

RESEARCH NOTES

Predicting On-set of Egg Production by *Meloidogyne hapla* on Lettuce from Field Soil Temperatures

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A direct relationship exists between temperature and the time required for development of second-stage larvae of *Meloidogyne* spp. to mature egg-laying females (4, 5). Milne and Du Plessis (2) used this relationship as a basis for predicting on-set of egg production by *Meloidogyne javanica* on tobacco. They found that second-stage larvae required 9,300 centigrade h to develop into egg-laying females in the field.

In this paper we report on an attempt to use field soil temperatures for predicting on-set of egg production on lettuce by an over-wintered population of *Meloidogyne hapla* Chitwood. If on-set of egg production can be predicted, it will be possible to determine the amount of time available for egg production before the crop is harvested; thus it may be possible to estimate the relative number of eggs produced on a given crop.

During 1973 and 1974, development of *M. hapla* was monitored on five lettuce crops grown in organic soil (Carlisle muck) in Oswego Co., New York. A continuous record of soil temperatures 10 cm deep was obtained with a recording thermometer. Nematode development was determined by direct microscopic examination of roots collected weekly and stained with acid fuchsin-lactophenol. At each sampling, the stage of development was determined for 100-200 of the most mature nematodes present according to the descriptions of Triantaphyllou and Hirschmann (3). Total egg production at the time of crop harvest was determined by a modification of the method of Loewenberg et al. (1). A 5-g root sample was macerated in 50 ml of 0.5% NaClO for 1 min in a food blender. The resulting suspension was diluted to 125 ml and stirred for 4 min; then it was passed through a 250- μ m (60-mesh) screen

to remove plant debris. This suspension was diluted to 500 ml and the eggs in two 5-ml aliquots were counted.

Degree-days and heat-units (4) were used to relate soil temperatures to development of *M. hapla*. Degree-days were calculated as the sum of the average temperature for each day from the time of crop emergence until the appearance of a given developmental stage of *M. hapla*. Heat-units were calculated each day from the average temperature and summed from the time of crop emergence until the appearance of a given stage of development. Heat-units were determined for threshold temperatures of 5, 7, and 10 C.

During 1973 and 1974, soil temperatures ranged from as low as 5 C in early May to highs near 30 C during July and August. Under these conditions, *M. hapla* completed a single generation on crops planted in May. At the time of crop harvest, 665 to 12,568 eggs/g root were produced from pre-plant population densities of 11 to 69 larvae/100 ml soil, respectively. The larvae required an average of 627 degree-days to develop into egg-laying females, or 6,293, 8,780, and 10,624 heat-units with threshold temperatures of 10, 7, and 5 C, respectively (Table 1). Of these measurements, the greatest variation was observed in heat-units calculated from the 10 C threshold temperature.

On-set of egg production by *M. hapla* on lettuce can be predicted with an accuracy of ± 4 days by using either degree-days or heat-units calculated from threshold temperatures of 5 or 7 C. The time required for on-set of egg production under field conditions was similar to that reported by Wong and Mai (5) for controlled environment conditions. The variation observed in this study may be partially due to variation in the time required for penetration of host roots by larvae that have overwintered and to the length of time

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TABLE 1. Number of degree-days or heat-units required for the development of *Meloidogyne hapla* second stage larvae to egg-laying females.

Planting date	Days to egg production ^a	Degree-days	Heat-units (in 1,000's) ^b		
			5 C	7 C	10 C
2 May, '73	54	649	9.1	6.9	4.2
14 August '73	25	576	10.4	9.3	7.8
9 May, '74	49	768	13.0	10.4	6.4
27 May, '74	35	556	9.7	8.0	5.7
20 July, '74	28	584	10.7	9.4	7.3
	Standard deviation	±86	±1.5	±1.3	±1.4
	Coefficient of variation (%)	13.7	13.9	15.2	22.6

^aCalculated from time of crop emergence until first appearance of eggs.

^bCalculated from threshold temperatures of 5, 7, and 10 C.

between collection of samples. The lower coefficient of variation obtained when 5 or 7 C is used for the threshold temperature in calculating heat-units suggests that 5-7 C is closer to the threshold for development of *M. hapla* than is 10 C. This finding is compatible with the threshold temperature of 7.5 C reported for *M. javanica* (2), but differs from the threshold temperature of 10 C reported by Tyler (4) for an unknown *Meloidogyne* sp.

Although on-set of egg production by *M. hapla* on lettuce can be predicted, the usefulness of such data under New York State conditions is uncertain because the nematode can complete its life cycle on early lettuce crops and have time for substantial egg production. Predictions of on-set of egg production may be useful, however, under different climatic conditions or on crops which may mature before on-set or shortly after egg production has begun. Predictions of on-set of egg production may

also be helpful in estimating the total number of generations completed by *M. hapla* on longer term crops.

LITERATURE CITED

1. LOEWENBERG, J. R., T. SULLIVAN, and M. L. SCHUSTER. 1960. The effect of pH and minerals on the hatching and survival of *Meloidogyne incognita incognita* larvae. *Phytopathology* 50:215-217.
2. MILNE, D. L., and D. P. DU PLESSIS. 1964. Development of *Meloidogyne javanica* (Treub.) Chit., on tobacco under fluctuating soil temperatures. *S. Afr. J. Agric. Sci.* 7:673-680.
3. TRIANTAPHYLLOU, A. C., and H. HIRSCHMANN. 1960. Post-infection development of *Meloidogyne incognita* Chitwood 1949. (Nematoda: Heteroderidae). *Ann. Inst. Phytopathol. Benaki, N.S.* 3:3-11.
4. TYLER, J. 1933. Development of the root-knot nematode as affected by temperature. *Hilgardia* 7:391-415.
5. WONG, T. K., and W. F. MAI. 1973. Effect of temperature on growth, development and reproduction of *Meloidogyne hapla* in lettuce. *J. Nematol.* 5:139-142.