IMPORTANCE OF SOIL TEXTURE TO THE PATHOGENICITY OF PLANT-PARASITIC NEMATODES ON RANGELAND GRASSES[†]

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ABSTRACT

Griffin, G. D. 1996. Importance of soil texture to the pathogenicity of plant-parasitic nematodes on rangeland grasses. Nematropica 26:27-37.

In greenhouse experiments at 26±3°C, soil texture affected the host-parasite relationship of 4 nematode species on crested wheatgrasses, Russian wildrye, intermediate wheatgrass, and Snake River wheatgrass. *Pratylenchus neglectus* was least affected by soil texture but was the most pathogenic of the species examined. *Xiphinema americanum* was most affected by soil texture and was the least pathogenic, reducing ($P \leq 0.05$) plant growth only in sandy soil. *Pratylenchus neglectus* reduced plant growth in clay, clay-sand and sandy soils, whereas *Merlinius brevidens*, and *Tylenchorhynchus acutus* reduced ($P \leq 0.05$) plant growth in clay-sand and sandy loam soils. The pathogenicity and reproduction of the 3 nematode species were greatest in sandy loam soil. Reproduction was highest for *P. neglectus*, while *X. americanum* failed to increase in any soil texture. 'Hycrest' crested wheatgrass was more tolerant of nematode invasion, attained the greatest plant growth, and exhibited some degree of tolerance and resistance to all nematode species. Shoot and root growth in 5 soil textures were negatively correlated with the percentage of sand. Reproduction of all nematode species was less in clay loam than in sandy loam soils.

Key words: *Agropyron desertorum*, *A. cristatum*, *Elymus lanceolatus*, Greenar, ectoparasitic nematodes, Fairway, Hycrest, *Merlinius brevidens*, Nordan, pathogenicity, *Pratylenchus neglectus*, *Psathyrostachys juncea*, reproductive index, root lesion nematode, Secar, Syn A, *Thinopyrum intermedium*, *Tylenchorhynchus acutus*, *Xiphinema americanum*.

RESUMEN

Griffin, G. D. 1996. Importancia de la texura del suelo en la patogenicidad de nematodos párasitos de plantas en terrenos de pastos silvestres. Nematrópica 26:27-37.

Estudios realizados en invernadero a 23±3°C mostraron que la textura del suelo afectó la relacion parásito-hospedante de cuatro especies de nematodos asociados a *Agropyron cristatum* cv. "Gycrest" y "Fairway", *Psathyrostachys juncea* cv. "Syn A", *Thinopyrum intermedium* cv. "Greenar", y *Elymus lanceolatus* cv. "Secar". *Pratylenchus neglectus* fue el menos afectado y resultó a la vez la especie mas patogénica de todas las estudiadas. Por el contrario, *Xiphinema americanum* fue la mas afectada por la textura pero a la vez la menos patogénica, reduciendo ($P \leq 0.05$) el crecimiento de la planta solo en suelos arenosos. *Pratylenchus neglectus* redujo el crecimiento de la planta en suelos de arcilla, arcilla-arena y arenosos mientras que *Merlinium brevidens* y *Tylenchorhynchus acutus* afectaron este indicador ($P \leq 0.05$) en suelos arena-arcilla y en suelo suelto arenoso. Las tres especies de nematodos, mostraron una mayor patogenicidad y capacidad de reproducción en suelo suelto arenoso. *P. neglectus* tuvo el mayor índice de

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reproducción mientras que la población de *X. americanum* no pudo ser incrementada en ninguno de los suelos ensayados. Hycrest fue la hierba más tolerante a la invasión por nematodos ya que logró el mayor crecimento, y en gereral mostró un mayor grado de tolerancia y resistencia hacia todas las especies de nematodos. El crecimiento de la parte superior de la planta y de las raíces, en cinco suelos con diferente textura, estuvo negativamente correlacionado con el porcentaje de arena presente en los mismos. La reproducción de todas las especies de nematodos fue menor en suelos de arcilla suelta que en suelo suelto arenoso.

Palabras clave: Agropyron desertorum, A. cristatum, Elymus, Radopholus similis, Xiphinema spp.

INTRODUCTION

Several genera of plant-parasitic nematodes associated with rangeland grasses in prairie and rangelands of the United States (Griffin *et al.*, 1996; Norton and Schmitt, 1978; Orr and Dickerson, 1967; Thorne, 1974; Thorne and Malek, 1968) are implicated in stand reduction, reduced growth, and low productivity of grasses (Griffin, 1992; Griffin and Asay, 1989; Griffin and Asay, 1996a; Ingham and Detling, 1984) and may contribute to the poor quality of some rangelands (Schmautz *et al.*, 1980). The relationships between nematodes and plants are affected by nematode reproductive potential, biological activity of the nematode, and growth of plant tissue necessary for nematode metabolic activity (Griffin, 1984). Recent studies documented differences in pathogenicity of some parasitic nematodes on grasses as well as differences in the tolerance of some grasses to nematode invasion (Griffin, 1992; Griffin and Asay, 1996a).

Environmental conditions are known to affect the host-parasite relationship between plants and nematodes (Freckman *et al.*, 1979; Griffin, 1984; Nickle, 1984; Ponchillia, 1972; Smolik and Lewis, 1982). To further investigate the major impact of the environment on the relationships between plant-parasitic nematodes and the growth and persistence of rangeland grasses, field and greenhouse studies were conducted to determine the importance of soil texture to the nematode-plant relationship for 3 ectoparasitic nematode species and crested wheatgrasses.

MATERIALS AND METHODS

Grass cultivars: Grasses in field and greenhouse studies are cultivars being used to improve conditions of western rangelands (Asay and Knowles, 1985; Asay *et al.*, 1985). They were 'Hycrest' crested wheatgrass (*Agropyron cristatum* [L.] Gaertner × *A. desertorum* [Fisch. ex Link] Schult), 'Fairway' crested wheatgrass (*A. cristatum*), 'Nordan' crested wheatgrass (*A. desertorum*), 'Synthetic A' (Syn A) Russian Wildrye (*Psathyrostachys juncea* (Fischer) Nevski), 'Greenar' intermediate wheatgrass (*Thinopyrum intermedium* Host), and 'Secar' Snake River wheatgrass (*Elymus lanceolatus* (Scribner and Smith) Gould (a grass resembling bluebunch wheatgrass) (Asay and Knowles, 1985; Asay *et al.*, 1985).

Field experiment: A preliminary chemical control study was conducted at Blue Creek, Utah, U.S.A., to determine the relationship of plant-parasitic nematodes on the growth and yield of rangeland grasses in the intermountain region. Field plots of Kearns fine silty loam soil (Table 1) infested with plant-parasitic nematodes were selected for the study. *Merlinius brevidens* (Allen) Siddiqi, *Pratylenchus neglectus* (Rensch) Filipjév & Schuurmans Stekhoven, *Tylenchorhynchus acutus* Allen and *Xiphinema americanum* Cobb were the major species and maximum populations

Table 1. Locations and classifications of soil textures used in experimental studies.

Location and soil texture	Percent by hydrometer				
	Sand	Silt	Clay	O. M.[z]	pH
THIOKOL, UT	19	65	16	3.2	7.9
(Thiokol fine silt loam soil; mixed mesic Xerollic Calciorthids)					
BLUE CREEK, UT	32	55	13	2.3	7.5
(Kearns fine silt loam soil; mixed mesic Calcic Haploxerolls)					
LOGAN, UT	27	31	42	2.5	7.8
(Logan fine silt loam soil; mixed mesic Typic Calciaquolls)					
LOGAN, UT	36	47	17	2.9	7.9
(Ricks sandy loam soil; sandy skeletal Calcic Haploxerolls)					
FARMINGTON, UT	60	24	16	2.0	7.9
(Timpanogas fine loam soil; mixed mesic Typic Argiustolls)					
CORNISH, UT	84	08	08	1.0	7.4
(Kidman fine sandy loam soil; coarse-loamy mixed mesic Calcic Haploxeroll)					

[z]Percent organic matter.

of 1.0-2.0 nematodes/cm^3 soil were found. Other genera including *Helicotylenchus* and *Paratylenchus* were found in lesser numbers. Plots were treated with preplant applications of the broad spectrum biocide, methyl bromide, or the nematicides, aldicarb and phenamiphos. Methyl bromide was applied under plastic at 0.5 kg/ 9.3 m^3 soil, whereas aldicarb and phenamiphos were applied as broadcast treatments at 9.0 kg a.i./ha and incorporated in the soil to a depth of 5.0 cm. Hycrest, Syn A, Greenar, and Secar grasses were planted in 4 rows on treated and untreated plots on 60 cm centers, 30 m long. Treatments were replicated 4 times in a randomized block design. Plots were fertilized with a 20-20-20 fertilizer to eliminate effects of a possible nutrient flush in treated plots. Dry shoot growth was harvested 240 days after sowing and data were analyzed with ANOVA and means were separated by Duncan's new multiple range test.

Greenhouse nematode inocula: Four plant-parasitic nematode species commonly associated with rangeland grasses in the intermountain region of the United States were used in the greenhouse studies. Root lesion nematode, *Pratylenchus neglectus*, inoculum was obtained originally from a western wheatgrass, *Pascopyrum smithii* (Rydb.) Love, planting in northern Utah and was cultured on western wheatgrass in the greenhouse. All stages of *P. neglectus* were extracted from grass roots with a modified mist chamber. The ectoparasitic nematodes, *M. brevidens*, *T. acutus*, and *X. americanum*, were extracted from a western wheatgrass planting in northern Utah with elutriation and sugar flotation (Byrd *et al.*, 1976; Jenkins, 1964). Nematode species were separated with a micropipette. All nematodes were surface sterilized with solutions of streptomycin and gentamycin aretan and were rinsed several times with distilled water prior to inoculation (Griffin and Gray, 1990). The inoculum was 98-100% pure and free from other plant-parasitic nematodes.

Greenhouse experiment 1: An initial study was conducted to determine the general effects of soil texture on host-parasite relationships of nematodes to grasses. Thirty-day-old seedlings (3-6 mm radicle) of crested wheatgrass cultivars Hycrest, Fairway, or Nordan were planted into 16-cm-diam plastic containers (one plant per container) containing 2 500 cm^3 steam sterilized Logan fine silty loam soil, Kidman fine sandy loam soil, or a 1:1 mixture of the 2 soils (Table 1). After 30 days growth, grasses were inoculated with mixed stages of *P. neglectus*, *M. brevidens*, *T. acutus*, or *X. americanum* at Pi 0 or 1.0 nematode/cm^3 soil. Nematodes in an aqueous suspension of deionized water were poured into 4 holes 10-cm-deep in the soil around the base of each plant. Uninoculated controls received only deionized water. Containers were maintained at a greenhouse temperature of 26±3°C. Supplemental light for a 19-hr daylength was provided by high-output fluorescent lamps. The experiment was a 4 × 3 × 3 × 2 factorial (4 nematode species × 3 grass species × 3 soil textures × 2 inoculum densities) in a randomized complete block design with 20 replications. Plants were watered daily and fertilized monthly with a general purpose fertilizer (20-20-20). Shoots were clipped and weighed 60 and 120 days after inoculation. The experiment was terminated at 120 days and cumulative shoot weights, root weights, and nematode reproductive factors (Pf = final nematode population divided by initial nematode inoculum) were determined. Nematodes were extracted from the soil by elutriation (Byrd *et al.*, 1976) and sugar flotation (Jenkins, 1964). Root lesion nematodes also were extracted from grass roots with a modified Baermann funnel technique (Griffin and Gray, 1990). Data were recorded and analyzed using ANOVA and linear regression.

Greenhouse experiment 2: A second greenhouse experiment was conducted to determine whether soil textures from different regions of Utah (Table 1) affected the pathogenicity of nematodes to different western grass species (Logan fine silty soil, Table 1, was not included in the study). Thirty-day-old seedlings (3-6 mm radicle) of Hycrest, Syn A, Greenar, and Secar were planted and inoculated as described in greenhouse experiment 1. Containers were maintained at a greenhouse temperature of 26±3°C. The experiment was a 4 × 4 × 5 × 2 factorial (4 nematode species × 4 grass species × 5 soil textures × 2 inoculum densities) in a randomized complete block design with 20 replications (1 plant per container). Shoots were clipped 60, 130, and 200 days after inoculation. The experiment was terminated after 200 days and combined shoot clipping weights, root weights, and nematode reproductive factors were determined. Terminal nematode populations were determined and analyzed in the manner outlined previously.

RESULTS

Field experiment: There was a significant increase ($P \leq 0.05$) in the growth of all grass cultivars in soil treated with methyl bromide, aldicarb, and phenamiphos (Table 2). The greatest plant growth occurred in the methyl bromide treatment; there were no differences in plant growth between the soils treated with aldicarb and phenamiphos. Dry shoot weights from soil treated with methyl bromide, aldicarb, and phenamiphos treatments increased by 104, 48, and 43%, respec-

Table 2. Effect of biocides on the growth of rangeland grasses in Kearns fine silty loam soil infested with plant-parasitic genera, *Helicotylenchus, Merlinius, Paratylenchus, Pratylenchus, Tylenchorhynchus,* and *Xiphinema.*

Treatments (biocide)[Z]	Dry shoot weight (g)[Y]			
	Hycrest	Syn A	Greenar	Secar
Methyl bromide	296 a	172 a	258 a	167 a
Aldicarb	215 b	126 b	217 b	128 b
Phenamiphos	208 b	117 b	212 b	116 b
Untreated control	145 c	79 c	102 c	69 c

[Y]Each value is the mean of 4 replicates. Plants grown on 60-cm centers in 4-row plots, 30-m long. Dry shoot weights were obtained after 240 days. Means within cultivars not followed by the same letter differ ($P \leq 0.05$) according to Duncan's new multiple range test.
[Z]Methyl bromide was applied under plastic at 0.5 kg/9.3 m^3. Aldicarb and phenamiphos were applied as broadcast treatments and incorporated to a depth of 5.0 cm immediately before planting.

tively, for Hycrest, 118, 59, and 48% for Syn A, 153, 113, and 108% for Greenar, and 143, 86, and 68% for Secar compared to their respective untreated plots.

Greenhouse experiment 1: Soil texture affected the host-parasite relationship of all nematode species on the grasses. In terms of shoot weight, nematodes were most pathogenic in Kidman fine sandy loam (Table 3). The pathogenicity of *P. neglectus* was least affected by soil texture, and the lesion nematode reduced plant weight more ($P \leq 0.05$) than *M. brevidens, T. acutus,* or *X. americanum. Pratylenchus neglectus* reduced shoot growth of all 3 grasses in Logan fine silty soil, Kidman fine sandy loam soil, and a combination of the 2 soils. *Merlinius brevidens* and *T. acutus* reduced dry shoot weight of Fairway and Nordan in the 3 types of soil and reduced the dry shoot weight of Hycrest in Kidman fine sandy loam and the combined soils. *Xiphinema americanum,* the least pathogenic of the 4 nematode species, reduced the dry shoot weight of Hycrest in Kidman fine sandy loam, and Fairway and Nordan in Kidman fine sandy loam and the combined soils. Dry roots weighed less than did the dry shoot weights. The greatest reduction in root growth occurred in Kidman fine sandy loam soil, and root growth was least affected in Logan fine silty soil.

Reproduction (Rf) of *P. neglectus* and *X. americanum* was unaffected by soil texture, whereas reproduction of *M. brevidens* and *T. acutus* was greatest ($P \leq 0.05$) in the Kidman fine sandy loam soil (Table 4). *Pratylenchus neglectus* reproduced the most while *X. americanum* did not increase in any soil texture on any cultivar and declined by 70% on Hycrest in Logan fine silty soil.

There were significant negative correlations between percent sand of the soils and shoot growth ($r = -0.78$) and root growth ($r = -0.64$). Also, a negative correlation was found between Rf and shoot growth ($r = -0.84$) and root growth ($r = -076$). Hycrest was the most tolerant of the 3 plant cultivars, attained the greatest plant growth, and exhibited the smallest reproductive index to the 4 nematode species.

Greenhouse experiment 2: Data were similar to that obtained in Experiment 1. *Pratylenchus neglectus* was the most pathogenic, and *X. americanum* was the least pathogenic

Table 3. Effect of soil texture on the pathogenicity of 4 plant-parasitic nematode species to dry shoot and root weights of Hycrest, Fairway, and Nordan crested wheatgrass cultivars at a greenhouse temperature of 26±3°C.[V,W]

Cultivar and nematode species	Soil texture					
	Silt[X]	Silt-Sand[Y]	Sand[Z]	Silt[X]	Silt-Sand[Y]	Sand[Z]
	Dry shoot weight (g)			Dry root weight (g)		
Hycrest						
P. neglectus	1.22 bA	1.23 cA	1.12 cB	0.83 cA	0.85 bA	0.76 cA
M. brevidens	1.97 aA	1.78 bA	1.21 cB	1.13 bA	0.94 bB	0.86 bcB
T. acutus	1.98 aA	1.85 bA	1.33 cB	1.12 bA	0.96 bB	0.89 bB
X. americanum	2.09 aA	2.07 aA	1.71 bB	1.28 aA	1.20 aA	0.95 bB
Control	2.12 aA	2.18 aA	2.16 aA	1.29 aA	1.27 aA	1.28 aA
Fairway						
P. neglectus	0.87 dA	0.85 dA	0.77 cA	0.66 cA	0.67 bA	0.59 cA
M. brevidens	1.37 cA	1.21 cA	0.79 cB	0.83 bA	0.77 bAB	0.70 cB
T. acutus	1.40 cA	1.25 cB	0.85 cC	0.86 bA	0.76 bB	0.72 cB
X. americanum	1.66 bA	1.44 bB	1.18 bC	1.15 aA	1.09 aA	0.92 bB
Control	1.87 aA	1.72 aA	1.79 aA	1.14 aA	1.12 aA	1.17 aA
Nordan						
P. neglectus	0.88 cA	0.83 dA	0.74 cA	0.55 cA	0.52 cA	0.48 cA
M. brevidens	1.28 bA	1.14 cA	0.74 cB	0.74 bA	0.69 bAB	0.61 bB
T. acutus	1.33 bA	1.19 cB	0.68 cC	0.76 bA	0.69 bAB	0.63 bB
X. americanum	1.62 aA	1.43 bB	0.87 bC	0.88 aA	0.86 aA	0.66 bB
Control	1.68 aA	1.61 aA	1.62 aA	0.90 aA	0.89 aA	0.88 aA

[V]Each value is the mean of 20 replicates (1 plant/replicate). Means within cultivars and weight categories not followed by the same letter differ ($P \leq 0.05$) according to Duncan's new multiple range test. Lower case letters refer to columns, capital letters refer to rows.
[W]Plants were inoculated at 30 days with Pi or 1.0 nematode/cm^3 soil and grown for 120 days after inoculation. Combined dry shoot weights from clippings were harvested 60 and 120 days after inoculation.
[X]Logan fine silt soil (mixed mesic Typic Calciaquolls [27% sand, 31% silt, 42% clay; OM 2.5%, pH 7.8]).
[Y]1:1 mixture Logan fine silt soil and Kidman fine sandy loam soil.
[Z]Kidman fine sandy loam soil [coarse-loamy mixed mesic Calcic Haploxeroll (84% sand, 8% silt, 8% clay; 1.0% OM, pH 7.4)].

of the 4 nematode species. All nematode species were more pathogenic in the a Kidman sandy loam and the Timpanogas fine loamy soil than in the Thiokol or Kearns fine silty loam soils or the Logan fine silty soil (Figs. 1 & 2). There were negative correlations between shoot (r=-0.76) and root growth (r=-0.69) and percentage of sand in the 5 soils. Shoot and root growth were least suppressed in Thiokol fine silty loam soil and were suppressed most in Kidman fine sandy loam soil. Soil texture also

Table 4. Effect of soil texture on reproduction of 4 plant-parasitic nematode species on Hycrest, Fairway, and Nordan crested wheatgrass cultivars at a greenhouse temperature of 26±3°C.[U,V,W]

Cultivar and nematode species	Soil texture		
	Silt[X]	Silt-Sand[Y]	Sand[Z]
Hycrest			
P. neglectus	3.1 cA	3.4 cA	3.8 cA
M. brevidens	0.8 bA	1.1 bAB	1.4 bB
T. acutus	0.9 bA	1.2 bA	1.3 bA
X. americanum	0.3 aA	0.5 aA	0.5 aA
Fairway			
P. neglectus	4.9 cA	4.8 cA	5.2 cA
M. brevidens	1.4 bA	1.5 bA	2.9 bB
T. acutus	1.3 bA	1.7 bA	2.8 bB
X. americanum	0.4 aA	0.6 aA	0.7 aA
Nordan			
P. neglectus	4.4 cA	4.3 cA	4.7 cA
M. brevidens	1.5 bA	1.8 bA	2.8 bB
T. acutus	1.6 bA	2.0 bA	2.7 bB
X. americanum	0.4 aA	0.7 aA	0.6 aA

[U]Each value is the mean of 20 replicates (1 plant/replicate). Means within cultivars not followed by the same letter differ ($P \leq 0.05$) according to Duncan's new multiple range test. Lower case letters refer to column, capital letters refer to rows.
[V]Reproductive index (Pf/Pi) = final nematode population/initial nematode population.
[W]Plants inoculated at 30 days with Pi 0 or 1.0 nematode/cm^3 soil and grown for 120 days after inoculation.
[X]Logan fine silt soil (mixed mesic Typic Calciaquolls [27% sand, 31% silt, 42% clay; OM 2.5%, pH 7.8]).
[Y]1:1 mixture Logan fine silt soil and Kidman fine sandy loam soil.
[Z]Kidman fine sandy loam soil [coarse-loamy mixed mesic Calcic Haploxeroll (84% sand, 8% silt, 8% clay; 1.0% OM, pH 7.4)].

affected nematode reproduction, and Rf was negatively correlated ($r = -0.77$) to root growth. Nematode Rf was greatest by *P. neglectus* on Secar in light textured soil and was generally least in Thiokol fine silty loam soil (Fig. 3). Kearns fine silty loam soil and Ricks sandy loam soil, which contained intermediate levels of silt and sand, also were intermediate in nematode pathogenicity and reproduction of the 4 nematode species on the 4 grass cultivars. *Xiphinema americanum* was the least pathogenic of the nematode species, and populations did not increase on any grass cultivars in any soil texture.

DISCUSSION

The results of methyl bromide, aldicarb, and phenamiphos treatments of rangeland grasses were consistent with the hypothesis that soil-borne organisms signif-

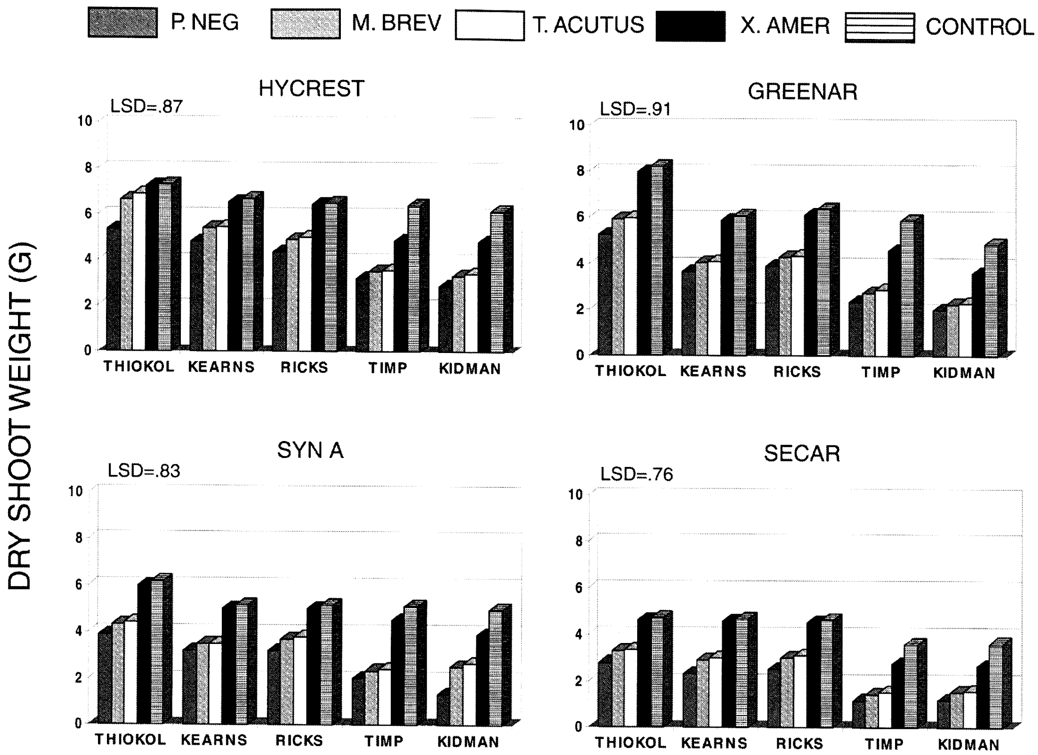

Fig. 1. Effect of *Pratylenchus neglectus*, *Merlinius brevidens*, *Tylenchorhynchus acutus*, and *Xiphinema americanum* on dry shoot weight of 4 rangeland grass cultivars grown in 5 different soil textures for 200 days at 26±3°C. (LSD refers to differences among nematodes within a given cultivar.)

icantly suppress the growth of these plants. No soil-borne insects were found in the experimental plots which suggested that nematodes were important plant pathogens of the rangeland grasses. The added plant growth following treatment with methyl bromide indicated that other factors such as fungi and/or bacteria also may be involved in growth suppression.

The relationships between nematodes and plants are affected by edaphic factors such as soil temperature, soil water, and soil texture (Griffin, 1991, 1992; Griffin and Asay, 1996a; Smolik, 1974), and by host plant differences in resistance and tolerance (Griffin, 1984, 1991a,b; Griffin and Asay, 1989, 1996a). The results of this study demonstrated consistent effects of soil texture on the host-parasite relationship of several nematode species and grasses. Nematode pathogenicity was negligible or significantly less in Thiokol fine silty loam soil than in Timpanogas fine loam soil or Kidman fine sandy loam soil. The effects of soil texture and other factors such as soil temperature and soil water (Griffin, 1991; Griffin and Asay, 1996a), may explain the inconsistent relationship between plant pathogens and host plants. Soil textures vary greatly throughout the western United States, and the results of this study indicate that particular host-parasite relationships may vary accordingly.

The reproductive potential of a nematode is important in a host-parasite relationship (Griffin and Asay, 1996a).

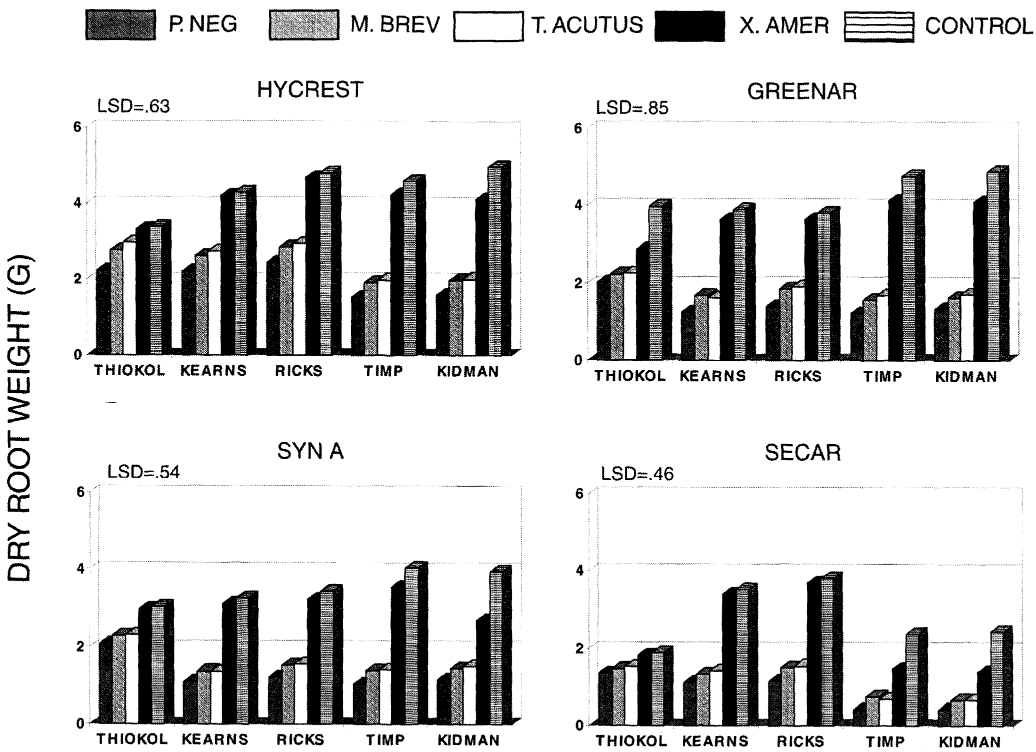

Fig. 2. Effect of *Pratylenchus neglectus*, *Merlinius brevidens*, *Tylenchorhynchus acutus*, and *Xiphinema americanum* on dry root weight of 4 rangeland grass cultivars grown in 5 different soil textures for 200 days at 26±3°C. (LSD refers to differences among nematodes within a given cultivar.)

Pratylenchus neglectus had the largest reproductive index and was the most pathogenic. *Xiphinema americanum* had the smallest reproductive index (< 1) and was the least pathogenic. Previous studies also have shown that *X. americanum* has only one life cycle per year (Griffin and Darling, 1964; Malik and Jairajpuri, 1983; Norton, 1963) resulting in a negative reproductive index during a growing season. For a given soil texture, nematode reproduction usually increases with the root growth of a susceptible host (Nickle, 1984). However in this study, soil texture that favored root growth was detrimental to nematode population development and pathogenicity. This was evident in the heaviest silt soils which apparently negatively affected nematode movement and feeding habits.

Hycrest was the most tolerant of the 4 plant cultivars and achieved the greatest plant growth. It supported the smallest reproductive index and fewest nematodes per g of root tissue of the nematode species that were tested. This agrees with data from previous studies (Griffin, 1992; Griffin and Asay, 1996a) and indicates that nematode tolerance was selected during development of this cultivar (Asay and Knowles, 1985; Asay *et al.*, 1985). It is, therefore, important to be cognizant of the pathological relationship between plants and nematodes and to consider this

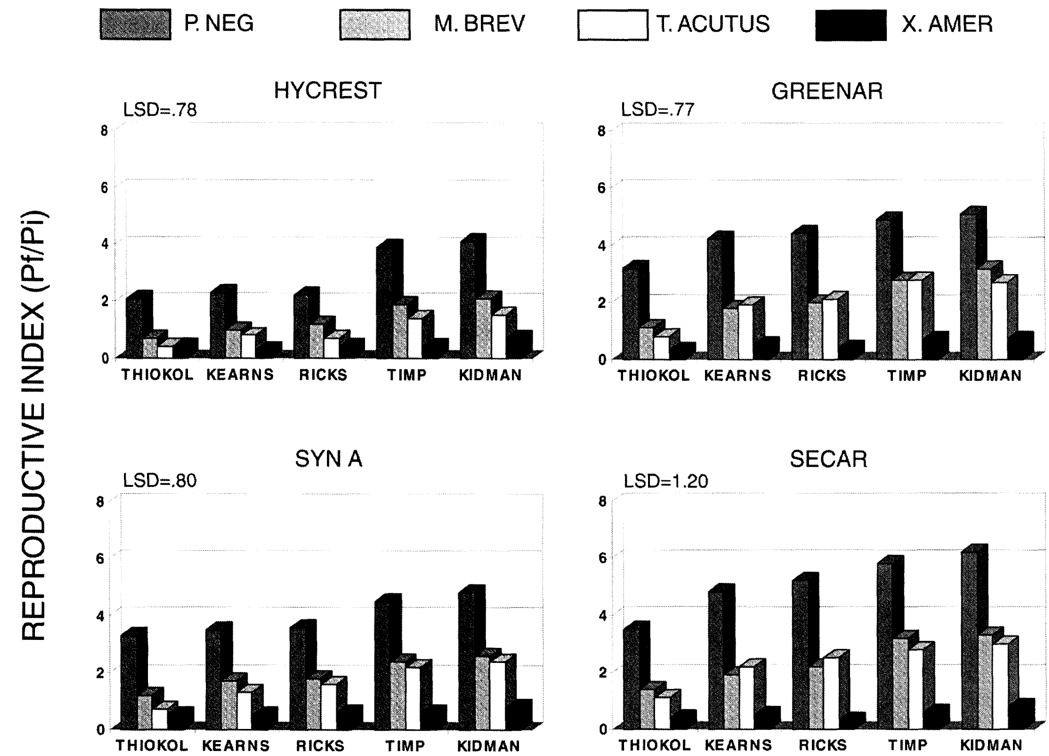

Fig. 3. Reproductive indices (Pf/Pi) of *Pratylenchus neglectus*, *Merlinius brevidens*, *Tylenchorhynchus acutus*, and *Xiphinema americanum* on 4 rangeland grass cultivars grown in 5 different soil textures for 200 days at 26±3°C. (LSD refers to differences among nematodes within a given cultivar.)

relationship in the selection of rangeland germplasm to be used for the development of new cultivars.

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