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SOME FACTORS AFFECTING HATCHING OF *MELOIDOGYNE INCOGNITA* (KOFOID AND WHITE 1919) CHITWOOD, 1949

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Summary

In vitro studies on hatching of *Meloidogyne incognita* have shown that the egg-masses hatched freely in water. Although larval emergence occurred in root exudates of various crops, the number of larvae hatched never exceeded the emergence in water. Hatching in water increased with temperature from 10 to 27 °C but it started to decline beyond 27 °C. Hatching within continuous 72 h of darkness was highest when compared with 12 h light alternating with 12 h darkness within the same period at room temperature of 27-28 °C. In saline solution, egg masses remain viable for at least 120 days at room temperature but hatching was highest after 10-40 days storage while lavae emergence markedly decreased after 80 days storage. When infected tomato root were dried in the open for 2 days only seven lavae emerged from egg-masses collected from desiccated root compared with 1 243 larvae hatched after drying the roots for 3 h and 2 295 from fresh roots.

Introduction

Root-knot nematodes, *Meloidogyne* spp., are among the pests which severely damage crops in the tropical and sub-tropical regions (Sasser, 1976.) Crop losses attributed to root-knot nematode infection may range from 5 to 100 per cent depending on the host, cropping history and prevailing environmental conditions. Highest crop losses occur in susceptible host and favourable environmental conditions for the nematode development. It has been reported that *M. incognita* is one of the predominant species world-wide (Sasser & Carter, 1982). Although methods for its control are well documented, the basic information on the biology is rare in the tropics.

The hatching of nematodes, in general, is influenced by several factors. Wallace (1959) reported that emergence of larvae from eggs of golden cyst nematodes *Heterodera rostochiensis* occurs at a higher rate when cyst are in potato root exudates. On the contrary, report by Loewenberg, Sullivan & Schuster (1960) indicates that emergence of cereal cyst nematodes *H. avenae* is independent of either root leaching or light.

Work by Fenwick (1949) showed that optimum temperature for hatching of *H. rostochiensis* is 25 °C. Bergoson (1959), on the other hand, reports that hatching in *M. incognita acrita* is highest at 27 °C. These findings suggest that different nematode species require different temperature regimes. Wallace (1965) indicated that larval emergence of *H. schactii* increased when oxygen concentration in the water containing the eggs was increased. It was observed by Peacock (1957) that in soil moisture below 10 to 37 per cent or of 100 per cent saturation, larvae and egg-masses of *Meloidogyne* failed to survive. Similarly, Hisling (1956) found that *H. avenae* is very sensitive to drought because when the infected soil is dried, the eggs die within 4 h. Dropkin & Martin (1957) reported that egg masses in saline solution can be stored for 150 days.

This paper reports the results of investigations conducted on the influence of root leachates, temperature, light, darkness, desiccation and saline solution on hatching of *M. incognita* egg-masses

at the Plant Pathology Laboratory, Crops Research Institute, Kumasi, Ghana.

Experimental

Preparation of root leachates

Nineteen plant species were used. They included oil palm, banana, plantain, pineapple, citrus, sweet potato, tomato and okro. The rest were ginger, sugar cane, cocoyam, cowpea, cassava, coffee, cocoa, sorghum, millet, maize and groundnut. The plants were grown separately in sterile loam and sand mixture in the ratio of 50:50 in 20 cm plastic pots which were kept outside on a bench. When the plants were 60-90 days old, the leachates were prepared as described by Winslow (1953) and Widowson (1958). Daily watering was done so that root leaching passed through the drainage holes at the bottom of each pot. The leachate from each plant was collected in a tray underneath the pot. It was poured unto a filter paper inside a funnel and the filtrate collected in an Erlenmeyer flask which was later plugged with non-absorbent cotton wool.

The leachates were stored at 5 °C in a refrigerator to prevent them from breaking down as reported by Fenwick (1956).

Collection of egg-masses

Infected tomato plants growing in *M. incognita* culture in pots were uprooted and adhering soil carefully washed in tap water. Batches of 10 egg-masses were collected under stereo microscope and put into 2 ml of storage or hatching medium in 6 cm × 2.4 cm specimen bottles each with a stopper which had four perforations for aeration.

Hatching experiments

Series of hatching test were carried out and each treatment was replicated four times. Harvesting of larvae was done at intervals of 24 h for 3-10 days, depending on the objective of the experiment. At harvest, the hatching medium containing the egg-masses and larvae was poured into a beaker. The unhatched egg-masses were put back into the specimen bottles and fresh hatching medium added. Cumulative number of larvae hatched per replicate was recorded.

Effect of root leachate

Egg-masses in the root leachate were kept on laboratory bench at room temperature and larvae hatched were recorded for 2 days.

Effect of temperature

Specimen bottles containing the egg-masses in distilled water as hatching medium were kept at 10, 15, 20, 27 and 35 °C. Harvesting of larvae was done every 24 h for 10 days .

Effect of light and darkness

Four replicates of egg-masses were kept at near ultra-violet light at temperature of 30 °C for 12 h alternating with 12 h darkness at room temperature of 27-28 °C. Another four were wrapped in a black polythene sheet and stored in a laboratory drawer at room temperature. Hatching in distilled water was carried out for 5 days.

Effect of desiccation

Infected tomato root were uprooted when the plants were 75 days old. Five heavily infected root systems were selected and dried in the open for 3-48 h before egg-masses were collected. Mid-day temperature in the open ranged from 32 to 34 °C during the period. Egg-masses from fresh roots served as control.

Longevity in storage

Egg-masses in 1 per cent saline solution were stored for 10, 40, 80 and 120 days at room temperature before hatching in distilled water.

Results

Effect of root leachates

The results of the hatching tests within 48 h in the different roots leachates are presented in Table 1. Mean number of larvae hatched in water was 916. Mean number of larvae hatched from the leachates of highly susceptible tomato and okro was 385 and 588, respectively. Mean hatch from the leachate of millet was 696.

TABLE 1
Influence of root leachates on hatching of M. incognita *egg-masses*

Botanical name of source of leachate	*Common name*	*Cultivar*	*Mean No. of larvae hatched*
Xanthosoma sagittifolium L. Schoct	Cocoyam	Local (pink)	106 f
Elaeis guineensis Jacq	Oil palm	Dura × Tenera	168 f
Vigna unguiculata Walp	Cowpea	1977	179 f
Musa paradisiaca sapientum var. Kuntz	Banana	Gros Michel	185 f
Musa paradisiaca L.	Plantain	Local (Apantu)	805 ab
Zea mays L.	Maize	Laposta	245 ef
Sorghum bicolar L. Moench	Sorghum	Local	293 def
Coffee arabica L.	Coffee	Robusta	272 def
Abelmoschus esculentum Moench	Okro	Local	588 abcd
Ananas comosus Merr.	Pineapple	Sugar leaf	328 def
Theobroma cacao L.	Cocoa	Hybrid	383 cdef
Lycopersicon esculentum Mill.	Tomato	Asesewa	385 cdef
Zingibar officinale Rosc	Ginger	Local	514 bcde
Citrus medica var. *linonum*	Citrus	Lemon	595 abcd
Ipomea batatas L.	Sweet potato	Local (pink)	669 abc
Pennisetum cinereum Stapf & Hubard	Millet	Manga	696 abc
Saccharum officinarum L.	Sugar cane	B. 41227	352 def
Manihot utilissima Pohl	Cassava	Ankra	876 a
Arachis hypegea L.	Groundnut	Kumawu	228 ef
	Water as control		916 a

LSD (P= 0.05) = 327.01

Mean number of larvae hatched not followed with same letters are significantly different at 5 per cent.

Effect of temperature

Larvae emergence occurred in all the temperature ranges tested. The cumulative larval hatch ranged from 24 to 18 999 depending on the temperature (Fig. 1).

Effect of light and darkness

The number of larvae hatched within 3 days in total darkness was 11 879 whereas 4 266 larvae were recorded from egg-masses kept in 12 h-light alternating with 12 h-darkness for the same number of days (Fig. 2).

Effect of desiccation

Cumulative larvae hatched after drying the infected roots were 1 243 and 7, after 3 h and 48 h drying, respectively (Table 2). Larvae hatched from egg masses of fresh roots were 2 295.

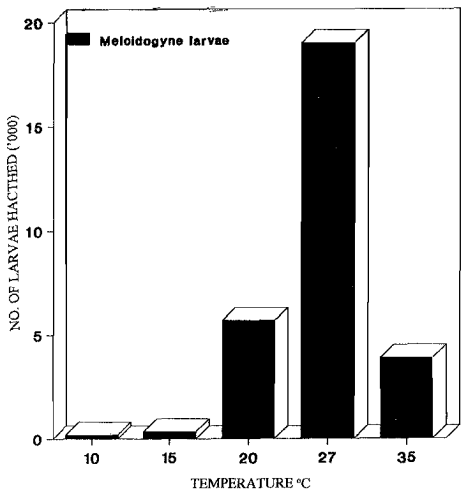

Fig. 1. Effect of temperature on hatching.

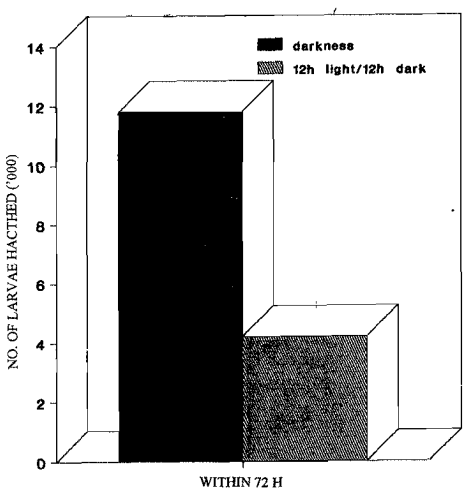

Fig. 2. Larvae hatched in darkness compared with alternating 12 h light and 12 h darkness.

Longevity in storage

Cumulative larval emergence was 1,006 and 8,846 after 10 and 120 days storage respectively (Fig. 3a and b).

TABLE 2

Influence of desiccation on hatching (larvae hatched after drying infected roots in the field)

Hatching intervals (h)	*Drying period (h)*		*Control (egg-masses from fresh roots)*
	3	*48*	
24	124	4	729
48	637	3	370
72	482	0	1196
Total	1243	7	2295
Decrease in hatch per cent over control	45.8	99.7	

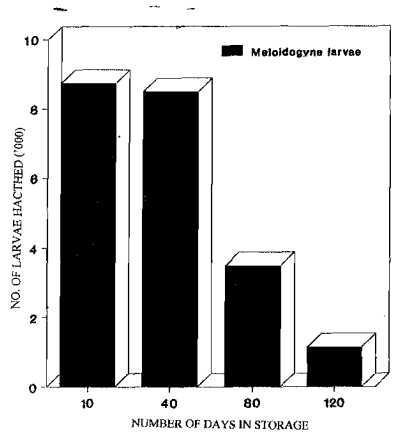

Fig. 3a. Larvae hatched after storing egg-masses for 10, 40, 80, and 120 days.

Discussion

High host specifically indicates difficulty on the part of the nematode in finding a source of food. This problem is partially overcome as in *H. rostochiensis* by much sensitivity of the nematode eggs to root exudates. They positively respond to the presence of host root exudate, resulting in high hatching (Wallace, 1959).

However, nematode species that are polyphagous hatch readily in water while root

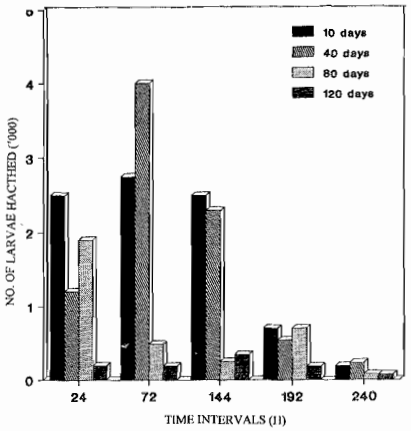

Fig. 3b. Larvae hatched at different time intervals after storage.

leachates do not significantly stimulate hatching (Shepherd, 1965). This is in agreement with the findings from the tests conducted in the leachates of various plants, where larval emergence in water was significantly higher than those in various root leachates ($P<0.05$). The results confirm the polyphagous habit of *M. incognita*. The findings, however, contradict the report by Viglierchio & Lownsberry (1960) who indicated that tomato root exudate induced more hatching of *Meloidogyne* spp. than water.

Temperature has significant influence on the hatching of *M. incognita* because larval emergence increased with temperature up to the optimum of 27 °C but at 35 °C hatching was significantly reduced ($P<0.01$). The results agree with the report by Bergerson (1959) that highest hatching of *M. incognita acrita* occurs at 27 °C.

Dropkin & Martin (1957) reported that egg-masses would remain viable in saline solution for 150 days. The results of the investigations show that though the egg can remain viable in saline solution, yet prolonged storage beyond 80 days markedly reduce larval emergence when hatched in water ($P<0.05$). For maximum hatching, the egg masses should not be stored over 40 days.

Total darkness stimulated hatching when compared with 12 h-light alternating with 12 h-darkness. The finding is contrary to the report by Winslow (1955) that nematode hatching is independent of light. This, probably, is due to the difference in nematode species.

It was observed that a few hours drying could reduce hatching by 45.8 per cent, while prolonged desiccation for 48 h markedly reduced it by 99.7 per cent confirming the report by Peacock (1957) that larvae and egg-masses of *Meloidogyne* spp. would not survive under dry conditions.

Conclusion

The results have shown that it is not only temperature, but darkness also can influence hatching of *M. incognita* egg-masses. Hatching freely occurs in water and it does not depend on root leachate. This explains why most of the field crops are attached by *M. incognita*. Desiccation markedly exerts effective control in that, even 3 h of drying infected roots can reduce the nematode population by 45.8 per cent, while prolonged drying almost completely kills all the nematodes. This implies that in seasonal cropping system where susceptible cultivars are grown, ploughing to expose infected roots to drying after harvesting, can effectively control the nematodes in the tropics.

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