Threshold temperature and minimum thermal time requirements for the complete life cycle of *Meloidogyne hapla* from northern Europe

by

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The base threshold temperature for the development of a population of *Meloidogyne hapla* from a glasshouse in Finland was estimated as 8.25°C. The thermal time requirement above this base for development from juvenile to the first juvenile of the second generation was about 553 day°. Two field populations from northern Europe had similar thermal requirements. In some experiments there was an indication that the rate of egg hatch had slowed at the lowest temperature used (17°C), possibly because of a slight diapause. Tomato was a better host than cabbage, but the thermal requirements of the *M. hapla* were similar on both.

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The rate of development of poikilothermic organisms is generally temperature dependent. There are lower and upper thresholds for development, between which the rate of development (expressed as the reciprocal of the time taken) is, at least in the median part, usually correlated linearly with temperature; the intercept gives the lower threshold temperature (Allee et al., 1949). When the relationship is linear the thermal time or accumulated temperature required for complete development is a constant (Garcia-Huidobro et al., 1982). These general principles were first used by Tyler (1933) to determine the temperature requirements for a part of the life cycle of an unknown *Meloidogyne* sp. Subsequently, several other studies have determined the threshold temperatures and thermal time requirements for the development of eggs or of egg-laying females of several *Meloidogyne* species.

This paper reports a study of the temperature requirements for the complete development of *M. hapla* from northern Europe. The work was done as a background to other experiments which examined whether this nematode could become established as a field pest in Finland and Scotland (Tiilikala et al., 1988).

Materials and Methods

Three populations of *M. hapla* were tested; these were from a glasshouse in Finland and from fields in Sweden and the Netherlands. The populations were
maintained on tomato, initially in a glasshouse in Finland and then in Scotland, at a temperature generally > 18°. Juveniles were collected during several days from egg-masses placed on small sieves in tap water. The test plants were tomato or cabbage (10-15 cm high) growing in sterilised loam in pots (7.5 cm diameter and 17.5 cm deep) which were without drainage holes. The plants were infected by using a hypodermic syringe to inoculate juveniles in 5 ml of water into the soil at a depth of at least 4 cm at several points around each plant. After inoculation the pots were placed in controlled-temperature water baths so that the level of the soil was below that of the water. Polystyrene discs with a hole for the plant stem were used to insulate the soil surface. A thermocouple was inserted into one pot in each water bath to check the soil temperature. In all experiments four baths were used; their temperatures differed by 3 or 4° steps. Any deviations from the set temperatures were corrected daily.

To collect the newly hatched, second generation juveniles the plant roots were gently washed free of soil a few days before the expected onset of their production and the plants transferred to new plastic pots of the same size as previously but now containing many holes in their base. The roots were covered with fine gravel and these pots were placed inside a second pot of the same size but without holes. These double-pot units were maintained at the set temperatures in the water baths. The newly hatched juveniles were collected by pouring about 150 ml of water through the gravel each day. This procedure was found to collect the majority of the juveniles free in the pot. Because the main aim of the work was to identify the hatch of the first juvenile the samples collected from the plants in each treatment were mixed together. Any juveniles collected were identified and counted using a stercobinocular microscope. The number of juveniles progressively increased in all experiments and collection and counting was continued for several days to help confirm the date when they were first produced.

Five experiments were done and the detailed methods are described below.

Experiment I. Sixteen pots each containing a single tomato plant cv. Rutgers were inoculated on 31 May 1985 with 200 juveniles per pot of the Finnish population. Four pots were placed in each water bath at 16, 20, 24 or 28°. After 42 days the temperature in the 16° bath was increased to 17°. The temperature in one pot in each bath was monitored continuously using a temperature recorder and the mean temperature up to the time of collection of the first juvenile was determined and used in subsequent calculations.

Experiment II. Groups of twelve pots growing tomato plants cv. Rutgers were inoculated on 14 June 1985 with 150 juveniles per pot of the Finnish, Dutch or Swedish populations and all pots maintained at 20° for 3 days. To limit the infection period the roots were gently washed free of soil after 3 days and repotted in sterilised loam. Three pots infected with each population were then transferred to water baths at 16, 20, 24 and 28°. As in Experiment I, the temperature in the 16° bath was increased to 17° on 12 July.