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Influence of Photoperiod and Temperature on Migrations of Meloidogyne Juveniles

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Abstract: Photoperiod influences the migration of *M. incognita* juveniles toward tomato roots. Approximately 33% migrated vertically 20 cm in 7 days to roots when 12 h dark were alternated with 12 h light. Only 7% migrated when light was constant for 24 h. Vertical migration of *M. incognita* juveniles was studied at 14, 16, 18, 20, and 22 C. The migration of *M. incognita* juveniles begins at about 18 C and reaches its maximum at 22 C. The migration of *M. hapla* and *M. incognita* juveniles were compared at 14, 18, and 22 C. Juveniles of *M. hapla* were able to migrate at a lower temperature than those of *M. incognita*. With *M. hapla,* there was no significant difference in migration between 18 and 22 C. *Key words: Meloidogyne incognita, Meloidogyne hapla,* attraction, photoperiod.

Direct sun or artificial light is known to influence nematodes living above ground, such as *Aphelenchoides* (1,6). There are some suggestions that light can affect plant-parasitic nematodes living in the soil indirectly through the plant. Darkness influenced penetration and the development of *Heterodera oryzae* (Luc and Berdon Brizuela) and *Heterodera sacchari* (Luc and Merny) (2), and the length of the light period affected cyst production by *Globodera rostochiensis* (Wollenweber) Stone (3,4) and egg mass production by *Meloidogyne incognita* (Kofoid and White) Chitwood (9). Temperature is known to influence such nematode activities as hatching, mobility, invasion, reproduction, development, and moulting (10).

The influence of photoperiod on migration of *M. incognita* juveniles was studied using tomato root systems grown under two different light periods, 12 and 24 h. The effect of temperature on migration was studied as a function of the time at five different temperatures—14, 16, 18, 20, and

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22 C—and the migration of second-stage juveniles of *Meloidogyne hapla* Chitwood and *M. incognita* was compared at 14, 18, and 22 C.

MATERIALS AND METHODS

Juveniles of *M. incognita* and *M. hapla* used in these experiments were derived from cultures maintained on tomato (*Lycopersicon esculentum* cv. Tropic) in the greenhouse. Only second-stage juveniles hatched from eggs in 48 h were used. The soil used contained 86% sand, 5.2% silt, and 8.8% clay. All soil was steamed for 1 h at 100 C.

The experimental apparatus has been described previously (7). A polyvinyl chloride tube 21 cm long, with an internal diameter of 2 cm, was filled with the soil and inserted into a hole made in the center of the bottom of a 150-cm³ styrofoam cup. Three hundred juveniles were introduced into the soil at 1 cm from the bottom of the tube. The bottom of the tube was closed by a plastic film and the top covered by an 85-m screen which separated the roots from the tube. Approximately 130 cm³ of soil was placed in the pot into which the 4-wk-old tomato seedlings were transplanted.

With this apparatus the vertical migration of *M. incognita* juveniles was studied under two light periods, 12 h and 24 h, with an intensity of 34,500 Lux in a growth chamber for 7 d at a constant temperature of 26 C. At the end of the experiments the tomato plants were removed from the pot and their root systems stained with cold cotton blue-lactophenol (5). Only juveniles found in the roots were counted. There were 10 replications for each light period and the experiment was repeated three times.

The penetration of 4-wk-old tomato roots by *M. incognita* juveniles was studied under the same two light periods in a styrofoam pot containing approximately 130 cm³ of soil. Seven days after nematode inoculation the root systems were stained and juveniles within the roots were counted. There were five replications of each light period and the experiment was repeated four times.

Using the same apparatus the vertical migration of *M. incognita* juveniles was studied as a function of time at five temperatures—14, 16, 18, 20, and 22 C—by placing the soil cup and tube in constant temperature tanks in the greenhouse. The experiments were terminated after 5, 10, 15, and 20 d. The root systems were then stained and the number of juveniles that infected the roots were counted. There were 10 replications for each temperature and time.

Vertical migrations of *M. incognita* and *M. hapla* juveniles were compared at 14, 18, and 22 C. Tomato roots were harvested 10 d after introduction of juveniles at the bottom of the tube and the root systems were stained. In order to avoid the effect of temperature on penetration and plant growth in these experiments, only the PVC tubes were maintained at constant temperature—14, 18, or 22 C. The pots containing the plants were maintained at the temperature of the greenhouse which varied daily between 21 and 29 C. There were 10 replicates for each nematode species × temperature combinations and the experiment was repeated three times.

RESULTS

A continuous 24 h exposure to light reduced the migration of *M. incognita* juveniles towards tomato plants in the soil (Table 1). More than 30% of the juveniles were able to migrate 20 cm and infest the root system of a tomato plant when 12 h dark alternated with 12 h light, but only 7% migrated 20 cm when the light was constant.

Constant light did not reduce the penetration of tomato roots by the same juve-

Table 1. Migration of *Meloidogyne incognita* juveniles toward tomato roots in a soil containing 86% sand, 5.2% silt, and 8.8% clay with tomato plants grown under two different light conditions.

	% migration and penetration after 7 d	
Experiment	12 h light and 12 h dark	24 h light
1	34.1 a*	7.2 b†
2	38.4 a	5.2 b
3	32.4 a	7.6 b

*Each number represents the mean of 10 replications.

†Numbers followed by same letter are not significantly different, according to an analysis of variance ($P = 0.05$).

Table 2. Penetration of tomato roots by *Meloidogyne incognita* juveniles in a soil containing 86% sand, 5.2% silt, and 8.8% clay under two different light periods.

Experiment	% penetration after 7 d: 12 h light and 12 h dark	% penetration after 7 d: 24 h light
1	51*	64
2	71	66
3	76	75
3	67	73

*Each number represents the mean of five replications.

niles (Table 2) when placed in close proximity to the roots. There were no significant differences between penetration of juveniles into roots of tomato plants lighted continuously and penetration into roots of plants exposed to 12 h alternating photoperiod.

Like all the nematodes' activities, the migration of *Meloidogyne* juveniles is affected by temperature. Figure 1 shows the percentage of *M. incognita* juveniles migrating 20 cm and penetrating a tomato plant as a function of the time. At the lowest soil temperature, 14 C, only about 2% of the juveniles accomplished this. At 18 C the

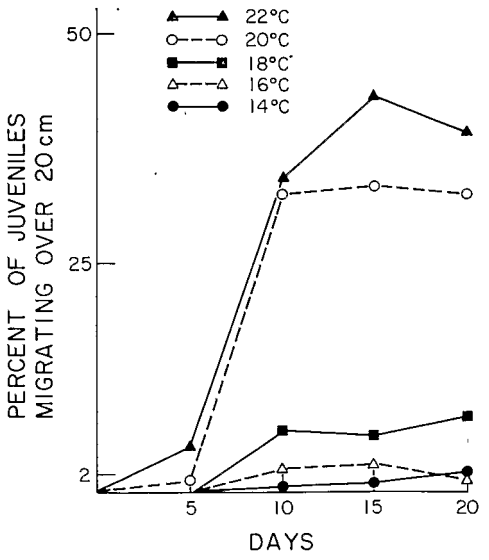

Fig. 1. Migration of *Meloidogyne incognita* juveniles toward tomato roots as a function of time at five temperatures.

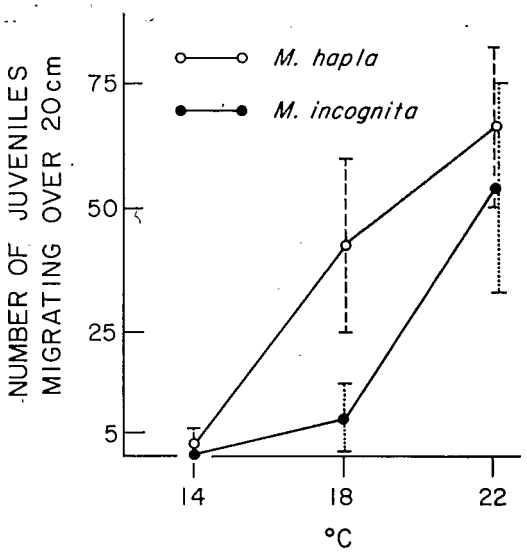

Fig. 2. Migration of *Meloidogyne incognita* and *M. hapla* juveniles toward tomato roots as a function of temperature.

percentage increased to 6–8% and at 20 and 22 C to 30%.

No significant differences were observed between migrations of *M. incognita* and *M. hapla* at 14 and 22 C (Fig. 2). At 18 C 17% of the *M. hapla* were able to migrate 20 cm in 10 d. This was significantly greater than the 3% of *M. incognita* capable of migration at that temperature.

DISCUSSION

Approximately 30% of the second-stage juveniles of *M. incognita* and *M. hapla* were able to migrate 20 cm vertically and penetrate a tomato root system. These observations and those of Prot (8) in West Africa suggest that *Meloidogyne* species commonly have the capacity to migrate large distances vertically.

The fact that migration to plants was significantly reduced but penetration not affected when the plants were kept under a constant light provides additional circumstantial evidence that plants provide an attractant that stimulates the movement of *Meloidogyne* juveniles over large distances in soil. The light period could affect qualitatively or quantitatively root excretions responsible for this root attraction.

The activity of *M. incognita* appears to have been inhibited rather than merely slowed at 14, 16, and 18 C. At these low

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temperatures the percentage of migration was no greater after 20 d than after 10 d. The migration of *M. incognita* began at about 18 C and reached a maximum at 20 C. *M. hapla* migration at 18 C was not significantly less than at 22 C. The ability of *M. hapla* juveniles to migrate at lower temperatures than *M. incognita* may explain in part differences in distribution (latitide-altitude) and importance of these species.

LITERATURE CITED

1. Bloom, J. R. 1964. Photonegative reaction of the chrysanthemum foliar nematode. Phytopathology 54:118-119.

2. Cadet, P., and G. Merny. 1978. Influence of some factors on sex-ratio in Heterodera oryzae and H. sacchari (Nematode: Heteroderidae). Revue Nématol. 1:143-149.

3. Ellenby, C. 1958. Day length and cyst formation in the potato root eelworm, Heterodera rostochiensis Wollenweber. Nematologica 3:81-90.

4. Franco, J., and K. Evans. 1979. Effects of day length on the multiplication of potato cyst-nematode (Globodera spp.) populations. Nematologica 25:184-190.

5. Guiran, G. de. 1967. Coloration des nématodes dans les tissus végétaux par le bleu coton a froid. Nematologica 12:646-647.

6. Moussa, F. F. 1972. The influence of light on infection of Asplenium nidus leaves with the foliar nematode Aphlenchoides fragariae. Meded. Landbhogesch. Opzoekst. Gent. 37:9-27.

7. Prot, J.-C. 1977. Amplitude et cinétique des migrations due nématode Meloidogyne javanica sous l'influence d'un plant de tomate. Cah. ORSTOM, Ser. Biol. 11:157-166.

8. Prot, J.-C. 1978. Vertical migration of four natural populations of Meloidogyne. Revue Nématol. 1:109-112.

9. Tarjan, A. C., and B. E. Hopper. 1953. Effect of increased photoperiod on egg mass production by the root-knot nematode, Meloidogyne incognita (Kofoid and White) Chitwood. Pl. Dis. Reptr. 37: 313-314.

10. Wallace, H. R. 1964. The biology of plant parasitic nematodes. St. Martin's Press Inc., New York.