Istituto di Nematologia Agraria, C.N.R., 70126 Bari, Italy

TEMPORAL AND SPATIAL DYNAMICS OF *PRATYLENCHUS VULNUS* PARASITIZING WALNUT

by

A. CIANCIO, S. LANDRISCINA and F. LAMBERTI

Summary. The population dynamics of *Pratylenchus vulnus* and *Longidorus proximus* were studied in the rhizosphere of walnut at Faiano (Salerno). The density of *P. vulnus* varied from 33 to 211 specimens /100 cc soil, with alternate peaks in October 1993 and summer 1994. The population of *L. proximus* varied from 14 to 275 nematodes per 100 cc soil and showed the highest increase in September. No interaction between the two species was observed and the changes of two populations appeared related to increasing density and host root damage. When Taylor's power law was applied to study the spatial spreading and aggregation of both species, *P. vulnus* appeared more aggregated than *L. proximus*, requiring higher numbers of samples for density estima-

Because of the development of walnut (*Juglans regia* L.) culture in marginal cultivated lands in southern Europe, several studies and observations on nematodes parasitizing this crop in Italy have been carried out (Inserra *et al.*, 1979; Lamberti, 1981; Inserra and Vovlas, 1981; Roca *et al.*, 1984).

In this paper we report on the infestation of walnut a by population of *Pratylenchus vulnus* Allen *et* Jensen and on the dynamics of a population of *Longidorus proximus* Sturhan *et* Argo. Data on density levels, aggregation and spatial sampling and spread of both species are presented and discussed.

Materials and methods

The population dynamics of *P. vulnus* and *L. proximus* was studied in the rhizosphere of a 80 year old walnut tree (cv. Sorrento) at Faiano, Salerno. Three equally spaced soil samples were collected from the circumference of the tree canopy at a depth of 20-40 cm and at three-five weeks intervals from June 1993 until December 1994. For each sample approximately two litres of soil were collected. The nematodes were extracted by a sieving and decanting technique using 720 μm and a 53 μm sieves and counted in the sieve extract using a Hawksley counting chamber.

The spatial distribution of both species was studied by collecting thirty soil samples randomly distributed under the tree canopy at a 60-80 cm average distance in May, 1995. The nematodes were extracted from soil and counted as described above. Specimens of *P. vulnus* were extracted from moisted walnut roots after five days incubation at room temperature in parafilm sealed bakers and counted as described above. Statistical tests for distribution and sampling efficiency included the analysis of nematode aggregation with Taylor's power law (Boag and Topham, 1984; McSorley *et al.*, 1985). Log transformed densities from ten observations each one the mean of three contiguous samples, six observations each one the mean of five replications, and fifteen observations each the mean of two contiguous samples, were used for both species. The number of samples (n) required to obtain a given confidence interval around the mean was calculated as $n = (t/D)^2\ a\ \bar{x}^{(b-2)}$, where D is the half-width interval to mean ratio, $\bar{x}$ is the mean nematode density, t = 2 and *a* and *b* correspond to Taylor's power law parameters obtained by the regression function of variance and mean values: $\log(s^2) = a + b \log(\bar{x})$ (McSorley *et al.*, 1985). The programs SAS and Mathcad were used for data processing and analysis (SAS, 1985).

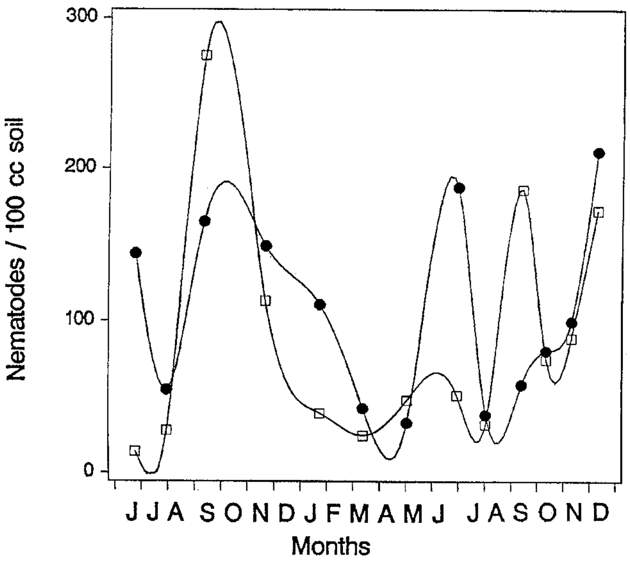

Fig. 1 - Population densities of *Pratylenchus vulnus* (•) and *Longidorus proximus* (□) in the rhisosphere of walnut at Faiano (Salerno) from June 1993 until December 1994.

Results and discussion

In the temporal sampling, both *P. vulnus* and *L. proximus* were found each month. The population of *P. vulnus* showed peaks in the population density in September, 1993 and July and December, 1994. The density of *P. vulnus* ranged from 33±15 specimens/100 cc of soil (mean±SD) in April, 1994 to 211±75 specimens/100 cc of soil in December, 1994. The all-months mean was 106±58 specimens/100 cc of soil. The mean percentages of juveniles ranged between 21.9 (October 1994) and 74.2 (September, 1994). Percentages of males and females ranged between 14.5 (September, 1994) and 58.3 (November, 1994) and 11.1 (September, 1994) and 100 (July, 1993), respectively.

The population density of *L. proximus* showed a marked increase in September in both years. The density of *L. proximus* varied from 14±13 specimens/100 cc of soil in June 1993 to 275±105 nematodes/100 cc of soil in September, 1993. The all-months mean was 88±75 specimens/100 cc of soil (Fig. 1).

In the spatial sampling, *P. vulnus* and *L. proximus* were found in 86.6% and 70% of total samples, respectively. The densities of *P. vulnus*

TABLE I - *Taylor's power law parameters for* Pratylenchus vulnus *and* Longidorus proximus *in the rhizosphere of walnut. Data are from spatial sampling with samples combinations of two, three and five replications per observation.*

Nematode species	n	r^2	a	b	$\bar{x}$	s^2
Pratylenchus vulnus	15	0.790***	0.432	1.725	67.2	1796.6
Pratylenchus vulnus	10	0.864**	0.200	1.857	76.3	1221.3
Pratylenchus vulnus	6	0.698	0.270	1.824	84.4	587.5
Longidorus proximus	15	0.734**	-0.07	1.991	31.4	517.3
Longidorus proximus	10	0.848**	1.212	1.188	35.5	631.5
Longidorus proximus	6	0.777	1.002	1.346	39.3	427.6

** significant for P<0.01; *** significant for P<0.001.

ranged between 21 and 333 nematodes/100 cc of soil. The percentages of juveniles were inversely correlated with the percentages of males and females (r = -0.491 and r = -0.636, $P<0.01$, respectively). The number of juveniles per female showed a negative correlation with the percentage of females (r = -0.498, $P<0.01$) and was correlated with the percentage of juveniles (r = 0.509, $P<0.01$).

Specimens of *P. vulnus* were extracted from 30% of root samples at densities ranging from 18 to 367 nematodes/g of roots. The densities of *L. proximus* ranged between 21 and 175 specimens/100 cc of soil. No nematode was found in the incubated root extract.

The mean and variance values and the Taylor's power law parameters for the different combinations of samples for both *P. vulnus* and *L. proximus* are given in Table I. The relationship between mean density and variance with ten samples each of three replicates are shown for both species in Fig. 2 a, b. The relationship between the number of samples required for both species using these Taylor's power law parameters and the half-confidence interval to mean ratio is shown in Fig. 3. At a 10% level of the half confidence interval, 43 sample were required for *P. vulnus* and 14 for *L. proximus* with three subsamples. A higher number of samples was required at the same confidence interval when using five or two replications per observation.

The population dynamics of *L. proximus* displayed some similarities with the density changes of *P. vulnus*. Both species fluctuated around levels which allowed the population to be maintained and co-existence in time. No detrimental effect of one species on the reproduction of the other was observed. In summer 1993 and 1994 the density peaks of *P. vulnus* followed at a short time interval the increases in *L. proximus*.

Self-competition due to nematode crowding rather than interspecific competition appears to be responsible for the trends observed in the population dynamics of *P. vulnus* and *L. proximus*. Detrimental effects produced by nematode

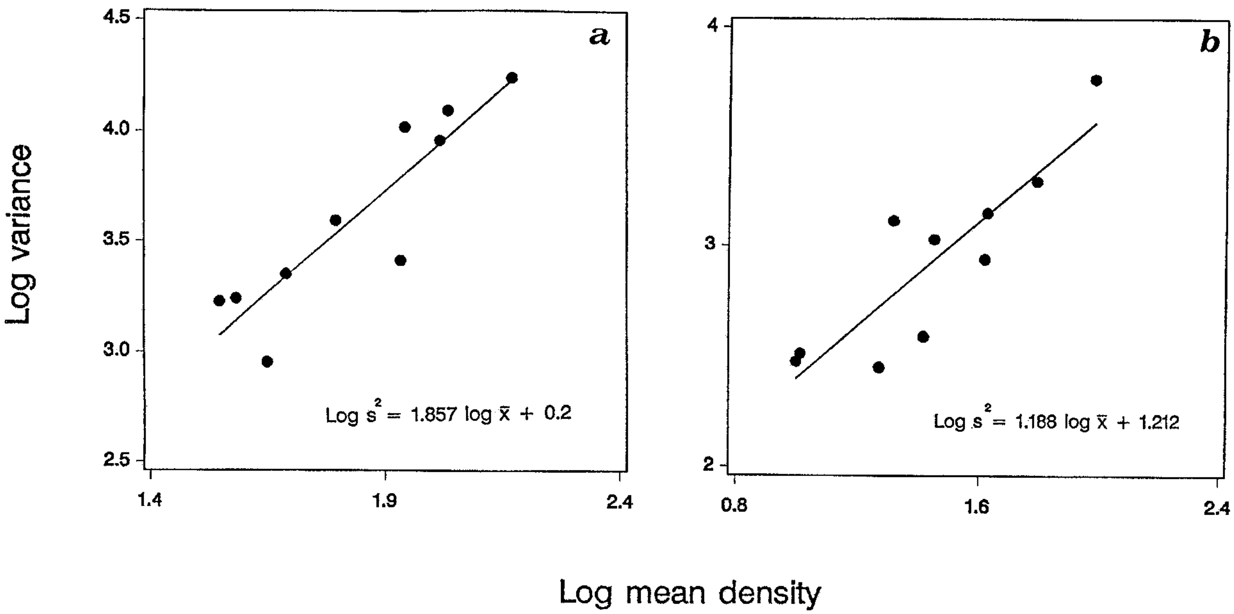

Fig. 2 - Relationship between mean density and variance from the spatial sampling data of *P. vulnus* (a) and *L. proximus* (b) collected at Faiano (Salerno) in May 1995. Each observation mean of three replications.

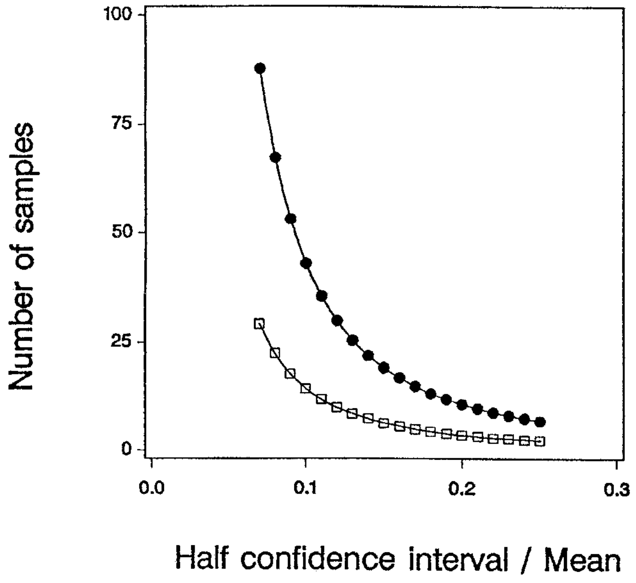

Fig. 3 - Relationship between number of samples and the half-confidence interval to mean ratio for *P. vulnus* (•) and *L. proximus* (□), as derived by Taylor's power law parameters with three replications per observation.

feeding on the host root system represent a further possible feedback mechanism regulating the growth of both populations.

In the spatial sampling, the occurrence of a density dependent feedback mechanism influencing *P. vulnus* reproduction was confirmed by the negative correlation observed between percentages of females in the population and the number of juveniles per female.

When using samples combinations of three and five subsamples per observation, *P. vulnus* was more aggregated than *L. proximus*. This was shown by parameter *b*, which is a specific index of spatial aggregation (Taylor, 1964; McSorley *et al.*, 1985). Higher *b* values were obtained for L. *proximus* with two subsamples per observations, probably because of the distance among samples rather than a specific nematode behavior (Boag and Topham, 1984). The *b* values of *L. proximus* were within the range of values observed for other *Xiphinema* and *Longidorus* spp., with samples collected at close distance ranges (Boag and Topham, 1984; Boag *et al.*, 1987).

Aggregation of *P. vulnus* is related to its semi-endoparasitic behaviour and to the presence of males, whereas the less aggregated pattern of *L. proximus* reflects the migratory and polyphagous ectoparasitic habit of this nematode.

Taylor's power law is useful in providing estimations of the numbers of samples required when assessing nematode density at a given efficiency level (McSorley *et al.*, 1985; Abd-Elgawad, 1992). Although the effect of distance among samples on Taylor's power law parameters is known (Boag and Topham, 1984), the effect of changing the number of replications per observation was unexpected. This is probably an indirect consequence of the spatial distribution of soil samples and their relative distances.

Nematodes parasitizing walnut in Italy include *P. vulnus* and several species of Criconematidae and Longidoridae (Inserra *et al.*, 1979; Lamberti, 1981; Inserra and Vovlas, 1981; Roca *et al.*, 1984).

Pratylenchus vulnus is a widespread species parasitizing several fruit crops in Europe and North America (Corbett, 1974; Lamberti, 1981). In cultivated fields, *P. vulnus* frequently occurs in association with other plant parasitic nematodes and can dramatically reduce plant and root growth as well as fruit production (Lownsbery, 1956; Corbett, 1974; Pinochet *et al.*, 1976; Anwar and Van Gundy, 1993).

Our data show that when sampling small parcels at any combination of replications in the agronomic conditions of Southern Italy, the number of samples required at the same confidence level for estimating *L. proximus* density is less than that needed for *P. vulnus*. This is related to the more aggregated pattern and host specificity of this species and must be taken into account when density estimations are required to assess root damage and crop losses.

Acknowledgement. The assistance of Dr. P. Fazio during this study is gratefully acknowledged. Research funded by the EU Commission, AIR contract CT92-0142.

A compassionate thought is dedicated to Mr S. Landriscina who deceased on August 15, 1995.

Literature cited

ABD-ELGAWAD M. M., 1992. Spatial distribution of the phytonematode community in Egiptian citrus groves. *Fundam. appl. Nematol.*, *15*: 367-373.

ANWAR S. A. and VAN GUNDY S. D., 1993. Influence of the interaction of *Meloidogyne incognita* and *Pratylenchus vulnus* on root-shoot growth parameters in grape. *Afro-Asian J. Nematol.*, *3*: 5-11.

BOAG B., BROWN D. J. F. and TOPHAM P. B., 1987. Vertical and horizontal distribution of virus-vector nematodes and implications for sampling procedures. *Nematologica*, *33*: 83-96.

BOAG B. and TOPHAM P. B., 1984. Aggregation of plant parasitic nematodes and Taylor's power law. *Nematologica*, *30*: 348-357.

CORBETT D. C. M., 1974. *Pratylenchus vulnus*. C.I.H. Description of plant-parasitic nematodes, Set 3, No. 37.

INSERRA R. N. and VOVLAS N., 1981. Parasitism of walnut, *Juglans regia*, by *Cacopaurus pestis*. *J. Nematol.*, *13*: 546-548.

INSERRA R. N., ZEPP A. and VOVLAS N., 1979. I *Pratylenchus* dell'Italia meridionale. *Nematol. medit.*, *7*: 137-162.

LAMBERTI F., 1981. Plant nematode problems in the mediterranean region. *Helm. Abstr.* Series B, *50*: 145-166.

LOWNSBERY B. F., 1956. *Pratylenchus vulnus*, primary cause of the root-lesion disease of walnut. *Phytopathology*, *46*: 376-379.

MCSORLEY R., DANKERS W. H., PARRADO J. L. and REYNOLDS J. S., 1985. Spatial distribution of the nematode community on Parrine marl soils. *Nematropica*, *15*: 77-92.

PINOCHET J., RASKI D. J. and GOHEEN A. A., 1976. Effect of *Pratylenchus vulnus* and *Xiphinema index* singly and combined on root growth of *Vitis vinifera*. *J. Nematol.*, *3*: 330-335.

ROCA F., LAMBERTI F. and AGOSTINELLI A., 1984. Three new species of *Longidorus* (Nematoda, Dorylaimida) from Italy. *Nematol. medit.*, *12*: 187-200.

SAS INSTITUTE, 1985. *Sas user's guide: Statistics, version 5 ed.* SAS Institute, Cary, N.C.: 956 pp.

TAYLOR L. R., 1961. Aggregation, variance and the mean. *Nature*, *189*: 732-735.

Accepted for publication on 2 September 1995.