*

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pratensis L. 'Fylking', Kentucky bluegrass; *P. trivialis* L., rough bluegrass; *Rumex crispus* L., curly dock; *Secale cereale* L. 'Balboa', rye; *Sorghum bicolor* Moench 'RS-610', sorghum; *Stellaria media* (L.) Vill., common chickweed; and *Triticum aestivum* L. 'Pawnee', wheat. Seeds were planted at variable times so that all plants emerged within a 1-week period. After emergence, seedlings were thinned to one/pot. Creeping bentgrass, *Agrostis palustris* Huds. 'Toronto C-15', was established from one single-node stolon cutting/pot.

Second-stage *M. naasi* larvae, mist-extracted from roots, were disinfested in 100 ppm phenyl mercuric acetate for 15 min and rinsed three times in sterile distilled water. Three weeks after plant emergence, each of three pots of each species for each nematode isolate was inoculated with a 10-ml aqueous suspension of 2000 larvae. Nematodes were evenly distributed on the soil surface around each plant, a technique which in preliminary studies resulted in infection equivalent to inoculating the root zone. Pots were arranged randomly on a greenhouse bench with an average ambient temperature of 24 C. Fifty days after inoculation, roots were washed free of soil and entire root systems examined under a dissecting microscope. Host status was considered positive when mature females with egg masses were detected in the roots.

To confirm isolate-differentiating reactions observed in the first experiment, creeping bentgrass, chickweed, curly dock and sorghum were reassessed. Procedures were the same, except that four pots of each plant species were inoculated with 4000 larvae for each nematode isolate and roots were stained with 0.1% acid fuchsin in lactophenol prior to examination to accentuate nematodes and egg masses.

RESULTS

All plant species tested except buckhorn proved to be hosts of at least one isolate of *M. naasi* (Table 1). Crabgrass was established as a new host. Most species were positive for all five isolates, but isolates could be separated distinctly by their reactions on creeping bentgrass, sugarbeet, curly dock, sorghum and common chickweed. Based on number of egg masses produced, several other species demonstrated differences in degree of host suitability, but the differences were not considered useful in differentiating races. When roots were indexed for both galling and egg mass production, the two parameters generally were in close agreement. The only exception was the reaction of the Kansas isolate on

TABLE 1. Host status of 22 plant species for five populations of *Meloidogyne naasi* from different geographical locations.

Scientific name	Common name	Isolate				
		England	California	Illinois	Kentucky	Kansas
Agropyron repens	Quackgrass	+[a]	+	+	+	+
Agrostis alba	Redtop	+	+	+	+	+
A. palustris 'Toronto C-15'	Creeping bentgrass	–	–	+	+	+
A. tenuis 'Astoria'	Colonial bentgrass	+	+	+	+	+
Avena sativa 'Wintok'	Oat	+	+	+	+	+
Beta vulgaris 'U.S. 75'	Sugarbeet	+	+	+	+	–
Dactylis glomerata	Orchard grass	+	+	+	+	+
Digitaria sanguinalis	Hairy crabgrass	+	+	+	+	+
Festuca pratensis 'N6-95'	Meadow fescue	+	+	+	+	+
Hordeum vulgare 'Traill'	Barley	+	+	+	+	+
Lolium multiflorum	Italian ryegrass	+	+	+	+	+
L. perenne	Perennial ryegrass	+	+	+	+	+
Oryzae sativa 'Stripe 36'	Rice	+	+	+	+	+
Plantago lanceolata	Buckhorn	–	–	–	–	–
Poa annua	Annual bluegrass	+	+	+	+	+
P. pratensis 'Fylking'	Kentucky bluegrass	+	+	+	+	+
P. trivialis	Rough bluegrass	+	+	+	+	+
Rumex crispus	Curly dock	–	+	+	–	+
Secale cereale 'Balboa'	Rye	+	+	+	+	+
Sorghum bicolor 'RS-610'	Sorghum	–	–	–	–	+
Stellaria media	Common chickweed	+	–	–	–	–
Triticum aestivum 'Pawnee'	Wheat	+	+	+	+	+

[a] + = host and – = nonhost, based on the presence or absence of egg masses, 50 days after inoculation.

TABLE 2. Differentiation of races of *Meloidogyne naasi* by reaction on four plant species.

Race		Host status of key plant species[a]			
No.	Location	Curly dock	Sorghum 'RS-610'	Creeping bentgrass 'Toronto C-15'	Common chickweed[b]
1	Berkshire Co., England	–	–	–	+
2	Siskiyou Co., Cal.	+	–	–	+
3	DuPage Co., Ill.	+	–	+	+
4	Kenton Co., Ken.	–	–	+	+
5	Leavenworth Co., Kan.	+	+	+	–

[a]+ = host and – = nonhost, based on presence or absence of egg masses, 50 days after inoculation.
[b]Supplemental host key species only; not reliable at low nematode densities.

sugarbeet where there were many large galls, none of which contained nematodes.

Isolate-differentiating reactions on plant species tested earlier were confirmed in the second experiment (Table 2). Creeping bentgrass was a host for the Illinois, Kentucky and Kansas isolates; curly dock for the Illinois, Kansas and California isolates; and sorghum for the Kansas isolate alone. However, a somewhat different reaction occurred on common chickweed; the root system developed very slowly and may have escaped infection in the first test, where it was rated as a host only for the England isolate. With an increase in inoculum in the second test, a few egg masses were detected in chickweed roots in one or more pots of the Illinois, Kentucky and California isolates.

DISCUSSION

Reactions of the five isolates of *M. naasi* on certain plant species confirmed that populations from diverse geographical origins differ in their host range. These findings demonstrate the existence of at least five physiological races within *M. naasi*. The distribution of the barley root-knot nematode may be more widespread than has been reported, since the galls produced on most susceptible plants are small and easily overlooked. As a result, additional races with further differences in host preferences may exist within this species.

Essentially following the methods of characterization suggested by Golden et al. (7) for races of *Heterodera glycines*, the known races of *M. naasi* are designated as follows: 1 = England; 2 = California; 3 = Illinois; 4 = Kentucky; and 5 = Kansas. The five races may be differentiated by their reaction on Toronto C-15 creeping bentgrass, curly dock and RS-610 sorghum as presented in Table 2. Although unreliable at low nematode densities, common chickweed is included as a supplemental plant species. In the event that additional races exist, this species along with others from Table 1 may be useful in comparing populations of *M. naasi*.

The existence of races of the barley root-knot nematode creates problems relating to nonchemical control measures. Caution must be exercised in making crop rotation and weed control recommendations for one population based on the host range of another. Moreover, if breeding for plant resistance to *M. naasi* becomes necessary, the importance of screening breeding lines against more than one population is obvious.

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