A THERMAL TIME BASED METHOD FOR DETERMINING THE FECUNDITY OF MELOIDOGYNE JAVANICA IN RELATION TO MODELLING ITS POPULATION DYNAMICS

BY

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Egg laying over 24 h by single females of Meloidogyne javanica within small segments of root was assessed on agar plates and compared with the numbers of eggs in their egg masses over a 65-day period. At a constant 26°C egg laying commenced between 18 and 21 days and continued for at least a further 45 days. Mean rates of egg laying were between 60 and 80 eggs per day between 23 and 45 days but declined thereafter. With a base temperature for development of 13°C an estimated 0.2°C days was required for the production of each egg and overall each female was estimated to have laid nearly 2000 eggs, 1500 of which were laid within 45 days of inoculation. The application of thermal time information to these results is briefly discussed in relation to modelling the population dynamics of root knot nematodes and the extent to which generations overlap.

Keywords: fecundity, thermal time, modelling, population dynamics, root-knot nematodes.

The parthenogenetic species of root-knot nematodes, which include Meloidogyne javanica, are serious pests of many tropical and sub-tropical crops. Damage is often not strongly correlated with the population density at planting because of the short generation time and fecundity of these nematodes (Trudgill et al., 1992). Several overlapping generations are possible on susceptible crops such as tomato, with the consequence that small populations can increase into large, damaging ones during the growth of the crop. This greatly complicates the modelling of their population dynamics and effects on crop yields, which are further complicated by host and environmental effects. However, as rates of egg laying and of development are linearly related to temperature (Ferris et al., 1978; Madulu & Trudgill, 1994; Trudgill, 1995), variations in the temperature of the environment can be accommodated.

The objective of the study reported here was to assess both rates and numbers of eggs produced on a good host (tomato) and, using thermal time information, to calculate the thermal constant (°C days requirement) for each egg laid by M. javanica.
MATERIALS AND METHODS

Seedlings of tomato cv. Carouso, susceptible to M. javanica were grown in 200 ml plastic cups filled with steam sterilized soil. Each cup was infested with ca. 300 juveniles, collected over 3 days, from a single egg mass line of M. javanica from Crete. The plants were maintained in a controlled environment with a 16 h photoperiod and a temperature of 26 ± 1°C inside the cups. They were watered as required and weekly received 10 ml dilute nutrient solution.

To assess the numbers of eggs produced and rates of egg laying single plants were knocked from their cups, their root systems soaked and gently washed free of soil at 3-5-day intervals between 16 and 65 days after inoculation. The clean roots were cut into small (ca. 1 cm) segments containing a gall and single egg mass. The egg masses, including loose and empty eggs, associated with 10 females were removed and each placed in a drop of 0.5% NaOCl (Hussey & Barker, 1973) for 5 min when eggs were counted. The galled tissue surrounding each female was then carefully dissected away with fine needles to expose just the posterior of the nematode; the body and head of the female were still buried within the root gall. The root pieces, each with one female, were then transferred to a thin layer of 1% water agar in a Petri dish. The dish was left open for a few minutes to allow the free water to evaporate before covering with the lid and sealing with parafilm. The dishes were maintained in an incubator at 26 ± 1°C and after 24 h the total numbers of eggs laid onto the agar, or adhering to the female, were counted. The females were replaced on the agar for a second 24 h period and the numbers of eggs laid counted to confirm that rates of egg laying were not decreasing rapidly.

RESULTS

Females taken 16 and 18 days after inoculation had not produced egg masses and did not subsequently lay eggs when placed on the agar. Also, no eggs were observed within other females which had been completely dissected from the roots, squashed and examined with a high power microscope. At 21 days egg masses were present and contained a mean of 23 eggs (range 0 to 53). In the subsequent 24 h these females laid a mean of 50 eggs (range 26 to 70). Those with fewest eggs in their egg mass before placing on the agar also tended to lay fewest eggs over the subsequent 24 h period. Between 24 and 41 days after inoculation mean rates of egg laying on the agar varied between 58 and 73 eggs per female per day with a maximum of 102 eggs produced by one female taken at 41 days. Thereafter the rate of egg laying on the agar declined (Fig. 1). By 55 days after inoculation the second generation females were also laying