

Effect of Watering Regimen on Injury to Corn and Grain Sorghum by *Pratylenchus* Species

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Abstract: The effect of simulated rainfall frequency on the pathogenicity of *Pratylenchus zae* and *P. brachyurus* was studied in four greenhouse experiments. Corn and grain sorghum were watered at different intervals during predetermined cycles to create a gradient of water-stressed plants. Each experiment included nematode and uninoculated treatments. Growth reaction of plants to different frequencies of watering was significant but was not affected by the presence of nematodes. *Pratylenchus zae* numbers differed among watering regimens on corn but not on sorghum. Numbers of *P. brachyurus* did not differ among watering regimens on corn or sorghum. Both lesion nematode species were harmful to corn, but sorghum increased plant growth in response to *P. brachyurus*. It is concluded that water stress is not the only environmental factor that influences the pathogenicity of these two species on corn and sorghum.

Key words: corn, grain sorghum, nematode, *Pratylenchus brachyurus*, *Pratylenchus zae*, *Sorghum bicolor*, water stress, *Zea mays*.

Corn (*Zea mays* L.) and grain sorghum (*Sorghum bicolor* (L.) Moench) are produced throughout South Africa under moderate to low summer rainfall conditions. The long-term annual rainfall ranges from 450 to 700 mm (Institute for Soil, Climate and Water: Data Bank). Sporadic and lengthy drought periods during the rainy season are common in these production areas. As with crop production under irrigation, the frequency of rain days as a hydroclimatological variable is just as important as rainfall depth for rainfed agriculture (10). It can therefore be expected that sporadic droughts can enhance the effect of pests and diseases, which results in further stress of plants.

Plant-parasitic nematodes, their population dynamics, and plant growth depend on soil water (8,19). Various studies indicated sensitivity of nematodes to changes in soil water status. Jordaan et al. (14) found a positive relationship between the incidence of *Pratylenchus brachyurus* (Godfrey) Filipjev & Schuurmans Stekhoven and *Rotylenchulus parvus* and long-term average annual rainfall. Griffin and Barker (9) found a decline in *Xiphinema americanum* numbers at high and low moisture levels. Robbins and Barker (20) reported a

similar trend with *Belonolaimus longicaudatus* on soybean. Den Toom (5) found that the effect of *Tylenchorhynchus dubius* on grass was enhanced by decreased soil moisture at low temperatures, but Jaffee and Mai (12) found no interaction between the effect of *Pratylenchus penetrans* (Cobb) Filipjev & Schuurmans Stekhoven on apple trees and low soil moisture.

Both corn and grain sorghum are parasitized by numerous endo- and ectoparasitic nematodes. *Pratylenchus zae* Graham and *Pratylenchus brachyurus* are the predominant species on corn in South Africa (2). Grain sorghum is primarily attacked by *P. zae*, *Pratylenchus crenatus* Loof, and *Pratylenchus penetrans* (3). *Pratylenchus brachyurus* is found on grain sorghum at low frequencies (3,15) but is restricted to areas where grain sorghum succeeds a corn crop.

No information exists on the interaction between lesion nematodes and water stress on corn and grain sorghum during the growing season. The objective of this study was to determine whether water stress enhances the effect of *Pratylenchus* spp. on these crops. We considered creating stressed plants by means of simulating rainfall frequency—a more reliable method for studying nematode effect on plants under stress than trying to maintain fixed water potentials in the soil. Soil water is a dynamic phenomenon, dependent

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upon many aspects of soil physics, including in- and outflow of water from soil (11). The creation of a gradient of stressed plants was thus our aim, rather than to relate certain levels of soil water to the plant and nematode interactions.

MATERIALS AND METHODS

A series of four greenhouse experiments was conducted at a day/night temperature regime of 30/18 C and a 14L:12D photoperiod. Pot size was 4 liters, and steam pasteurized loamy sand (Hutton type, 9% clay, 4% loam, 86% sand; 1% organic matter) was used in all experiments. Fertilizer was applied according to soil nutrient analyses. Two separate experiments were done with corn (cv. PAN 473) and two with grain sorghum (cv. NK304), one each with *P. zaeae* and *P. brachyurus*.

Experimental layouts were completely randomized, with nematodes and no nematodes as the main factors and four watering regimens as subfactors. Each subfactor was replicated with 12 pots. Five seeds were planted per pot. Nematodes in 20-ml aqueous suspensions were pipetted over the seeds and then covered with a 2.5-cm layer of soil. In the corn experiments, the nematode-infested pots received $17,500 \pm 300$ *P. zaeae* and $9,000 \pm 100$ *P. brachyurus* per pot, respectively. Infested pots in the grain sorghum experiments received $9,000 \pm 100$ *P. zaeae* and $6,300 \pm 80$ *P. brachyurus* per pot, respectively. These inoculum densities are representative of natural populations associated with these crops (2,3). Nematodes used in the experiments were cultured axenically on excised corn roots (16). Plants were thinned to one plant per pot 2 weeks after planting by removing only the aerial parts. Root systems were left intact to give nematodes the opportunity to penetrate roots and reproduce.

To ensure minimal differences in soil moisture among pots at the onset of the first cycle, different watering regimens were implemented 2 weeks after planting, until which time all pots were watered ev-

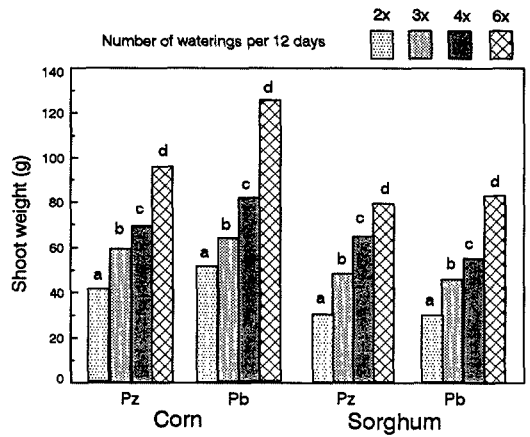


FIG. 1. Shoot weight of corn and grain sorghum in response to *Pratylenchus zaeae* (Pz), *Pratylenchus brachyurus* (Pb), and four different watering regimens.

ery second day. Water was added to the base trays until the soil surface became damp. Thereafter, pots were watered every second, third, fourth, and sixth day of 12-day cycles, respectively. The experiments were harvested after five 12-day cycles.

Plant height and fresh root and shoot weights were determined. Nematodes were extracted from 5 g fresh roots (4) and 200 g soil (13) from the inoculated treatments and counted with a stereomicroscope. Total numbers of nematodes per

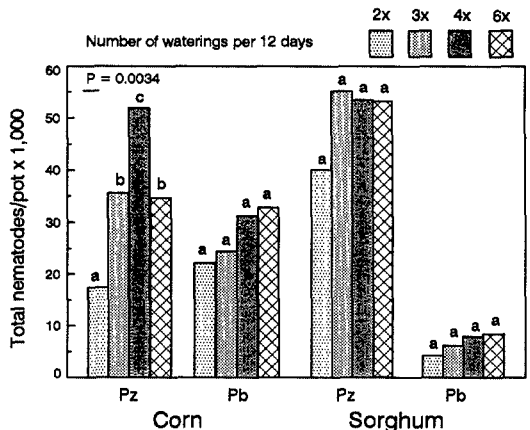


FIG. 2. Numbers of *Pratylenchus zaeae* and *Pratylenchus brachyurus* associated with corn and grain sorghum subjected to different watering regimens. Bars within each cluster marked by the same letter do not differ at $P = 0.05$.

TABLE 1. Growth measurements of corn and grain sorghum in response to *Pratylenchus zeae* (Pz) and *Pratylenchus brachyurus* (Pb) pooled over four watering regimens.

Main effects	Corn-Pz			Corn-Pb			Sorghum-Pz			Sorghum-Pb		
	Plant height (cm)	Shoot weight (g)	Root weight (g)	Plant height (cm)	Shoot weight (g)	Root weight (g)	Plant height (cm)	Shoot weight (g)	Root weight (g)	Plant height (cm)	Shoot weight (g)	Root weight (g)
+ nematodes	87.1 a	65.3 a	45.6 a	115.0 a	76.4 a	54.1 a	101.7 a	54.5 a	27.3 a	95.8 b	53.4 a	27.3 b
- nematodes	87.2 a	67.4 a	57.8 b	117.6 a	84.1 b	60.0 b	100.2 a	55.7 a	27.8 a	90.2 a	52.9 a	24.4 a
<i>P</i> -value	0.9845	0.5402	0.0007	0.2811	0.0039	0.0279	0.4942	0.4354	0.6686	0.0001	0.7615	0.0105
Interaction <i>P</i> -value	0.5491	0.5959	0.7956	0.5360	0.1522	0.1869	0.7784	0.9973	0.3713	0.2363	0.0493	0.4676

Values in the same column followed by the same letter do not differ ($P < 0.05$).

pot were calculated by multiplying counts per sample by the total soil and root weights. Nematode counts were $\log(x + 1)$ transformed. Factorial analyses on the various plant growth measurements and nematode counts were conducted for each experiment. Significant differences between means were determined by *t*-tests.

RESULTS

Gradients of shoot biomass in response to the watering regimens were obtained in all four trials (Fig. 1). All other plant growth parameters followed the same trend in reaction to the different watering regimens in all the trials (data not shown).

The total number (Fig. 2) of *P. zaeae* per pot differed significantly ($P < 0.05$) between the watering regimens in corn, where the lowest regimen supported the least nematodes and the second highest regimen the most nematodes. The total numbers of *P. zaeae* in sorghum and *P. brachyurus* in both corn and sorghum did not differ significantly among the watering regimens.

Root weight of corn was reduced significantly by both *Pratylenchus* spp., whereas shoot weight was reduced only by *P. brachyurus* (Table 1). Sorghum infected with *P. brachyurus* showed significantly increased plant height and root weight in relation to that of uninoculated sorghum plants. *Pratylenchus zaeae* had no effect on any plant growth parameter of sorghum. The shoot weight of sorghum showed a significant interaction between watering regimen and the presence or absence of *P. brachyurus*. There were, however, no significant differences between shoot weights of infected and uninfected plants in this experiment.

DISCUSSION

Both *P. zaeae* and *P. brachyurus* affected corn but not sorghum in this study, which confirms the injuriousness of these nematodes to corn and the absence of damage to sorghum (17,18). Differences in the effect of these nematodes on corn were found in

previous studies (McDonald, unpubl. data) and may be due to the different feeding sites and habits of these two species (1,7,18). The improved growth of sorghum in response to *P. brachyurus* can be explained in terms of the known ability of grain sorghum to compensate for pest damage (6,22).

The relationship between numbers of *P. zaeae* on corn plants with different watering regimens is similar to the results of others (9,20), but the populations of *P. brachyurus* on both crops and *P. zaeae* on sorghum was unaffected by the degree of stress their host plants suffered.

Although water stress may affect population densities of nematodes, other factors are also known to influence their pathogenicity to host plants (5,12,23). The interaction of water stress and other factors such as O₂ concentration, tolerance of the host plant, and other climatic and edaphic factors may govern the pathogenicity of the nematodes on the crop (18,20). It is possible, however, that low soil moisture may obscure symptom expression of nematodes on crops (21).

The continuity of nematode populations in field situations over a number of seasons may complicate the interrelationships of nematodes, their hosts, and the environment. Further investigation is needed to establish the effect of these conditions in conjunction with each other on the pathogenicity of lesion nematodes on their hosts.

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