Effect of Tylenchorhynchus nudus on Growth of Kentucky Bluegrass[1]

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Abstract: The effect of *Tylenchorhynchus nudus* on growth of Kentucky bluegrass was investigated under controlled environmental conditions in both a phytotron and a greenhouse. The nematode significantly reduced weights of clippings, crowns and roots. Pathogenicity was greater in sandy loam soil than in loam and was enhanced by submitting plants to nutrient and/or moisture stresses; soil nutrient level was most critical. The results suggest that *T. nudus* contributes significantly to summer decline of bluegrass lawns in South Dakota. *Key Words*: stunt nematode, soil moisture, soil fertility, soil type, *Poa pratensis*, pathogenicity.

The role of plant-parasitic nematodes in turf decline in the midwestern United States has received little study. Perry et al. (3) demonstrated that *Helicotylenchus digonicus* Perry, Darling and Thorne causes a severe decline of Kentucky bluegrass, *Poa pratensis* L., in Wisconsin. Sumner (6) found species of *Helicotylenchus* and *Tylenchorhynchus* associated with unthrifty bluegrass in Nebraska but was unable to demonstrate any pathological effects of the nematodes on the grass. Sikora et al. (4) showed that *Meloidogyne naasi* Franklin was highly pathogenic to creeping bentgrass, *Agrostis palustris* Huds., and that *T. agri* Ferris and *Pratylenchus penetrans* (Cobb) Filipjev and Shuurmans-Stekhoven at least inhibited root growth of this grass.

Decline of Kentucky bluegrass turf in South Dakota is not uncommon during hot, dry periods of the summer months. For various reasons, fertilizing and supplemental watering recommendations for maintaining good lawns are seldom adhered to during these months. A stunt nematode, *T. nudus* Allen, is frequently associated with bluegrass turf in South Dakota (5). The nematode is particularly abundant in the eastern half of the state and is thought to be a factor in the summer decline of bluegrass lawns. It readily fed as an ectoparasite on the roots of winter wheat, *Triticum aestivum* L., in glass-sided observation chambers (author's *unpublished*). The objective of the present study was to determine the effect of *T. nudus* on growth of Kentucky bluegrass under controlled conditions.

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MATERIALS AND METHODS

T. nudus was isolated from soil around roots of soybean on the Plant Science Research Farm, Brookings, S.D., and maintained on red clover, *Trifolium pratense* L., in a greenhouse. Soil used in experiments was steam-pasteurized for 3 hr. Nematodes were obtained from pot cultures by the extraction method of Christie and Perry (1) and used within 24 hr. Pots of 'South Dakota Common' Kentucky bluegrass, seeded at a rate equivalent to 4 kg/500 m^2, were inoculated by pouring an aqueous suspension of the appropriate number of nematodes over the seeds, which then were covered with a small quantity of additional soil.

Two experiments were conducted. One experiment was designed to measure the effect of *T. nudus* on seedling growth of bluegrass under precisely controlled environmental conditions. Plastic pots, 9-cm diam, each containing 210 cc of Blendon loamy sand (87% sand, 7% silt, 6% clay), were seeded with surface-sterilized bluegrass seed. One-half of the pots received a washed suspension of 1000 *T. nudus* and the remainder an equivalent volume of nematode wash water. Each treatment was replicated 10 times, and the pots were arranged randomly in a phytotron maintained at a constant temperature of 23 C, 50% relative humidity and a light intensity of 25,824 lx (2,400 ft-c) with a 16-hr photoperiod. Once a week, 50 ml of sterile White's (2) nutrient solution was added to each pot. Otherwise, pots received distilled water whenever the soil surface became dry. The grass was clipped to a height of 5 cm every 3 weeks with the aid of a guide ring, and the clippings from each pot were oven-dried at 60 C for 5 days before weighing. The experiment was terminated 4 months after inoculation.

A second experiment was a 2^4 factorial, designed to measure the long-term effects and interactions of soil type, water and nutrients on the pathogenicity of *T. nudus*. Ninety-six

15-cm clay pots were each filled with 1800 g of Vienna loam or Dickie sandy loam (43 and 73% sand, 34 and 12% silt, 23 and 15% clay, respectively). One-half of the pots of each soil type were inoculated with 5000 washed *T. nudus*, while the remaining pots received only sterile distilled water. Pots were arranged on a bench in an air-conditioned greenhouse maintained at 24 ± 4 C. Plants were watered regularly but not fertilized until 2 months after inoculation. At that time the grass in all pots was clipped to a height of 5 cm, and two different water and nutrient regimes were initiated. Half of the pots in each prior treatment were watered regularly, usually every 4 days; whereas the remaining half received water only when the plants were obviously wilted, usually once a week. These treatments were further subdivided so that half the pots received 250 ml of a 20-20-20 analysis fertilizer solution every 4 weeks and half received no supplemental nutrients. Each of the 16 treatments was replicated six times in a randomized complete block design. The grass was clipped and weighed as in the first test, and the experiment terminated 10 months after inoculation.

Terminal analysis was essentially the same in both experiments. Following a final clipping the root ball with remaining crown was soaked in 2 liters of water for 1 - 2 hr. The soil then was gently washed from the roots with running tap water into a bucket. In the first test, nematodes were extracted from the entire suspension by the method of Christie and Perry (1). In the second test, the volume of the suspension was raised to an 8 liters and a 2-liter aliquot was removed for similar processing. Root systems and crowns were oven-dried at 60 C for 5 days and weighed.

RESULTS AND DISCUSSION

Results of the study under controlled environmental conditions demonstrated that *T. nudus* is pathogenic to Kentucky bluegrass (Table 1). The nematode caused significant (P=0.01) reductions of 28% in cumulative clipping weight and 36% in root and crown weight. The mean number of nematodes recovered from inoculated pots was 8093, representing an 8-fold increase in 4 months.

Under greenhouse conditions, the pathogenic effects of *T. nudus* on Kentucky bluegrass were markedly increased when plants were grown under stresses in the physical environment (Table 2). Where the grass was watered and fertilized regularly, the average clipping weights of inoculated pots were significantly (P=0.01) reduced by 7% in the sandy loam and by 9% in the loam soil. When moisture alone was withheld, reductions were doubled in both soils. Reductions in top growth were greatest where nutrients were withheld and were particularly severe (40-44%) in the sandy loam soil. There were no obvious growth differences between nutrient treatments with or without moisture stress in this soil, probably because of the severe effects of nutrient stress itself. Withholding nutrients, however, appeared to be of lesser importance in the loam soil when moisture was withheld.

TABLE 1. Effect of *Tylenchorhynchus nudus* on seedling growth of Kentucky bluegrass grown in a phytotron.

Treatment	Cumulative dry clipping wt (g)[a]	Final dry wt (g) of roots and crowns[a]
Non-inoculated	0.83	0.16
1000 *T. nudus*	0.60	0.10
F	52.80**	22.08**

[a]Each value is the mean of ten replications 4 months after inoculation.
**Significant at the P=0.01 level.

Effects of *T. nudus* on root and crown weights in the sandy loam soil followed a pattern similar to those of clipping weights, with the least reduction (14%) where plants were under no stress and most (35 - 36%) where nutrients were withheld. However, in the loam soil, reductions in root growth were not increased by stress treatments, and the greatest weight reduction (27%) occurred where plants received regular watering and fertilizing. The plants had grown for 2 months prior to initiation of stress treatments, which may have accounted for the lack of differences in root growth in this heavier soil. Other than reduced root systems, there were no gross symptoms of nematode damage to infested roots.

Populations of *T. nudus* had increased 11 to 40-fold by the end of the experiment, demonstrating that Kentucky bluegrass is a highly favorable host for this nematode. There were no significant differences in final populations between the stress treatments in the loam soil. However, population increase in the lighter soil was significantly (P=0.01) retarded where nutrients were withheld, attributable to the smaller root systems in these treatments.

TABLE 2. Effect of *Tylenchorhynchus nudus* on growth of Kentucky bluegrass under moisture and nutrient stresses in sandy loam soil and in loam soil.

Nutrient stress	Moisture stress	Nematode inoculum	Cumulative clipping wt (g)[a]	Percent reduction[b]	Final root and crown wt (g)[a]	Percent reduction	Final number of nematodes[a,c]
			Sandy loam soil				
No	No	None	18.7		38.6		
No	No	5000	17.4	7	33.4	14	171,565
No	Yes	None	19.0		32.8		
No	Yes	5000	16.3	14	25.2	23	200,760
Yes	No	None	3.3		27.2		
Yes	No	5000	1.8	44	17.6	35	96,576
Yes	Yes	None	2.8		26.7		
Yes	Yes	5000	1.6	40	17.2	36	127,448
			Loam soil				
No	No	None	20.7		52.8		
No	No	5000	18.8	9	38.8	27	146,768[d]
No	Yes	None	20.7		40.2		
No	Yes	5000	17.0	18	38.7	4*	132,908[d]
Yes	No	None	5.3		42.7		
Yes	No	5000	3.4	35	33.3	22	178,228[d]
Yes	Yes	None	4.7		35.8		
Yes	Yes	5000	3.8	21	28.7	20	159,048[d]

[a]Each value is the mean of six replications, 10 months after inoculation.
[b]All reductions are significant (P=0.01), except 0.05 for *.
[c]Differences between nutrient treatments are significant (P=0.01).
[d]Differences are not significant (P=0.05).

The pathogenic effect of *T. nudus* under the conditions of this study suggests that the nematode is a significant contributory factor in summer decline of this turfgrass in South Dakota. Stress conditions enhance this effect, particularly on lighter soils, with soil nutrient level apparently more important than moisture.These findings indicate that the detrimental effect of *T. nudus* and perhaps other nematodes on bluegrass lawns can be lessened or overcome through maintenance of adequate fertility and moisture levels in the soil during the critical summer months.

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