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Rangeland Grasses as Hosts of *Meloidogyne chitwoodi*[1]

G. D. Griffin,[2] R. N. Inserra,[3] and N. Vovlas[4]

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Several plant-parasitic nematodes are known to reduce pasture and rangeland productivity (1). Among the endoparasitic nematodes found associated with grasses in the United States, *Meloidogyne* spp. and *Pratylenchus* spp. are the most aggressive (1). Recently, *M. chitwoodi* Golden et al. was shown to parasitize barnyardgrass (*Echinochloa crus-galli* [L.] Beauv.), downy bromegrass (*Bromus tectorum* L.), lovegrass (*Eragrostis orcuttiana* Vasey), meadow fescue (*Festuca arundinacea* Schub.), and orchardgrass (*Dactylis glomerata* L.) (4). However, it is not known if range grasses are also attacked by this parasite. The objectives of this study were to determine the response of seven grass species to *M. chitwoodi.*

Meloidogyne chitwoodi was obtained from potato (*Solanum tuberosum* L.) collected in Idaho and maintained on tomato (*Lycopersicon esculentum* Mill. cv. California Pack) in a greenhouse. Inoculum was recovered by extracting eggs and juveniles (J2) from infected tomato roots with a NaOCl method (2). Pregerminated seeds of seven grass species were sown in individual 7-cm-d plastic pots containing 600 cm^3 of methylbromide treated sandy loam soil (72% sand, 18% silt, 10% clay). Three weeks later the soil was inoculated with 5,000 eggs/container. Eggs were introduced into the soil by pouring 12 ml of an aqueous suspension into five holes, each 5 cm deep, around the base of each seedling. 'Nugaines' wheat (*Triticum aestivum* L.), a good host for *M. chitwoodi* (4), was included as a control. Treatments were replicated 10 times. Plants were randomized and grown in a growth chamber at 25 ± 2 C, which is favorable for nematode infection and re-

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[1] Cooperative investigation, USDA ARS, and the Utah Agricultural Experiment Station. Journal paper No. 2930.
[2] Nematologist, USDA ARS, Crops Research Laboratory, Logan, UT 84322.
[3] Nematologist, Crops Research Laboratory, Utah State University, Logan, UT 84322.
[4] Nematologist, Istituto Nematologia Agraria CNR, 70126 Bari, Italy.

TABLE 1. Reaction of grass species to *Meloidogyne chitwoodi* after growing for 75 days in a growth chamber.*

Common name	Scientific name	Eggs/gram fresh roots†	Percent susceptible plants
'Barton' western wheatgrass	*Pascopyrum smithii* (Rydb.) Löve	14,805 a	70
Bluebunch wheatgrass	*Pseudoroegneria spicata* (Pursh) Löve	0 a	0
Great Basin wild ryegrass	*Leymus cinereus* (Scribn. & Merr.) A. Löve	548 a	14
Intermediate wheatgrass	*Elytrigia intermedia* (Host) Nevski	0 a	0
'Nordan' standard crested wheatgrass	*Agropyron desertorum* (Fisch. ex Link) Schult.	14,193 a	47
Orchardgrass	*Dactylis glomerata* L.	47,523 b	100
Smooth bromegrass	*Bromus inermis* Leyss.	12,193 a	82
'Nugaines' winter wheat	*Triticum aestivum* L.	69,444 b	100

* Each plant was inoculated with 5,000 eggs.
† Values are mean of 10 replicates. Column means followed by the same letters are not statistically different according to Duncan's multiple-range test ($P = 0.01$).

production (6). Plants were watered daily, fertilized monthly, and harvested 75 days after soil infestation. Roots were carefully removed and washed free of soil. Eggs were extracted from roots by the NaOCl method (2), and the number of eggs per gram of fresh roots was calculated. Data were subjected to analysis of variance and mean comparisons made with Duncan's multiple-range test.

A few selected roots of each grass species that supported *M. chitwoodi* were used for histological examination. Root segments were fixed in FAA, dehydrated in tertiary butyl alcohol series, and embedded in paraffin. Sections 10–15 μm thick were stained with safranin and fast-green, mounted in Dammar xylene, and observed under a compound microscope (3).

Meloidogyne chitwoodi reproduced on five of the seven grass species tested (Table 1). Orchardgrass had the highest rate of nematode reproduction which did not differ ($P = 0.01$) from that of Nugaines wheat. Significantly ($P = 0.01$) fewer eggs were recovered from 'Barton' western wheatgrass, Great Basin wild ryegrass, 'Nordan' standard crested wheatgrass, and smooth bromegrass than from orchardgrass. No reproduction was observed on bluebunch wheatgrass and intermediate wheatgrass. The genetic heterogeneity within the cross-pollinated grasses of Barton western wheatgrass, Great Basin wild ryegrass, Nordan standard crested wheatgrass, and smooth bromegrass may have accounted for the variation observed in nematode reproduction. This variability among plants within each of these grass species resulted in the large error in the analysis of variance and explains why differences in nematode reproduction were not significant. According to an index developed by O'Bannon et al. for other hosts of *M. chitwoodi* (4), orchardgrass was considered a very good host of *M. chitwoodi*; Barton western wheatgrass, Nordan standard crested wheatgrass, and smooth bromegrass were good hosts; Great Basin wild ryegrass was a poor host; and bluebunch wheatgrass and intermediate wheatgrass were nonhosts of the Columbia root-knot nematode. Infected roots of the susceptible grasses had very small galls that were easily overlooked. Only galls on roots of the Great Basin wild ryegrass were readily evident and extended from the root tip along the root axis.

Histological examination of grass root sections infected with *M. chitwoodi* revealed fragmentation, obliteration, and asymmetry of the stele caused by the formation of giant cells (Fig. 1A, C, D, F). Abnormal proliferation of lateral roots was common (Fig. 1B, E). The giant cells showed dense and granular cytoplasm and hypertrophied nuclei and nucleoli (Fig. 1C–E). The swollen females in some cases occupied the entire cross section of the root, thereby apparently inhibiting normal vascular movement of water, minerals, and photo-

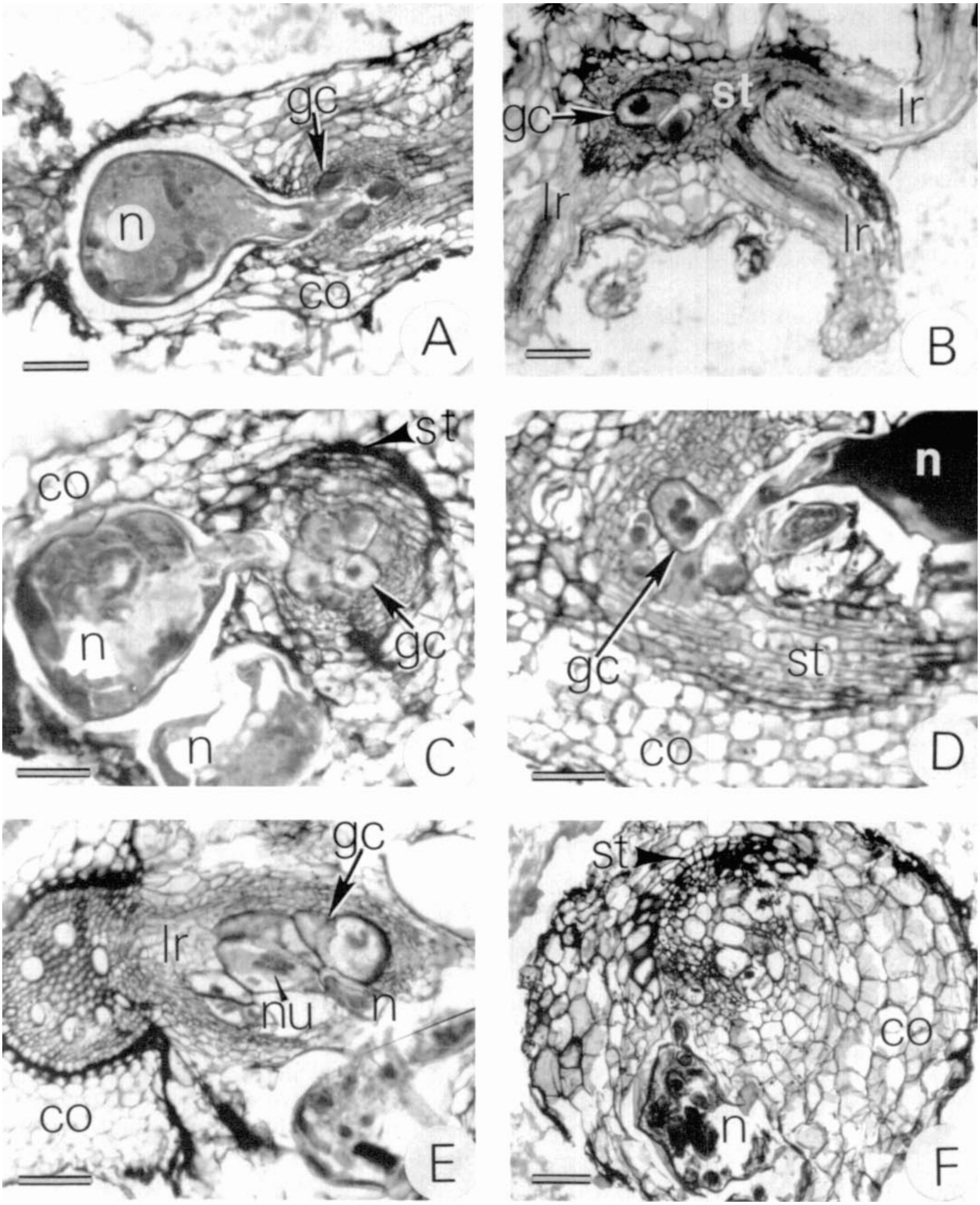

FIG. 1. Anatomical changes induced by *Meloidogyne chitwoodi* on rangeland grass roots. A) Longitudinal root section of *Dactylis glomerata* showing a swollen female nematode (n) occupying the entire root section. Giant cells (gc) are visible at the nematode feeding site. co = cortex. B) Cross section of *D. glomerata* showing lateral root (lr) proliferation in relation to the giant cells (gc). st = stele. C) Cross section of *Pascopyrum smithii* cv. Barton showing two swollen females (n) embedded in the cortex (co). Giant cells (gc) have partially obliterated the stele (st). D) Longitudinal section of *Bromus inermis* with a female (n) in the cortex (co) and giant cells (gc) in the stele (st). E) Cross section of *Agropyron desertorum* cv. Nordan showing giant cells (gc) with hypertrophic nuclei and nucleoli (nu) in the stele of a lateral root (lr). co = cortex; n = nematode. F) Cross section of *Leymus cinereus* cv. Great Basin showing a nematode female (n) embedded in the cortex (co) and asymmetry of the stele (st). A–F) Scale bars = 100 μm.

synthesis products (Fig. 1A, C). Lateral roots were also attacked by the nematode, resulting in the formation of giant cells (Fig. 1E).

Some forage grasses such as Great Basin wild ryegrass and Nordan standard crested wheatgrass are economically important because of their adaptation to grazing and environmental stress. These tests show that these forage grasses are hosts of *M. chitwoodi.*

As reported for other *Meloidogyne* species (7), infection by *M. chitwoodi* may increase host sensitivity to drought by obliterating, compressing, or interrupting the host vascular system. The frequency of resistant plants within the species tested suggests, however, that it should be possible to obtain resistant germplasm of most of the grasses studied. *Meloidogyne chitwoodi* appears to be widespread in the Pacific northwest on several economically important crops, but no attempt has yet been made to determine the incidence of this nematode on native plants. Infested irrigation and run off water may be involved in the dissemination of this nematode in Idaho, Oregon, and Washington where canal and river water is usually reused (5).

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