Influence of Temperature on Population Development of Eight Species of Pratylenchus on Soybean[1]

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Abstract: In a soil temperature study, population increase on 'Clark 63' soybean was most rapid at 30 C in *Pratylenchus alleni, P. brachyurus, P. coffeae, P. neglectus, P. scribneri,* and *P. zeae* and at 25 C in *P. penetrans* and *P. vulnus.* The last two were the only species that reproduced at 15 C. Populations of all species increased over the range of 20–30 C, except those of *P. neglectus* at 20 C and *P. coffeae,* which was not tested below 25 C. Only *P. brachyurus, P. neglectus, P. scribneri* and *P. zeae* reproduced at 35 C. At their optimum temperatures, *P. scribneri* exhibited the greatest population increase, 1248-fold, and *P. penetrans* the least, 32-fold. This is the first report of soybean as a host for *P. vulnus. Key Words: Pratylenchus alleni, P. brachyurus, P. coffeae, P. neglectus, P. penetrans, P. scribneri, P. vulnus, P. zeae,* lesion nematodes, host-parasite relationships, ecology, susceptibility, *Glycine max.*

The activity of soil-inhabiting nematodes is influenced to some degree by each of the many biotic and abiotic factors in their complex environment. Temperature is particularly important, affecting movement, rate of growth and reproduction, sex determination, relative abundance of food, and expression of nematode damage to plants (11). There have been numerous reports concerning the influence of this factor on host-nematode relationships but few involving soybean (*Glycine max* [L.] Merr.) and lesion nematodes. Knowledge of the effects of temperature on population development of these nematodes on soybean is limited to findings of Lindsey and Cairns (6), who reported that the density of *Pratylenchus brachyurus* (Godfrey) Filipv. and Schuurm.-Stekh. populations in roots of several cultivars generally increased with temperature up to the test maximum of 29 C.

Greenhouse culture tests have indicated that several species of *Pratylenchus* reproduce rapidly on soybean during the summer months. This study was conducted to determine the influence of temperature on the population development on soybean of *P. alleni* Ferris, *P. brachyurus, P. coffeae* (Zimmerman) Filipv. and Schuurm.-Stekh., *P. neglectus* (Rensch.) Filipv. and Schuurm.-Stekh., *P. penetrans* (Cobb) Filipv. and Schuurm.-Stekh., *P. scribneri* Steiner, *P. vulnus* Allen and Jensen, and *P. zeae* Graham.

MATERIAL AND METHODS

Original sources of nematodes were: *P. alleni* from *Syringa persica* L., Onarga, Illinois; *P. brachyurus* from *Ananas comosus* Merr., Corozal, Puerto Rico; *P. coffeae* from *Dioscorea rotundata* Poir, Corozal, PR; *P.*

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neglectus from *Chenopodium album* L., Fort Michell, Nebraska; *P. penetrans* from *Medicago sativa* L., callus tissue, University of Maryland; *P. scribneri* from *Zea mays* L., Urbana, IL; *P. vulnus* from *Rosa* sp. (greenhouse), Pana, IL; *P. zeae* from *Glycine max*, Mayaguez, PR. Where species identities had not been fully established, they were subjected to comprehensive morphological and morphometric comparison with original descriptions. Nematode populations were increased on soybean and inocula extracted from roots in a mist chamber by the funnel-spray method of Oostenbrink (7).

Two 'Clark 63' soybean seedlings were planted in each of 152 fifteen-cm-diam plastic pots containing 1,400 cm^3 of steam-sterilized Sparta loamy fine sand, a non-organic, heterogeneous soil with a pH of 4.5. When cotyledons emerged, an inoculum of 1,000 nematodes of the appropriate species/pot was poured into a hole in the center of the pot and the hole was filled with soil. Inocula consisted of only vermiform stages in approximately equivalent numbers within and among species. After 5 days of incubation on a greenhouse bench, each pot was nested in a impervious pot of similar diam. Four pots of each species were arranged randomly in 15, 20, 25, 30, and 35 C constant-temperature tanks, except for *P. coffeae*, which was studied only at the upper three temperatures because of low availability of inoculum. No nodulating bacteria were added to the plants, but a 23-19-17 fertilizer solution was applied monthly.

Plants were grown in the tanks for 75 days, which preliminary tests indicated was the optimum incubation period before nematode-population ceiling levels were reached in some of the species at favorable temperatures. Plant weights were recorded for comparison of growth. Nematodes were extracted from washed intact root systems in a mist chamber (7) and from soil by a modification of the method of Christie and Perry (2).

RESULTS AND DISCUSSION

The eight species of *Pratylenchus* differed considerably in their temperature requirements and ability to reproduce on soybean (Table 1). The optimum temperature for population development of *P. alleni, P. brachyurus, P. coffeae, P. neglectus, P. scribneri*, and *P. zeae* was 30 C, while that for *P. penetrans* and *P. vulnus* was 25 C. The last two were the only species that reproduced at the relatively low temperature of 15 C. Populations of all species increased to some extent over the range of 20 to 30 C, except those of *P. neglectus* at 20 C and *P. coffeae*, which was not tested at the lower temperature. Only *P. brachyurus, P. neglectus, P. scribneri*, and *P. zeae* reproduced at 35 C. The temperature optima for all but *P. alleni* and *P. penetrans* were well defined by substantially reduced population development at ±5 C of the optimum. Where reproduction was significant, 95–99% of the nematodes were recovered from roots.

Among the species at their respective optimum temperatures, *P. scribneri* had the

TABLE 1. Numbers of nematodes recovered from roots of soybean grown 75 days at constant temperatures after inoculation with eight species of *Pratylenchus* at 1000/pot.

Species	Nematode numbers (1000's)[a]				
	Temperature (C)				
	15	20	25	30	35
P. alleni	0.1a	5.1a	30.9ab	47.ab	0.2a
P. brachyurus	0.1a	5.6a	26.5ab	529.2c	8.0a
P. coffeae	—	—	64.9b	332.2bc	1.0a
P. neglectus	0.2a	0.7a	2.2c	1106.6d	29.7b
P. penetrans	4.8b	27.0b	31.1ab	7.5a	0.1a
P. scribneri	0.2a	1.7a	25.5ac	1197.5e	41.6b
P. vulnus	5.6b	87.5c	271.1d	3.9a	0.1a
P. zeae	0.1a	1.7a	7.5c	138.5ab	33.0b

[a]Each value is the mean of four replications; column means followed by unlike letters differ ($P \leq 0.05$), according to Duncan's new multiple-range test.

greatest amount of reproduction, increasing in numbers 1248-fold over the initial level at 30 C. Its population also increased more than that of any other species at 35 C. In general, *P. neglectus* and *P. zeae* behaved similarly to *P. scribneri,* but reproduction was less extensive. Population development of all three species at 35 C may have been restricted by retarded plant growth caused by high-temperature stress. Development was much reduced at 25 C and negligible at 20 C. Unpublished results of a related study (1) confirmed the temperature response of *P. scribneri* and indicate that its real optimum on soybean is 33 or 34 C. Comparable trends in temperature response were found by Thomason and O'Melia (10) with *P. scribneri* on sugar beet (*Beta vulgaris* L.), Sudan grass (*Holcus sudanensis* Bailey), and snap bean (*Phaseolus vulgaris* L.), and by Graham (5) with *P. zeae* on tobacco (*Nicotiana tabacum* L.) and corn (*Zea mays* L.).

Pratylenchus brachyurus, P. coffeae and *P. alleni* had similar temperature requirements, which were lower than those of the more thermophilic species. Unlike those species, *P. brachyurus* and *P. alleni* populations increased at least 5-fold at 20 C. Within this group at their optimum of 30 C, population development was most extensive in *P. brachyurus,* which increased 529-fold. Lindsey and Cairns (6) also found that population densities of this species increased in roots of soybean as temperatures approached 30 C. Graham (5) obtained a similar response to temperature in *P. brachyurus* on corn and tobacco. The temperature optimum for *P. coffeae* was the same as that found by Radewald et al. (8) on rough lemon (*Citrus jambhiri* Lush). Population development by *P. alleni* was comparatively low. Although its numbers at 25 and 30 C did not differ widely, unpublished results of related work (1) with this species confirmed that its optimum is close to 30 C and that reproduction ceases at 35 C.

P. penetrans and *P. vulnus* had similar requirements for relatively cool temperatures. There was some degree of population increase at temperatures as low as 15 C but little development at 30 C and none at 35 C. *P. penetrans* showed the least increase of any of the eight species, only 31-fold at its optimum of 25 C. Numbers were not substantially lower at 20 C, indicating that its real optimum on soybean probably lies at 22 or 23 C. Dickerson et al. (3) reported that populations of this species increased most rapidly at 24 C on corn and at 16 C on potato (*Solanum tuberosum* L.). Dunn (4) obtained highest numbers from alfalfa plants at 30 C in 90 days, although the ceiling level may have been reached earlier at lower temperatures, because he recorded greater population growth at 27 C than at 30 C on alfalfa callus. Sher and Bell (9) found that *P. vulnus* reproduced on rose (*Rosa* sp.) throughout a range of 18–32 C but that populations increased most rapidly between 24 and 29 C. *P. vulnus* has not heretofore been known to parasitize soybean. The finding that it readily reproduces on that plant thus constitutes the first report of soybean as a host.

Results of this study demonstrate considerable physiological differences among species of *Pratylenchus* with respect to temperature requirements. The individual preferences may be a significant factor governing the distribution of at least some of the species, as was concluded by Wallace (11) for many other nematodes. The results also show that temperature plays an important role in the relative susceptibility of soybean to members of the genus *Pratylenchus.*

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