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Pathological Effects of *Pratylenchus neglectus* on Wheatgrasses[1]

G. D. GRIFFIN[2]

Abstract: In controlled greenhouse and growth chamber studies, *Pratylenchus neglectus* reduced dry shoot and dry root weight of rangeland grasses. Greenar intermediate wheatgrass and Secar Snake River wheatgrass were more susceptible to *P. neglectus* than Hycrest crested wheatgrass, Fairway crested wheatgrass, and Nordan crested wheatgrass at a greenhouse bench temperature of 26 ± 3 C. Hycrest was the most tolerant to parasitism by *P. neglectus.* An initial nematode inoculum density of four nematodes/cm^3 soil reduced dry shoot weights of Hycrest, Fairway, Nordan, Greenar, and Secar by 22%, 33%, 36%, 47%, and 49%, and reduced dry root weights by 26%, 31%, 32%, 38%, and 42%. There was a positive relationship between dry root weight, the nematode inoculum density, and the nematode reproduction index (final nematode population/initial nematode inoculum). However, there were more nematodes/g root tissue on Secar than on the crested wheatgrasses, and significantly more nematodes/g root tissue on Greenar, Fairway, and Nordan than on Hycrest. *Pratylenchus neglectus* was most pathogenic at four nematodes/cm^3 soil at 30 C and least pathogenic at one nematode/cm^3 soil at 15 C. Greenar and Secar were more susceptible to the nematode than Hycrest, Fairway, and Nordan at two and four nematodes/cm^3 soil at 20 to 30 C. The nematode reproductive indices were greatest at 30 C and were positively correlated with dry root weight. Secar supported the most and Hycrest had the fewest nematodes/g root.

Key words: Agropyron cristatum, Agropyron desertorum, crested wheatgrass, *Elymus lanceolatus,* nematode, reproduction, root weight, shoot weight, snake river wheatgrass, susceptible, temperature, tolerance.

More than 155 million ha of rangelands in the eight states of the Intermountain Region of the United States provide essential forage for livestock. These rangelands also provide habitat for wildlife and are important recreational areas. Unfortunately, only 14% of these rangelands are classified in good condition or are producing within 60% of their natural potential (16). In general, rangelands can be upgraded by better management or by replacing existing vegetation with improved grasses, forbs, and shrubs. Revegetation with improved forage grasses is a relatively economical and long-lasting means of improving rangelands. Breeding programs to develop superior plant materials for this purpose have received more emphasis during the past decade (1,2).

Wheatgrasses have received much attention by plant breeders because they are among the most important forage grasses in western North America, particularly during the spring and early summer (1). Productivity of rangeland grasses is significantly suppressed by plant-parasitic nematodes, which increase their densities during the period of maximum plant growth (6,8,10,11,15).

The root lesion nematode, *Pratylenchus neglectus* (Rensch) Filipjev & Schuurmans Stekhoven, an endemic species, is associated with poor growth of field, forage, and rangeland grasses in the United States rangelands (7,9,10,14,18). Plant growth of rangeland grasses increased when nematodes, including *P. neglectus,* were controlled with nematicides (17). There is a lack of experimental data on the pathological effects of plant-parasitic nematodes on rangeland grasses. The objectives of this study were to determine how temperature and invasion by *P. neglectus* affected the growth of five wheatgrass selections.

MATERIALS AND METHODS

Nematode inoculum: Pratylenchus neglectus was obtained from western wheatgrass, *Pascopyrum smithii* (Rydb.) Löve, from northern Utah and propagated on Nugaines wheat, *Triticum aestivum* L., in a temperature-controlled greenhouse at 26 ± 3 C. Nematode inoculum was obtained

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[2] Nematologist, USDA ARS, Forage and Range Research Laboratory, Utah State University, Logan, UT 84322.

by incubating infected wheat roots in a modified Baermann funnel. Nematodes were surface sterilized (9) before use and rinsed with distilled water.

Greenhouse experiment: Seedlings (3–6 mm radicle) of Hycrest crested wheatgrass (*Agropyron cristatum* (L.) Gaertner X *A. desertorum* (Fisch. ex Link) Schult), Fairway crested wheatgrass (*A. cristatum*), Nordan crested wheatgrass (*A. desertorum*), Greenar intermediate wheatgrass (*Thinopyrum intermedium* Host), and Secar Snake River wheatgrass (*Elymus lanceolatus* (Scribner and Smith) Gould) were planted into individual 6-cm-d plastic containers containing 540 cm^3 steam-sterilized Kidman fine sandy loam soil (coarse–loamy mixed mesic Calcic Haploxeroll [84% sand, 8% silt, 8% clay; pH 7.4, 1.0% OM]). After 34 days plant growth, soil in each container was infested with a geometric series of 0, 1.0, 2.0, or 4.0 *P. neglectus* (mixed stages) per cm^3 soil. These inoculum densities approximate early season field Pi associated with wheatgrasses.

Nematodes suspended in deionized water were poured into four holes 10 cm deep in the soil around the hypocotyl base. Containers were maintained at a greenhouse temperature of 26 ± 3 C. Supplemental light for a 19-hour daylength was provided by high-output fluorescent lamps. The experiment was a 5 × 4 factorial (5 cultivars × 4 inoculations) in a randomized complete block design with 20 replications, one plant per replicate. Plants were watered daily and fertilized monthly. Shoots were clipped 50, 110, and 170 days after nematode infestation. The experiment was terminated 170 days after infestation, and accumulative dry shoot weights from the three clippings, dry root weights, and the nematode reproductive indices (final nematode population divided by initial nematode inoculum) (5) were determined. Nematode Pf (final nematode population) were determined by combining total number of nematodes per root system and container of soil. Nematodes were extracted from the soil by elutriation (4) and sugar flotation (12), and from grass roots by a modified Baermann funnel technique (9). Data were recorded and analyzed by standard ANOVA and a linear regression analysis.

Growth chamber experiment: A similar study involved infesting soil containing 28-day-old plants housed in a controlled environment. Growth chamber temperatures were maintained at 15, 20, 25, or 30 C (± 1 C), and a 19-hour daylength was provided by high-output fluorescent lamps. The experiment was a 5 × 4 factorial (5 cultivars × 4 inoculations) in a randomized complete block design with 10 replications, one plant per replicate. Shoots were clipped 60 and 120 days (plant harvest) after inoculation and shoot weights were accumulated. Plant weights and nematode reproduction rate were determined and analyzed as in the greenhouse study.

Experiments were repeated once with similar results. Data presented here are from the first test of each experiment.

Results and Discussion

Pratylenchus neglectus at Pi 4.0 nematodes/cm^3 soil reduced ($P < 0.05$) shoot and root growth of all wheatgrasses in the greenhouse at a bench temperature of 26 ± 3 C (Table 1). No growth suppression of any of the grasses was observed at Pi of 1.0 nematode/cm^3 soil. *Pratylenchus neglectus* at Pi of 2.0 nematodes/cm^3 soil suppressed ($P < 0.05$) only the growth of Greenar wheatgrass compared to the uninoculated controls. Reduction in dry root weight by *P. neglectus* was similar to that of dry shoot weights (Table 1). Secar is less vigorous than the other wheatgrasses, and shoot and root growth of inoculated and uninoculated plants were lower ($P < 0.05$) than that of the other grass species and cultivars.

The nematode reproductive indices showed that the five wheatgrass species and cultivars were good hosts of *P. neglectus.* Nematode reproduction was greatest at the lowest Pi (1.0 nematode/cm^3 soil),

TABLE 1. Pathogenicity of *Pratylenchus neglectus* on five rangeland wheatgrass cultivars at a greenhouse temperature of 26 ± 3 C 170 days after inoculation.†

Inoculum level	Hycrest	Fairway	Nordan	Greenar	Secar
		Dry shoot weight (g)			
0	1.78 bA	1.44 bB	1.35 bB	1.50 cB	1.12 bC
500	1.83 bA	1.39 bB	1.33 bB	1.45 cB	1.06 bC
1,000	1.70 bA	1.33 bB	1.29 bB	1.29 bB	0.87 bC
2,000	1.38 aA	0.97 aB	0.87 aB	0.79 aB	0.57 aC
		Dry root weight (g)			
0	0.89 bA	0.83 bA	0.86 bA	0.85 cA	0.69 bB
500	0.86 bA	0.80 bA	0.79 bA	0.75 bcA	0.57 bB
1,000	0.82 bA	0.77 bB	0.76 bB	0.63 abC	0.53 bC
2,000	0.66 aA	0.57 aA	0.58 aA	0.52 aB	0.40 aB
		Reproduction indices (Pf/Pi)‡			
500	8.5 cA	9.1 cA	8.9 cA	9.1 cA	9.4 cA
1,000	5.8 bA	6.4 bA	5.7 bA	6.4 bA	6.5 bA
2,000	3.2 aA	3.5 aA	3.9 aA	3.8 aA	3.2 aA

Each value is the means of 20 replicates (1 plant/replicate). Means not followed by the same letter differ ($P < 0.05$) (lowercase letters for columns, uppercase letters for rows).
† Plants inoculated at 34 days.
‡ Nematode reproductive indices Pf/Pi (final nematode population per plant divided by initial nematode inoculum).

which allowed extensive root growth. Cultivars did not differ ($P > 0.05$) in the reproductive indices, but they did differ ($P < 0.05$) in numbers of nematodes/g fresh root tissue. At the largest Pi (4.0 nematodes/cm^3 soil), nematodes/g roots were 4.8, 6.1, 6.7, 7.3, and 8.0 on Hycrest, Fairway, Nordan, Greenar, and Secar, respectively ($P = 0.05$ at 1.1). Similar results were obtained when the experiment was repeated.

Temperature influenced the host–parasite relationships between the five wheatgrasses and *P. neglectus*. At 15 C, nematodes did not affect dry shoot weights of Hycrest, Fairway, and Nordan, but they suppressed ($P < 0.05$) dry shoot weights of Greenar and Secar at Pi 4.0 nematodes/cm^3 soil (Fig. 1). *Pratylenchus neglectus* was more virulent on all grass cultivars at increased temperatures. The greatest growth suppression of all grasses occurred at Pi 4.0 nematodes/cm^3 soil at 20–30 C. Hycrest dry shoot weights were suppressed less than those of the other cultivars at 2.0 and 4.0 nematodes/cm^3 soil at 20–30 C, indicating that Hycrest is more tolerant to nematode parasitism than the other grasses.

Nematode root damage of inoculated plants increased with temperature (Fig. 2). No root damage by the nematode was observed at 15 C. The greatest reduction in root growth of all grass cultivars occurred at 30 C at a Pi of 4.0 nematodes/cm^3 soil. At this nematode density and temperature, dry root weight of Hycrest was suppressed less ($P < 0.05$) than dry root weights of the other cultivars. At the largest Pi (4.0 nematodes/cm^3 soil), root growth was poorest in Greenar and Secar, and dry root weight of Secar was less ($P < 0.05$) than that of the other cultivars.

There was a positive relationship between nematode reproduction and temperature in the growth chamber experiment; nematode Pf was greatest at 30 C (Fig. 3). There were no differences in the reproductive indices of *P. neglectus* determined on the five grass cultivars. However, as in the greenhouse study, the lowest Pf in the roots occurred on Hycrest roots, whereas the largest Pf were observed on Secar roots (Fig. 4). Pf values of 6.2, 10.5, 11.5, 13.0, and 25.3 nematodes/g fresh root tissue were observed on Hycrest, Fairway, Nordan, Greenar, and Secar, respectively, and occurred at Pi 4.0 nematodes/cm^3 soil at 30 C ($P = 0.05$ at 3.4).

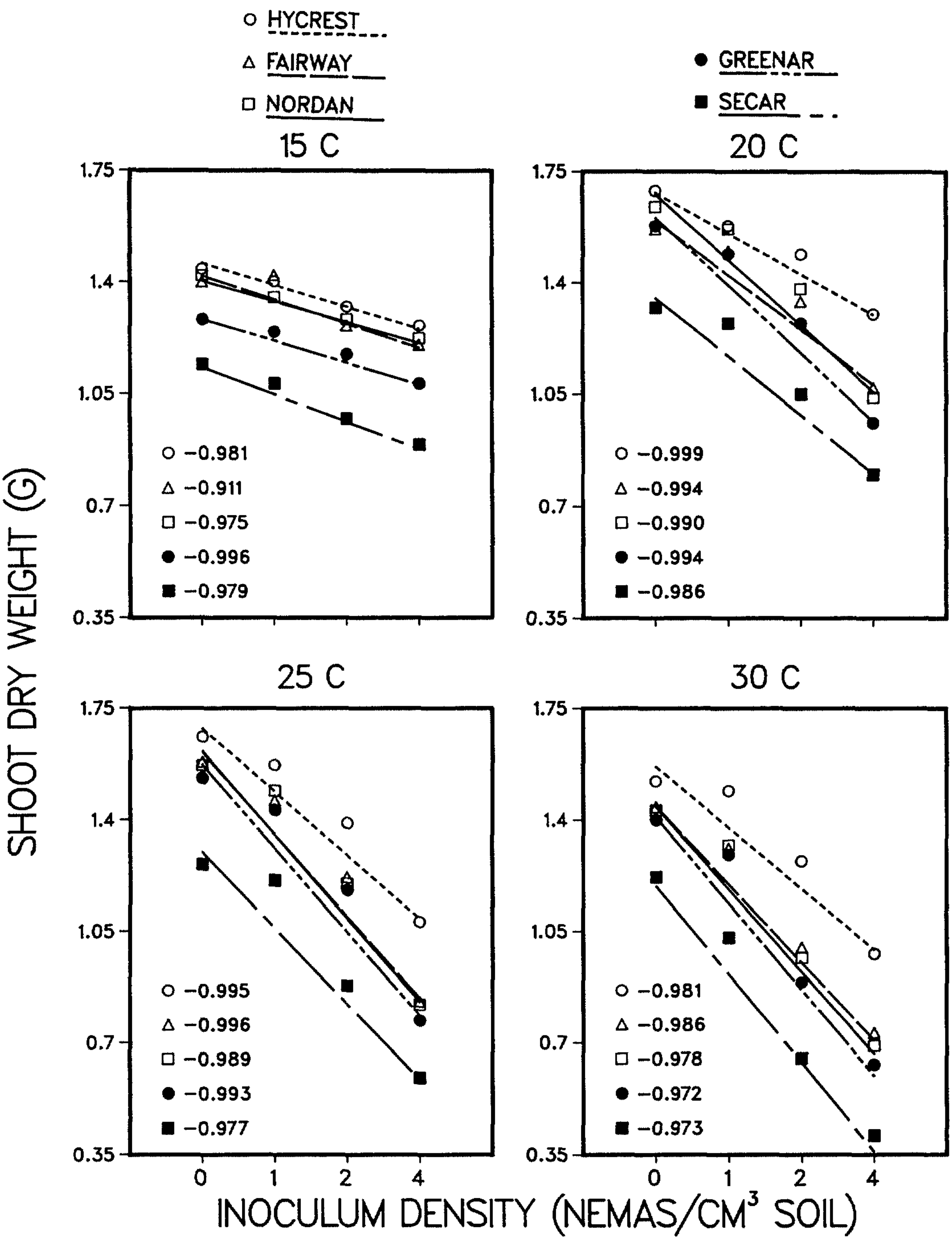

FIG. 1. Relationship (correlation coefficient R^2) of temperature and Pi (inoculum density) of *Pratylenchus neglectus* on the dry shoot weight of five wheatgrass cultivars grown for 120 days after inoculation.

The adverse effects of *P. neglectus* on rangeland wheatgrasses observed in these experiments are consistent with the results of field studies involving nematicides (17) and show the potential importance of *P. neglectus* as a damaging parasite on rangeland grasses. The optimum temperature for *P. neglectus* development and repro-

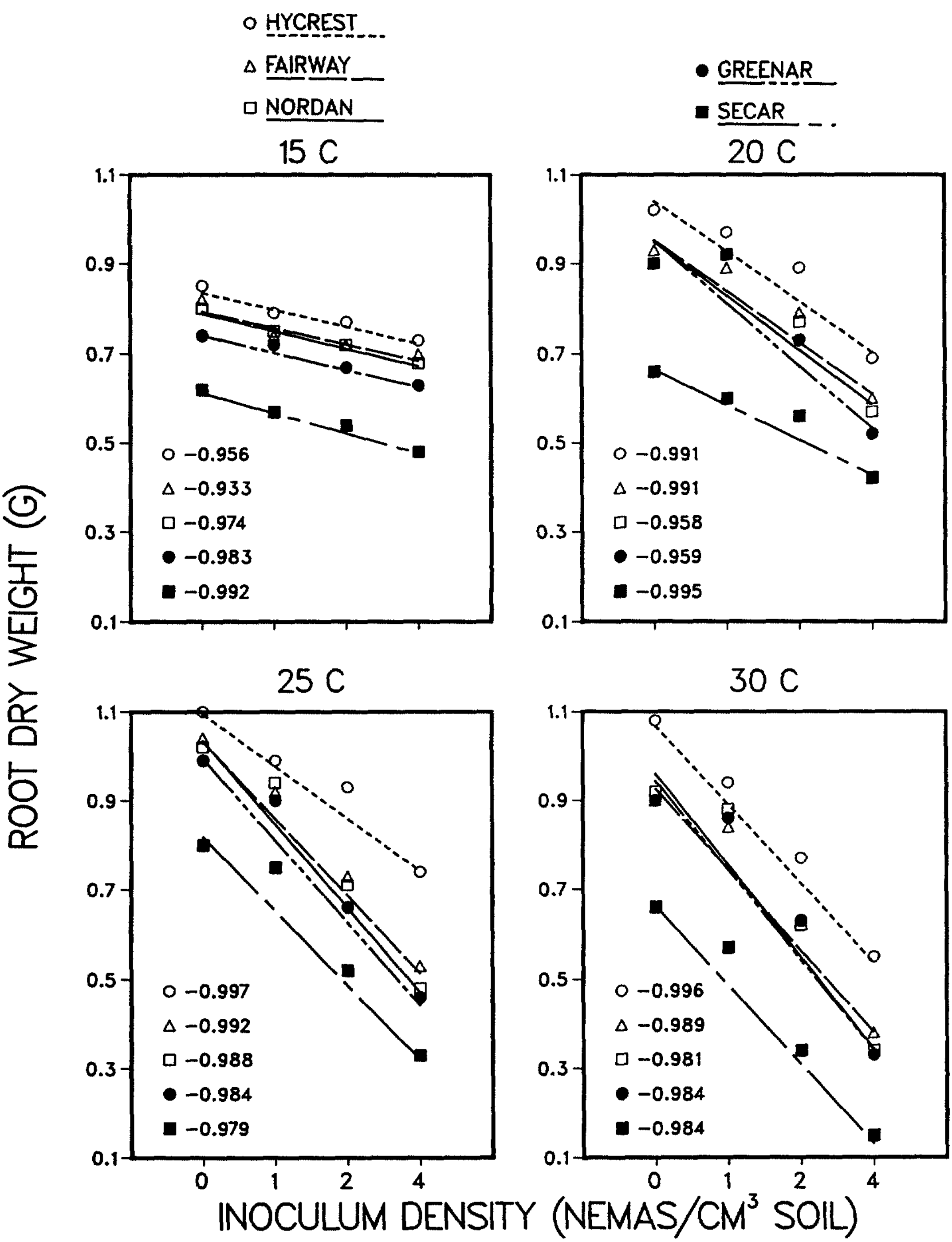

FIG. 2. Relationship (correlation coefficient R^2) of temperature and Pi (inoculum density) of *Pratylenchus neglectus* on the dry root weight of five wheatgrass cultivars grown for 120 days after inoculation.

duction on wheatgrass was 30 C, which was also the temperature preferred by Utah and Wyoming populations of *P. neglectus* and a Canadian population of *P. penetrans* on alfalfa (7,9,13). Hycrest apparently is more tolerant of *P. neglectus* than are the other grass cultivars, as was found in a growth comparison of crested wheat-

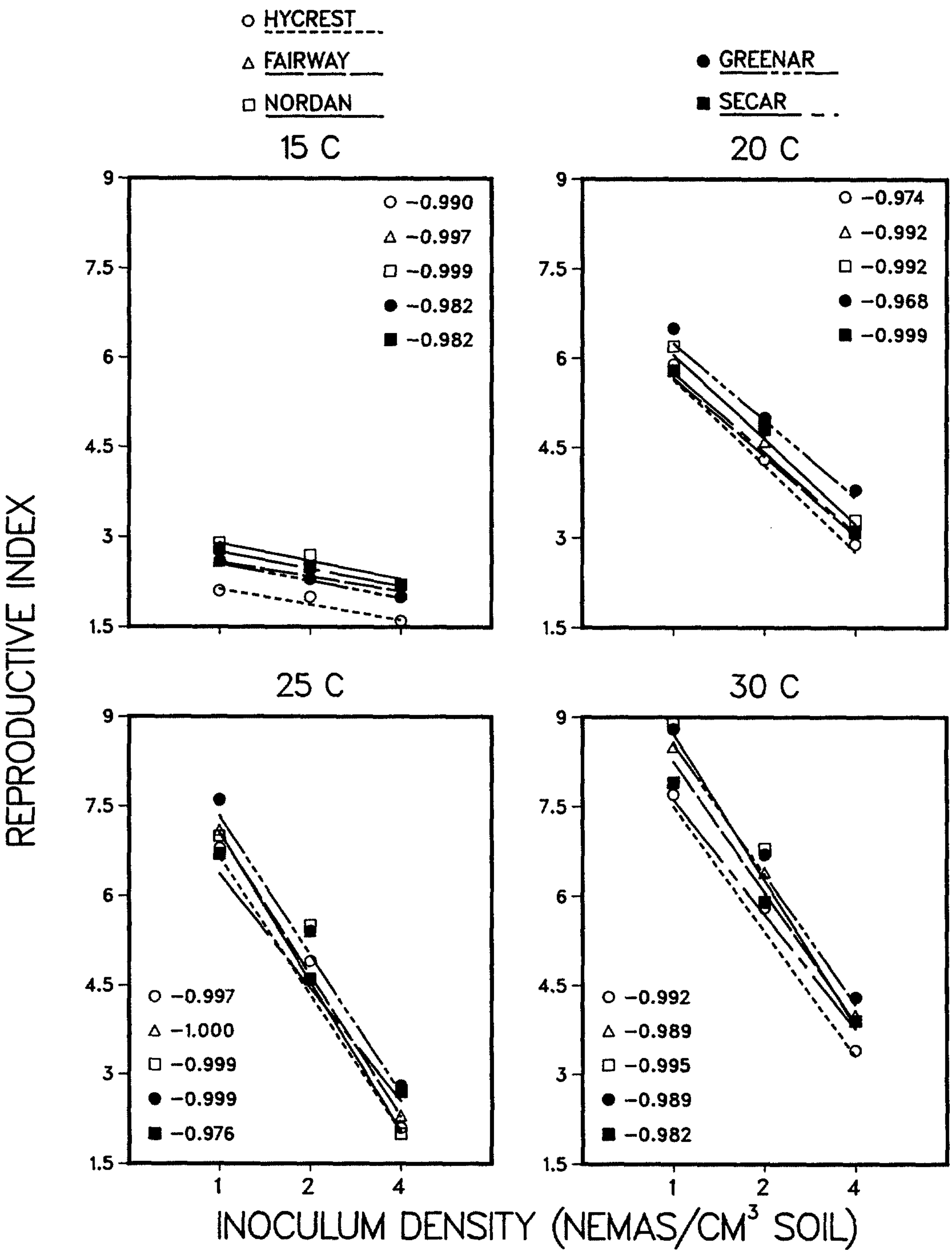

FIG. 3. Relationship (correlation coefficient R^2) of temperature and nematode Pi (inoculum density) on the reproduction index (Pf) of *Pratylenchus neglectus* on five wheatgrass cultivars grown for 120 days after inoculation.

grasses under field conditions (3). Hycrest also supported the lowest root densities of the nematode.

Pratylenchus neglectus has migratory endoparasitic habits and is not a specialized parasite; therefore, it is unlikely that

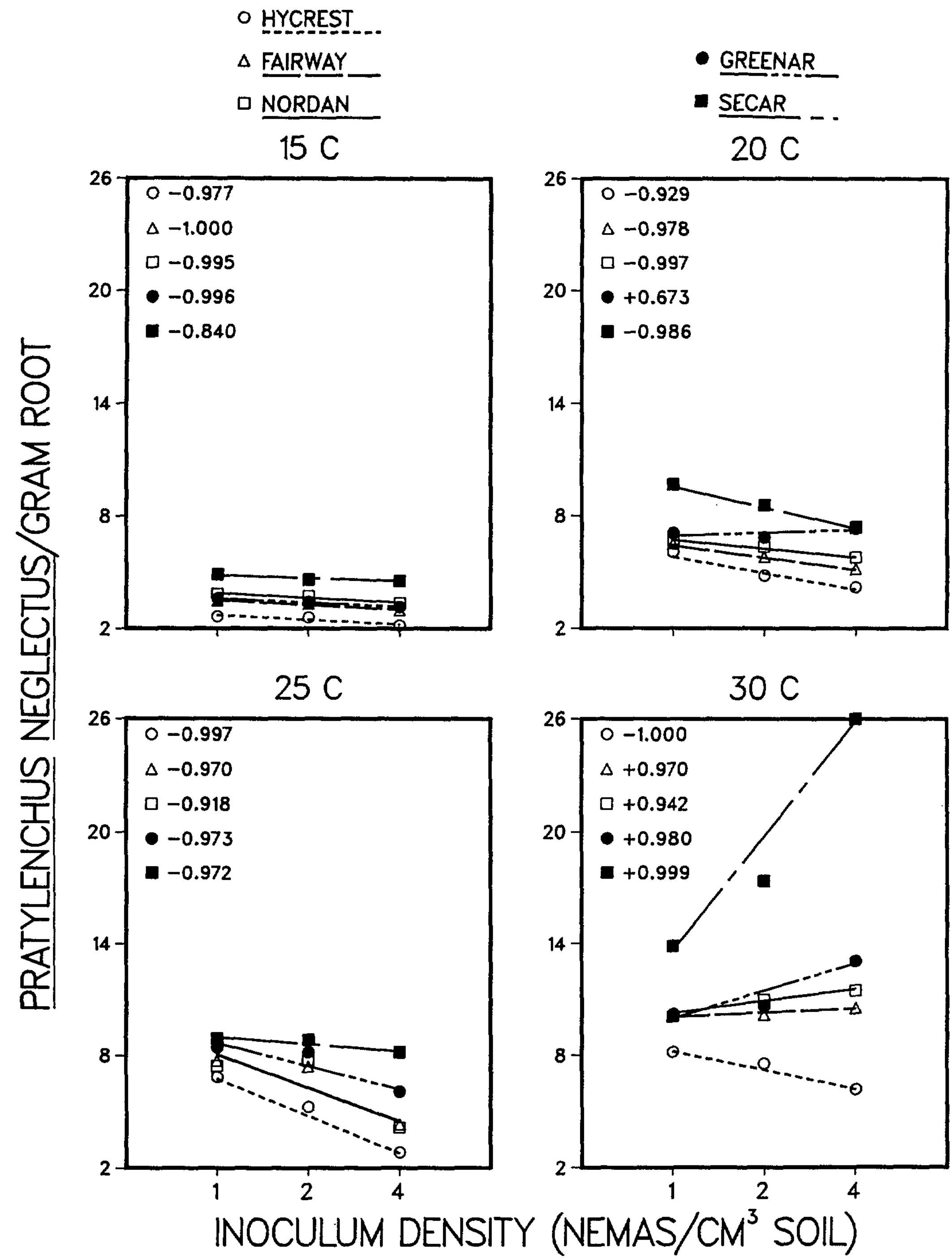

FIG. 4. Relationship (correlation coefficient R^2) of temperature and Pi (inoculum density) on nematodes/g fresh root (Pf) of *Pratylenchus neglectus* on five wheatgrass cultivars grown for 120 days after inoculation.

sources of complete resistance to the nematode will be found in wheatgrass germplasm. However, a hybridization program (2), should increase nematode tolerance of new wheatgrass selections to *P. neglectus*.

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