RESEARCH PAPERS - TRABAJOS DE INVESTIGACION

EFFECT OF TIME LAPSE ON PATHOGENICITY AND POPULATION DYNAMICS OF *PRATYLENCHUS ALLENI* AND *P. SCRIBNERI* IN SOYBEANS. [EFECTOS DEL TIEMPO EN LA PATOGENICIDAD Y DINAMICA POBLACIONAL DE *PRATYLENCHUS ALLENI* Y *P. SCRIBNERI* EN SOYA].[1]/

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ABSTRACT

In a 10-month greenhouse study of population dynamics, numbers of *Pratylenchus alleni* Ferris and *P. scribneri* Steiner increased rapidly during the first four months after inoculation in Clark 63 soybeans, reached a "ceiling level", and began to decline. Populations of *P. alleni* peaked after five months at 178X the inoculum level, while those of *P. scribneri* peaked after eight months at 188X the initial level.
Key Words: Clark 63 soybeans, ceiling level, population levels, intraspecific competition and antagonistic interactions.

INTRODUCTION

Temperature, moisture, soil type and other environmental factors affect the activity of soil-inhabiting nematodes. Soil temperature particularly affects expression of nematode damage to plants and is an important factor in the seasonal fluctuations of plant growth and nematode numbers (8).

The distribution and abundance of phytoparasitic nematodes is governed by changes in numbers as the host matures and senesces. In the soil, numbers of nematodes change as the season progresses. This paper presents results from a study on the population dynamics of two species of *Pratylenchus* on soybeans.

MATERIALS AND METHODS

Population dynamics of *P. alleni* Ferris and *P. scribneri* Steiner in Clark 63 soybeans cv. were studied over a 10-month period in the greenhouse at Urbana, Illinois. The experiment was initiated in late April and terminated in late February. Two five-day old soybean seedlings were planted at inoculation time in each of 100, 15 cm-diam clay pots containing 1,300 cm^3 of autoclaved Sparta loamy-fine sand (84.0% sand, 10.2% silt and 4.9% clay) with 0.4% organic matter content and pH 4.3. *Pratylenchus alleni* at 2,000 nematodes/pot were added to 50 pots and each of the

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remaining pots received 2,000 *P. scribneri.* Eleven groups of pots, five replicates per nematode species, were arranged in a randomized complete block design on a greenhouse bench. Plants received supplemental fluorescent light to provide a 16-h day length. Throughout the study, soil temperatures were recorded at a depth of 6.25 cm, twice daily before watering and ambient temperatures were recorded twice daily (Table 1). No nodulating bacteria were added to the plants but a 23-19-17 (N, P, K) fertilizer solution was applied monthly. At monthly intervals during 10 consecutive months, plants from one group of pots were cut at the cotyledonary node and their shoot dry weights recorded. Roots were removed from 1,300 cm^3 of soil by washing them in a plastic bucket. Nematodes were extracted from the soil suspension in the bucket by a modification of the method of Christie and Perry (2) and extracted from the roots in a mist chamber (6) for 10 days. After the 10-day nematode extraction period, roots were oven-dried at 80° C for 72 h. Tops of all plants which senesced by the fifth month after inoculation, were cut at the base of the cotyledonary node and their dry shoot weights recorded. Immediately following processing of the appropriate group, two seedlings were planted in each of the remaining pots. Pots were replanted similarly three months later.

Table 1. Monthly range and means of temperatures (C) in and around pots of soybeans plants inoculated with *Pratylenchus* spp. and grown in the greenhouse.

	Temperature (C)			
	Soil*		Ambient*	
Month	Range	Mean	Range	Mean
May	14-29	23	9-33	24
June	16-28	24	13-33	24
July	20-34	24	16-33	25
August	18-27	24	14-31	25
September	18-28	24	15-35	24
October	22-26	25	17-34	28
November	22-28	25	16-33	26
December	24-26	25	17-33	29
January	22-24	23	10-31	25
February	22-26	24	28-31	30

*Soil temperatures were recorded twice daily at a depth of 6.25 cm; ambient temperatures were recorded twice daily.

RESULTS AND DISCUSSION

Population levels of the two nematode species did not differ significantly at any point in the 10-month period (Table 2). Total numbers/pot of both species declined by the first month after inoculation; while there was a rapid increase in populations during the subsequent three months. During the first four months, the curves generally assumed the "J" shape (Figure 1), typical of population growth of plant-parasitic nematodes in the absence of competitors (7, 8).

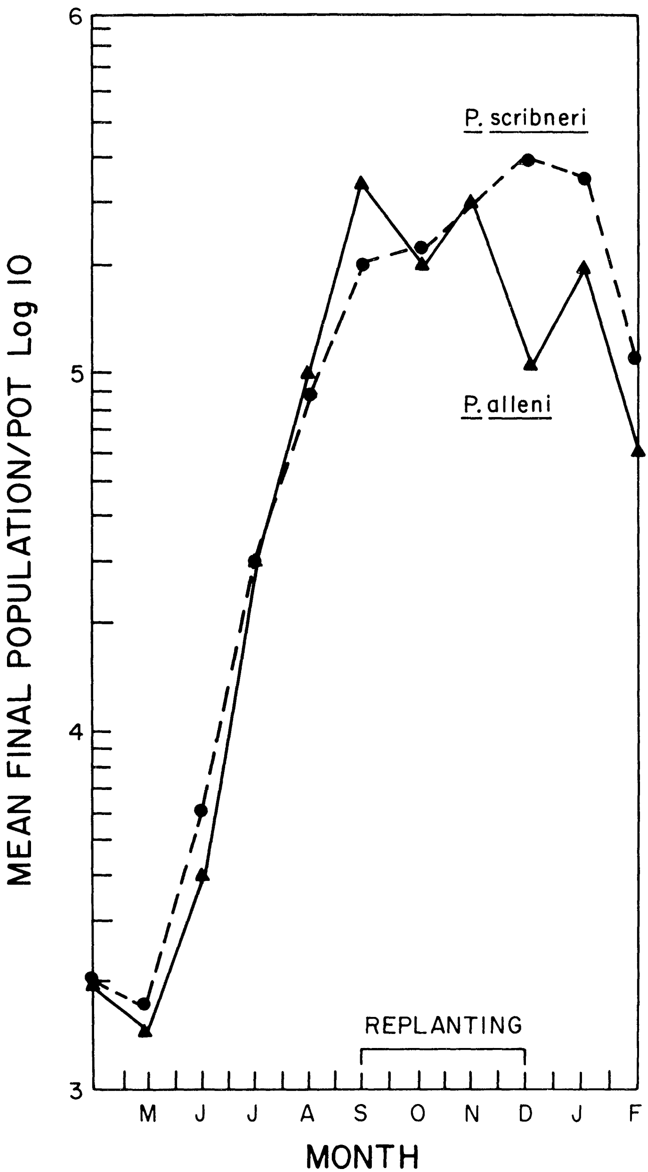

Fig. 1. Population dynamics of *Pratylenchus alleni* and *P. scribneri* in pots of greenhouse-grown soybeans over a period of 10 months after inoculation with 2000 nematodes. There were no significant differences between the population levels of the two species at any point in the curve.

Table 2. Numbers of *Pratylenchus alleni* (Pa) and *P. scribneri* (Ps) recovered from the soil and roots of greenhouse-grown soybeans at monthly intervals over a period of 10 months after inoculation with 2,000 nematodes/pot.

	May	June	July	Aug.	Sept.[z]	Oct.	Nov.	Dec.[z]	Jan.	Feb.
Numbers (1,000's) of nematodes in 1,300 cm^3 of soil [y]										
Pa	0.3	0.6	0.6	2.6	62.0	23.6	31.3	28.5	16.0	18.0
Ps	0.2	0.5	0.7	8.0	90.0	53.7	143.6	162.5	144.3	90.6
Numbers (1,000's) of nematodes in the roots [y]										
Pa	1.2	4.1	31.6	115.4	294.0	201.4	298.3	133.3	191.6	45.0
Ps	1.5	6.1	32.0	81.7	99.8	187.3	162.0	213.8	157.8	52.0

[z] All remaining pots replanted.
[y] Each value is the mean of five replications; column means do not differ (P = 0.05), according to Duncan's New Multiple Range Test.

Table 3. Dry shoot and root weights (g) of greenhouse-grown soybeans at monthly intervals over a period of 10 months after inoculation with 2,000 *P. alleni* (Pa) or *P. scribneri* (Ps).

	May	June	July	Aug.	Sept.[z]	Oct.	Nov.	Dec.[z]	Jan.	Feb.
Shoots [y]										
Pa	1.4a	15.5a	32.4b	49.0a	52.1a	1.0a	5.0a	35.7a	9.6a	10.7a
Ps	1.8b	15.3a	27.1b	38.6a	42.8a	1.3a	6.9a	46.1a	15.1b	15.1b
Roots [y]										
Pa	0.1	2.5	3.6	5.5	7.7	7.9	5.6	5.3	9.1	6.1
Ps	0.3	2.7	4.0	4.2	7.4	6.2	5.3	7.4	7.3	10.2

[z] All remaining pots replanted.
[y] Each value is the mean of five replications; shoot column means followed by unlike letters differ (P = 0.05), according to Duncan's New Multiple Range Test; root column means do not differ.

Numbers of *P. scribneri* appeared to increase somewhat more rapidly than those of *P. alleni* until July, when populations of both species had increased over 16-fold. For two months thereafter, numbers of *P. scribneri* increased less rapidly than those of *P. alleni*. Populations of *P. alleni* peaked in September reaching 178X the inoculation level. Following the first replanting, numbers of the latter species declined briefly, probably because of a reduction in suitable feeding sites.

Populations of *P. scribneri* increased gradually from August and peaked in December at 188X the initial density despite replanting in September. Its numbers during the latter part of this period were substantially higher than those of *P. alleni*. The second replanting in December did not immediately affect populations of either species. Numbers of both species declined sharply, however, during the one month period of January to February, probably as the result of intraspecific competition and antagonistic interactions between nematodes and microorganisms in both living and decaying dead roots. As illustrated by the theoretical curve of nematode and population dynamics developed by Oostenbrink (7), initial nematode densities rise after planting, reach a certain peak and decline due to intraspecific competition, parasite-predator pressure and/or because the spatial or nutritional capacity of the plant becomes limiting to the population.

Until the last month of this study, numbers of nematodes in the root system exceeded those in the soil (Table 2). The root-soil population ratio of *P. alleni*, however, tended to be higher than that of *P. scribneri* after July. Only in *P. scribneri* did the ratio approach 1:1 in September, when plants were senescing. This ratio was also obtained in the November to January period when total populations were at their highest levels. At the termination of the experiment, in February, numbers of *P. scribneri* in roots had dropped below those in the soil, while root populations of *P. alleni* remained higher than soil populations.

Shoot weights of plants inoculated with *P. alleni* were significantly lower than those of *P. scribneri* one month after inoculation, probably because of the lower root weights and higher nematode densities within roots in pots of the former species (Table 3). Similar differences occurred again in January and February. No other differences in shoot or root weights between treatments were detected throughout the study.

The shape of the population curves of *P. alleni* and *P. scribneri* resembles those of many species of plant-parasitic nematodes on different crops under natural conditions, in a temperate climate where the growing season is limited to less than nine months. During the first part of the curve, populations increased rapidly because of ample feeding sites and absence of population-regulating factors. Populations reached the "ceiling level", as described by Oostenbrink (7), and finally began to decline because of intraspecific competition for feeding sites, and suppresion by other biotic factors.

As in other experiments using autoclaved soil, lesion nematode populations in pots developed to levels considerably higher than those normally encountered in a similar volume of soil under field conditions. Such exceptionally high levels occur because of absence of natural control factors in initially sterile soil, highly favorable moisture and temperature conditions for population development in the greenhouse and, as pointed out by Coates (1) who studied population dynamics of *Tylenchorhynchus agri* Ferris, much greater density of roots per volume of soil in the restricted confines of a pot.

The population curves under greenhouse conditions are probably more similar to those of field conditions in the southern areas of the temperate zone. In these areas, a somewhat longer growing season and less extreme temperature fluctuations extend the seasonal development of parasitic nematode populations more than in the northern areas of the zone. In general, the curves are similar to those found with populations of *P. zeae* Graham and *P. brachyurus* (Godfrey) Filipv. and Schuurm.-Stekh. in the southeastern coastal plain of the U.S. as determined over a 4-year period by Johnson et al. (4). In that study, populations grew rapidly during the summer to peaks in late summer on corn and in mid-autumn on soybeans. In the Illinois-Indiana area, however, Ferris and Bernard (3) showed that soil populations of *P. scribneri* and *P. hexincisus* on soybeans, increased slower to peaks in early summer, then drastically declined in late summer to relatively low levels through autumn. Olthof (5) found that population development of *P. penetrans* (Cobb) Filipv and Schuurm.-Stekh. in soil in Ontario tobacco and rye fields was highly variable from year to year but tended to be low in the summer and high in the fall. The findings of these workers are not entirely comparable to the results of the present study, however, and do not provide a clear picture of the population dynamics of lesion nematodes under field conditions. In neither of those studies was an analysis made of the root population, which may represent much of the total population while the host is actively growing and may fluctuate in relation to the soil population from month to month.

It is generally accepted that, at low initial soil or root population densities such as those used in this experiment, populations of *P. alleni* which reproduces amphimictically should develop more slowly than those of *P. scribneri* which reproduces parthenogenetically, at least early in the cycle, because of the presumed necesity for copulation between male and virgin and future adult females prior to reproduction in the former species. Although there were some differences in the rate of population growth between the species, the differences were not significant at any point along the curves.

RESUMEN

En un estudio de dinámica poblacional, llevado a cabo por 10 meses en el invernadero, las poblaciones de *Pratylenchus alleni* y *P. scribneri* aumentaron rápidamente durante los primeros cuatro meses después de haber sido añadidos a plántulas de soya de la variedad Clark 63, alcanzaron un nivel poblacional máximo y comenzaron a declinar. Las poblaciones de *P. alleni* alcanzaron un nivel máximo cinco meses después de ser añadidos a plántulas de soya. Dicho aumento representó un 178X sobre el nivel de inóculo inicial. Por otro lado, las poblaciones de *P. scribneri* alcanzaron un nivel máximo ocho meses después de la inoculación que representó 188X el nivel inicial.

Claves: niveles de población, máximas poblacionales, Glycine max, competencia interespecífica, relaciones antagonísticas.

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