Effect of Diurnal Changes in Soil Temperatures on Resistance to *Meloidogyne incognita* in Tomato[1]

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Thermoperiodism is known to influence the growth of tomato, *Lycopersicon esculentum* (10), but its effect on reproduction of the root-knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood, infecting tomato has not been reported. Tomato genotypes carrying the *Mi* gene for resistance to root-knot nematodes lose their resistance when exposed to constant high temperature (4,5,6,8).

The objective of this research was to investigate the effects of high/low (day/night) temperature on the resistance of *Lycopersicon esculentum* Mill. and *L. peruvianum* var. *dentatum* Dun. genotypes to *M. incognita*. The degree of nematode reproduction on the host plant, i.e., host efficiency (3,9), was the parameter used for determining host resistance.

Two greenhouse experiments were conducted. In the first experiment, selected plant introductions of *L. peruvianum* var. *dentatum* were used: PI 306811, PI 129149-2(sib)-5-4, PI 129149-3-1-2, and PI 129149-3-2-1 (R2). In the second experiment, *L. esculentum* selections and commercial cultivars were tested: Floradade, Nematex-22, Floradade × Nematex-22, Patriot-17, Piersol, PI 266376, PI 129149-2(sib)-5.4, and PI 129149-2(sib)-5-16×43.

Ten 12-day-old tomato seedlings of each cultivar or selection were individually transplanted into plastic pots (12 cm d × 16.5 cm deep) containing previously autoclaved sandy soil. The pots were placed in a controlled temperature tank and maintained at a constant soil temperature (32.5 C) for the duration of the experiment. Ten 12-day-old seedlings of each cultivar or selection, similarly transplanted, were exposed to a diurnal soil temperature change: 32.5 C for 12-h days and ambient (19–25 C) for 12-h nights. Twelve days after transplanting, the seedlings were inoculated with 200 *M. incognita* Race 1 (eggs and juveniles) per seedling as previously described (1). Ambient air temperature during the experimental period ranged from 19 to 27 C in the first experiment, and from 19 to 24 C (night) and 24 to 30 C (day) in the second experiment.

Twenty-eight days after transplanting, the roots were harvested and the number of egg masses counted.

Resistance of *L. peruvianum* PI's, 306811, 129149-2(sib)-5-4, 129149-3-1-2, and 129149-3-2-1 (R2) to root-knot nematode was greater under differential temperature conditions than when maintained at constant high temperature (Table 1). In addition to the generally lower nematode reproduction rating, six plants without egg masses were found in three of the selections subjected to diurnal changes in soil temperature. This indicates that the second-stage juveniles were unable to develop and reach maturity under the thermoperiodic conditions.

Results of the thermoperiod test on *L. esculentum* were similar to those with *L. peruvianum* (Table 2). All tomato genotypes that were maintained continuously at a high soil temperature exhibited a significantly higher number of egg masses than when exposed to diurnal soil temperature changes. These results may explain why in many places the *Mi* gene for resistance to root-knot nematodes in tomato cultivars is operative even with high day temperatures. It was not surprising to find that thermoperiodism strongly affects the reproduction of root-knot nematode in tomato roots. Night soil temperature seems to be an important factor in controlling tomato resistance to *M. incognita*. Although night soil temperatures under field conditions

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Table 1. Effect of thermoperiodism on resistance, based on the number of egg masses/plant, of tomato, *Lycopersicon esculentum* and *Lycopersicon peruvianum* var. *dentatum*, inoculated with 200 *Meloidogyne incognita*.

Cultivar or PI	No. egg masses/plant		No. plants without egg masses	
	Constant*	Diurnal†	Constant*	Diurnal†
L. esculentum				
Floradade	80.9		0	
L. peruvianum var. *dentatum*				
306811	44.5	4.7	0	0
129149-2(sib)-5-4	21.7	1.7	0	3
129149-3-1-2	30.9	5.1	0	2
12149-3-2-1(R2)	28.3	3.3	0	1

*Soil temperature held at 32.5 C; 12-h day, 12-h night.
†12-h day at 32.5 C, 12-h night at ambient (19–25 C).

are normally lower than daytime soil temperatures, recent innovations in cultural practices, such as the use of full-bed plastic mulch, keep the soil temperature high for a longer time after dark than would be the case with uncovered soil. Plastic mulch may maintain soil temperature above the limit for normal function of the *Mi* gene under appropriate environmental conditions.

Of the nine cultivars and PI accessions screened at a continuous temperature of 32.5 C, Floradade had the highest nematode reproduction and *L. peruvianum* PI 129149-2(sib)-5-16×43 (selected sib) had the lowest nematode reproduction (Table 2). When screened under diurnal changes in temperature, three distinct levels of resistance were observed (Table 2). One level included only the susceptible cultivar, Floradade, which had 88.5 egg masses per plant. Another level included Floradade × Nematex-22 (F_1), 74T2, and PI 266376, which had mean egg masses per plant ranging from 3.2 to 4.0. A third group included Piersol, PI 129149-2 (sib)-5-4, Nematex-22, Patriot-17, and PI 129149-2(sib)-5-16×43, all of which had less than 1.2 egg masses per plant.

Under diurnal changes in soil tempera-

Table 2. Effect of thermoperiodism on resistance, based on the number of egg masses/plant, of tomato, *Lycopersicon esculentum* and *Lycopersicon peruvianum* var. *dentatum*, inoculated with 200 *Meloidogyne incognita*.

Cultivar or PI	No. egg masses/plant*		No. plants without egg masses	
	Constant†	Diurnal‡	Constant†	Diurnal‡
L. esculentum				
Floradade	108.2 a	88.5 a	0	0
Nematex-22	16.0 e	0.9 c	0	5
Patriot-17	19.8 de	0.4 c	0	7
Floradade × Nematex (F_1)	41.0 b	4.0 b	0	0
Piersol	32.9 bc	1.1 c	0	2
74T2	27.9 cd	3.2 b	0	0
L. peruvianum var. *dentatum*				
129149-2(sib)-5-16×43	6.9 f	0.3 c	1	8
129149-2(sib)-5-4	24.9 cd	1.0 c	0	7
266376	23.7 cd	3.6 b	0	2

*Values are means of 10 replicates. Values in a column not followed by the same letter differ significantly at $P = 0.05$ according to Duncan's multiple-range test. Means from the diurnal treatments are significantly lower ($P = 0.05$) than the corresponding means at constant temperature for all accessions.
†Soil temperature held at 32.5 C; 12-h day, 12-h night.
‡12-h day at 32.5 C, 12-h night at ambient (19–24 C).

ture, only a few second-stage juveniles of *M. incognita* develop and reproduce. Inoculated tomato genotypes that had only a few egg masses on the average when exposed to continuous high soil temperature showed greater resistance under thermoperiodic conditions than tomato entries showing greater numbers of egg masses when exposed to continuous high soil temperature. The results suggest that metabolic mechanisms of resistance, such as those postulated to involve chlorogenic acid (7) or ascorbic acid (2), will fail to be inhibited by high daytime soil temperature if the plant is exposed to a nonstress soil temperature at night.

LITERATURE CITED

1. Araujo, M. T. 1979. Resistance under high temperature to root-knot nematode (Meloidogyne spp.) in tmoato (Lycopersicon spp.). Ph.D. Dissertation. University of Florida.

2. Arrigoni, O., G. Zacheo, R. Arrigoni-Liso, T. Bleve-Zacheo, and F. Lamberti. 1979. Relationship between ascorbic acid and resistance in tomato plants to Meloidogyne incognita. Phytopathology 69:579-581.

3. Cook, R. 1974. Nature and inheritance of nematode resistance in cereals. J. Nematol. 6:165-174.

4. Dropkin, V. H. 1969. The necrotic reaction of tomatoes and other hosts resistant to Meloidogyne: Reversal by temperature. Phytopathology 59:1632-1637.

5. Holtzman, O. V. 1964. Soil temperature affects the resistance of tomato to the root-knot nematode. Hawaii Farm Sci. 13(4):13-14.

6. Holtzman, O. V. 1965. The effect of soil temperature on resistance of tomato to root-knot nematode (Meloidogyne incognita). Phytopathology 55: 990-992.

7. Hung, C., and R. A. Rhode. 1973. Phenol accumulation related to resistance in tomato to infection by root-knot and lesion nematode. J. Nematol. 2:253-258.

8. Laterrot, H., and P. Pecaut. 1965. The effect of high temperature on the resistance of the variety Anahu to Meloidogyne incognita. T.G.C. Report 15:38-39.

9. Taylor, A. L., and J. N. Sasser. 1978. Biology, identification and control of root-knot nematodes (Meloidogyne species). International Meloidogyne Project. North Carolina State University.

10. Went, F. W. 1944. Plant growth under controlled conditions. II. Thermoperiodicity in growth and fruiting of the tomato. Amer. J. Bot. 31:135-150.