

**OBSERVATIONS ON THE SEASONAL FLUCTUATION OF  
MELOIDOGYNE HAPLA ON KIWI (*ACTINIDIA DELICIOSA*)  
IN SPAIN**

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ABSTRACT

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A study of the population dynamics of *Meloidogyne hapla* was carried out during a 1-year period in a kiwifruit (*Actinidia deliciosa*) orchard located in Cabrils, Barcelona, Spain. *Meloidogyne hapla* population was highest in January and March reaching 8 640 and 7 520 nematodes in 250 cm<sup>3</sup> of soil, respectively. High soil population in winter was correlated with lack of rains and abnormally high temperatures during the months of December, January, and February which caused an early hatching of eggs in soil and root tissues. Following intensive rains, a sharp decrease in population was recorded in November. Rainfall appeared to be the main climatic factor affecting fluctuations in nematode populations.

*Key words:* *Actinidia deliciosa*, kiwi, *Meloidogyne hapla*, population dynamics.

RESUMEN

Pinochet, J., S. Verdejo y A. Soler. 1990. Observaciones sobre la fluctuación estacional de *Meloidogyne hapla* en kiwi *Actinidia deliciosa* en España. Nematropica 20:31-37.

Un estudio de la dinámica de población de *Meloidogyne hapla* se llevó a cabo durante un año en una plantación de kiwi (*Actinidia deliciosa*) en Carbils, Barcelona, España. Las poblaciones de *M. hapla* aumentaron a sus niveles máximos en Enero y Marzo, alcanzando 8 640 y 7 520 nematodos en 250 cm<sup>3</sup> de suelo, respectivamente. La alta población alcanzada durante el invierno se relacionó con la falta de lluvias y temperaturas anormalmente altas registradas durante los meses de Diciembre, Enero y Febrero, que causaron una eclosión anticipada de los huevos en el suelo y las raíces. Una fuerte reducción en la población se registró en Noviembre después de lluvias intensas. La lluvia parece ser el principal factor climático que afectó las fluctuaciones en las poblaciones del nematodo.

*Palabras claves:* *Actinidia deliciosa*, kiwi, *Meloidogyne hapla*, dinámica de poblaciones.

INTRODUCTION

Culture of kiwifruit (*Actinidia deliciosa* (A. Chev.) Liang and Ferguson) is relatively new in Spain. The country has approximately 650 ha dedicated to this crop. About 70% of the production is concentrated in the region of Galicia which is located in the Northwest portion of the

Iberian peninsula (11). Since 1984, kiwifruit production has been expanding rapidly into the northern regions of Cantabria, Navarra, and Catalonia on the Mediterranean Sea.

The presence of *Meloidogyne hapla* Chitwood, commonly occurring in other kiwifruit production areas of Europe (12,13), has been found to be widespread in Spain. In a recent survey conducted in Galicia, Mansilla et al. (9) found the nematode in 98% of field samples covering 164 ha. In the Province of Barcelona, where kiwifruit culture is fairly new, 7 of 14 sampled fields were infested with *M. hapla* (unpubl.). Although economic losses caused by *M. hapla* and other root-knot nematode species to kiwifruit in Spain are unknown, they are estimated to be similar to those that occur in countries that have comparable agronomic conditions (2,3,5,8,14). The use of nematicides offers one of the few management alternatives in established orchards and plantations, even though the plant is quite sensitive to phytotoxicity (6,9). Therefore, information on seasonal behavior of *M. hapla* in kiwifruit would help determine the appropriate time of application, optimal dose and number of nematicide applications required per year in infested plantations.

#### MATERIALS AND METHODS

A total of 240 composite samples were collected from a kiwifruit orchard (cv. Hayward) in Cabrils, Province of Barcelona. Previous sampling of the site indicated that *M. hapla* was widespread and the only plant-parasitic nematode present. Soil and root samples were taken from ten randomly selected sites. Each site was planted with one vine. These vines were labeled for future samplings. Indicator stickers were used in the area surrounding vines in order to avoid sampling in the same position. Soil was collected to a depth of 30 cm and at a distance of approximately 40 to 50 cm away from the base of the plant with a 2-cm-diam soil probe. Four cores were taken per vine. Sampling took place every 29 to 31 days for a 1-year period. Each field sample weighed approximately 500 g. The samples were mixed thoroughly and a 250 cm<sup>3</sup> aliquant was processed to extract nematodes from the soil by centrifugation and sugar flotation methods (7). Root tissues collected in the 500 g soil sample were separated and weighed. Nematodes were extracted from the roots by maceration in a blender for two 15-second periods separated by a 10-second interval in a 0.25–0.30% NaOCl solution (1). Eggs and second-stage juveniles (J2) were concentrated using sieves with 74- and 25- $\mu$ m openings (200 and 500 mesh), respectively. Counts of nematodes in root tissues were not taken during the first 2 months of this study (May and June 1988).

Soil and root populations of *M. hapla* were related with the mean monthly temperature of soil, ambient temperature, and rainfall for 12 months. Soil temperature of the first 20 cm of depth was measured twice a day with PT-100 thermic soil sensors. Meteorological information was provided by the weather forecast station of the Centro de Investigación Agraria de Cabrils located 40 m from the orchard. During this study, kiwifruit vines received supplementary irrigation (undertree and localized), between May and August, 1988. Rainfall during September 1988 to early May 1989 was very low, and abnormally mild temperatures prevailed from December 1988 to March 1989 (Fig. 1A). Cultural practices and sanitary conditions were more rigorous than those normally practiced in kiwifruit production in the area. The 0.5-ha orchard was 5 years old and located on a sandy loam textured soil (75% sand, 15% silt, and 10% clay) with a 2% slope. The orchard was established with planting stock (cv. Hayward) imported from France. Fruit production of approximately 120 kg per vine, was considered better than average. The active vegetative period for kiwifruit in this Mediterranean environment is around 290 days a year. The orchard site was fumigated with methyl bromide before planting. After establishment, fertilization with nitrogen-based compounds and mulching were the main agronomic practices that may have influenced nematode populations.

## RESULTS AND DISCUSSION

*Meloidogyne hapla* maintained its activity and was abundant throughout the year, reaching levels of 8 640 and 7 520 nematodes/250 cm<sup>3</sup> of soil during the winter months of January and March, respectively (Fig. 1B). In general terms, the winter months were characterized by very dry weather that did not exceed 22 mm of rainfall during any month and unusually mild temperatures for that time of the year. Mean soil temperature in the first 20 cm of depth fluctuated between 9.1 and 12.5 C during the months of December 1988 to March 1989 and apparently allowed some nematodes to complete their life cycle. A sharp decrease during the months of May, June, and November 1988 in the nematode population in both roots and soil was observed, possibly as a result of the high rainfall during these months. Another reduction in nematode population, although less pronounced, also was observed during April 1989, during which rainfall was 101 mm. The most important fluctuation in nematode population was recorded between the months of October and November 1988 when the population dropped from 7 347 to 700 nematodes in 250 cm<sup>3</sup> of soil. This decrease occurred following a monthly precipitation of 137 mm in November and may have been due to oxygen reduction and/or movement of nematodes into deeper layers

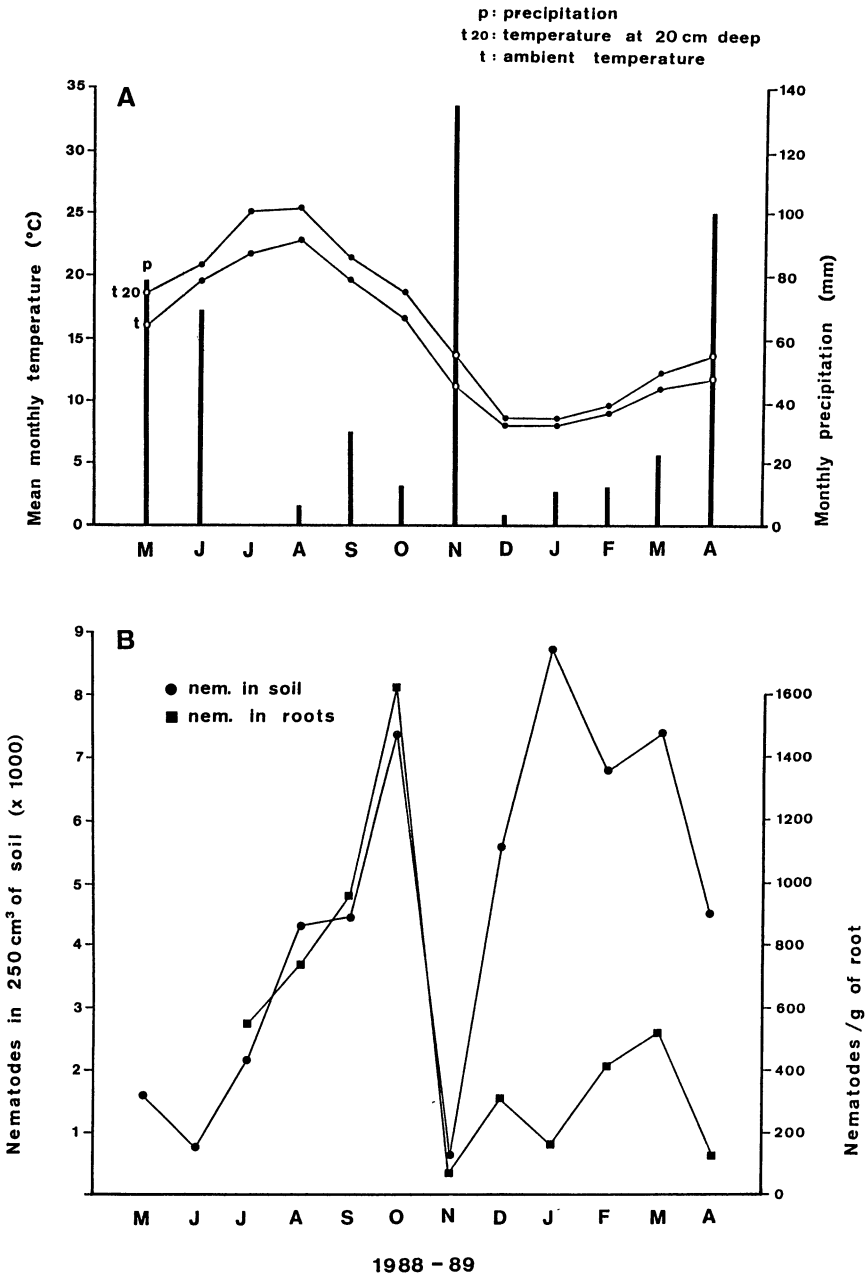


Fig. 1. Nematode population dynamics in a kiwifruit orchard in Cabrils, Barcelona, Spain. A) Mean monthly temperature and monthly precipitation during a 1-year period. B) Seasonal fluctuation of *Meloidogyne hapla* in the soil and roots for the same period.

of the soil. During December and January, a rapid increase of the soil population was observed in spite of the low soil temperatures, suggesting that rainfall and not temperature was the main environmental factor related to nematode population decrease under the conditions that prevailed that season in Cabrils, Barcelona (Fig. 2).

Nematode populations in roots and in soil followed similar seasonal fluctuation patterns from August to November 1988. After the heavy rains of November, the soil population recovered and reached a twelve-fold increase in a brief period of time (8 weeks), meanwhile the root population increased slightly at a low level from December 1988 to April 1989.

The results indicate that the highest nematode levels in the soil were found during the winter months when the kiwifruit plant was dormant

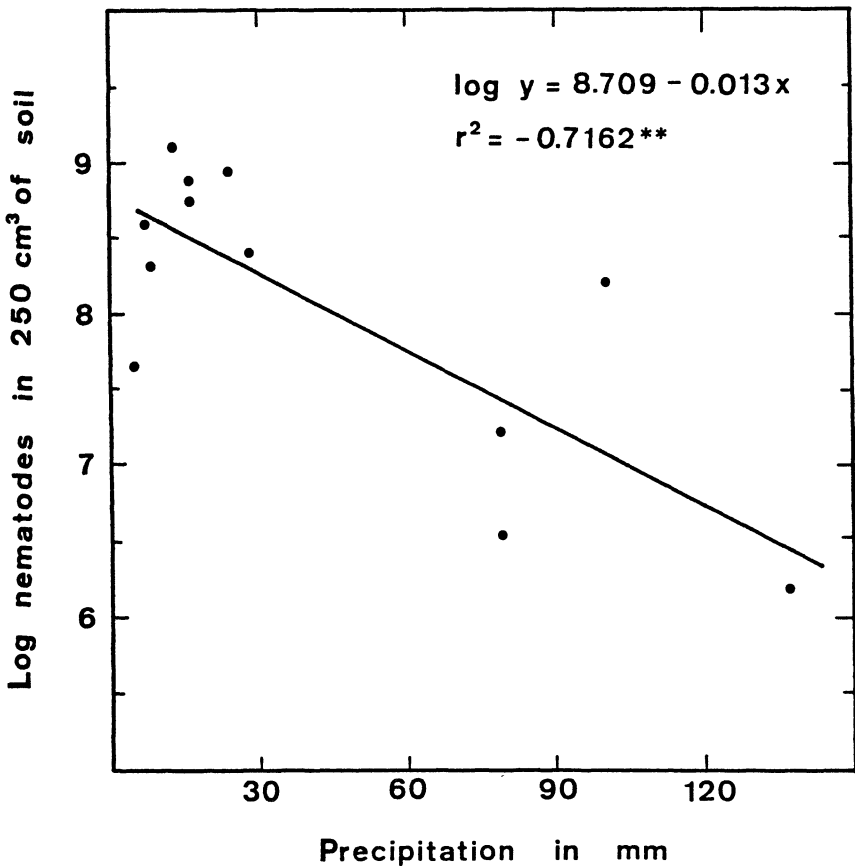


Fig. 2. Regression of the population of *Meloidogyne hapla* in soil around roots of kiwifruit on precipitation during May 1988–April 1989.

(November to March) while the highest total levels were found in October. Because *M. hapla* is a nematode with cooler temperature requirements to complete its life cycle than other root-knot nematode species (4,10), it is likely that hatching of eggs in the roots and in soil took place just over 9 C which was the minimum soil temperature registered during December 1988 and January 1989. Also noteworthy is the observation that during the winter months, J2 and eggs were extracted from the roots in approximately equal proportions, while from August to November nematodes extracted from roots were mainly in the egg stage.

The optimum time of nematicide application in a normal year would be during the spring (April or May), after the climatic factors of the winter season have performed a natural reduction of the nematode population in the soil and roots. In an unusually dry year which occurred during this study, a better management practice would have been to treat during the winter months when the soil population was highest and the host was dormant. However, weather patterns are unpredictable and winter rains usually occur. The data indicate that a split application in early spring followed by another late in that season might be feasible when a high inoculum is detected at the beginning of the season following a dry and mild winter. Unfortunately, the plot was mistakenly treated with nematicides and therefore, it was not possible to continue this study a second year.

Damage caused by *M. hapla* in this study appeared to be minimal. The high nematode population found throughout several months of the year apparently did not affect vegetative growth, yield, or fruit size, suggesting that the kiwifruit plant is quite tolerant to *M. hapla*. Factors contributing to the tolerance of the kiwiplant that were present in the orchard included a good nutritional balance, extensive root colonization by VA mycorrhizal fungi and wind protection. However, the long-term effects of the nematode in relation to decline in production are unknown.

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