Optimum Initial Inoculum Levels for Evaluation of Resistance in Tomato to *Meloidogyne* spp. at Two Different Soil Temperatures[1]

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Abstract: The effects of *Meloidogyne incognita* or *M. javanica* at five initial inoculum levels of 20, 100, 200, 1,000, and 2,000 eggs and infective juveniles per seedling on 'Floradade,' 'Nematex,' 'Patriot,' and 'PI 129149-2(sib)-5' tomatoes maintained at 25 or 32.5 C were studied. The number of egg masses on roots of the susceptible cultivar Floradade was similar for both species of root-knot nematodes at either 25 or 32.5 C soil temperatures. At 25 C, very low numbers of egg masses were produced by both species of root-knot nematodes on Nematex, Patriot, and *Lycopersicon peruvianum* PI 129149-2(sib)-5. At 32.5 C, the best inoculum level for assessing resistance in these tomato genotypes was 200 eggs and infective juveniles per seedling. With 28 days of incubation, this temperature and inoculum level produced quantitative differences in resistance for both species of *Meloidogyne*. *Key words: Lycopersicon,* root-knot nematode.

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The tomato breeding program in Florida has included the incorporation of resistance to the southern root-knot nematode. In 1967, however, Walter (7) reported that high soil temperature may be the main reason this resistance broke down and was highly ineffective in Florida. In our search for a source of resistance which doesn't break down at high soil temperatures (32.5 C) we noted roots of tomato genotypes inoculated with 2,500 *Meloidogyne incognita* (Kofoid and White) Chitwood or *M. javanica* (Treub) Chitwood differed from each other in gall diameters, but not egg mass indices. Because of the high positive correlation between gall size and number of juveniles in the gall (3), we sought an inoculum density that would provide a good quantitative assessment of resistance in tomato genotypes grown at high soil temperatures. We also evaluated each treatment at 25 C. The tomato genotypes maintain their resistance to *Meloidogyne* at this temperature.

MATERIALS AND METHODS

Three *Lycopersicon esculentum* Mill. cultivars (Floradade, Nematex, and Patriot) and one *L. peruvianum* Dun. cultivar (PI 129149-2(sib)-5) were inoculated with five inoculum densities: 20, 100, 200, 1,000, and 2,000 eggs and infective juveniles (nematode units) per plant of *M. incognita* or *M. javanica*. The population of *M. incognita* was originally collected in Gilchrist County, Florida, from tobacco and had been identified as race 1 (5). The population of *M. javanica* was originally collected in Columbia County, Florida, from tobacco. Both species had been increased separately on tomato, *L. esculentum* 'Rutgers,' in the greenhouse.

The inoculum was prepared according to the method of Hussey and Barker (4). Ten 12-day-old seedlings, germinated from seeds planted in sterile Saftblast, were transplanted into plastic pots measuring 12 cm in diameter and 16.5 cm in depth. The pots were filled with autoclaved soil and placed in two water tanks in which the temperature was maintained at either 25.0 $\pm$ 0.5 C or at 32.5 $\pm$ 0.5 C. Each pot had a tube for drainage. The greenhouse air temperature ranged from 18 to 25 C.

Twelve days after transplanting, the five most uniform seedlings among the 10 seedlings transplanted per pot were selected for inoculation. Four pots containing five plants of each tomato cultivar were inoculated by pipetting in an egg/juvenile suspension of each inoculum density for each nematode species. Each cultivar was grown at 25 C and at 32.5 C for 28 days. When the number of egg masses exceeded 100, it was recorded as >100.

The plants were removed and the roots were washed and examined for egg masses. To detect differences in nematode reproduc-

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tion, the number of egg masses per plant, rather than gall indices, was determined.

The data were analyzed using the general linear models procedure in the Statistical Analyses System (SAS).

RESULTS AND DISCUSSION

The number of egg masses observed on four tomato genotypes after inoculations with either *M. incognita* or *M. javanica* at five inoculum densities and two temperatures is presented in Figures 1 and 2. For the susceptible cultivar Floradade, the number of egg masses recorded for both species of *Meloidogyne* was very similar at each inoculum density and at both temperatures. At 25 C, Floradade had more *M. incognita* egg masses than did PI 129149-2(sib)-5 or the two tomato cultivars, Nematex and Patriot, each carrying a gene for resistance to *M. incognita*. Also, at 25 C, all four tomato genotypes produced slightly more *M. javanica* than *M. incognita* egg masses, except *M. incognita* on Floradade at an inoculum density of 100. At 32.5 C, there was a breakdown in the resistance of PI 129149-2(sib)-5 and in the two tomato genotypes carrying resistance to *M. incognita*.

As the initial inoculum concentration increased, more *M. incognita* (Fig. 3) and *M. javanica* (Fig. 4) egg masses were produced on all the genotypes maintained at 32.5 C. But there were no significant differences in the number of *M. incognita* egg masses produced on Patriot, Nematex, and PI 129149-2(sib)-5 at any of the four inoculum densities. These three tomato genotypes produced similar numbers of egg masses at each inoculum density. However, significantly fewer egg masses were observed on these three tomato genotypes when inoculated with 200 nematode units than were observed on Floradade inoculated with only 100 nematode units (Fig. 3). Also, the reproduction observed on Floradade when inoculated with 200 nematode units of *M. incognita* per plant was nearly 50% greater than on Patriot, Nematex, and PI 129149-2(sib)-5.

The number of *M. javanica* egg masses produced on PI 129149-2(sib)-5 inoculated with 100 nematode units per plant differed

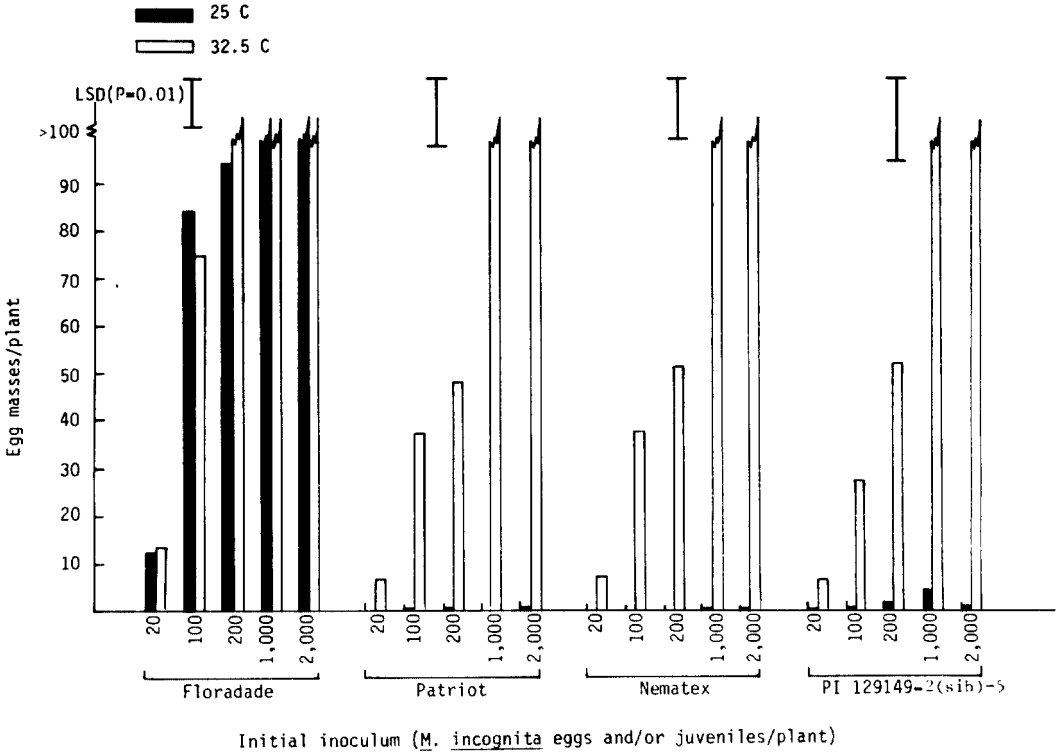

Fig. 1. Effect of temperature, five different inoculum densities, and four tomato genotypes on *Meloidogyne incognita* egg mass production 28 days after inoculation.

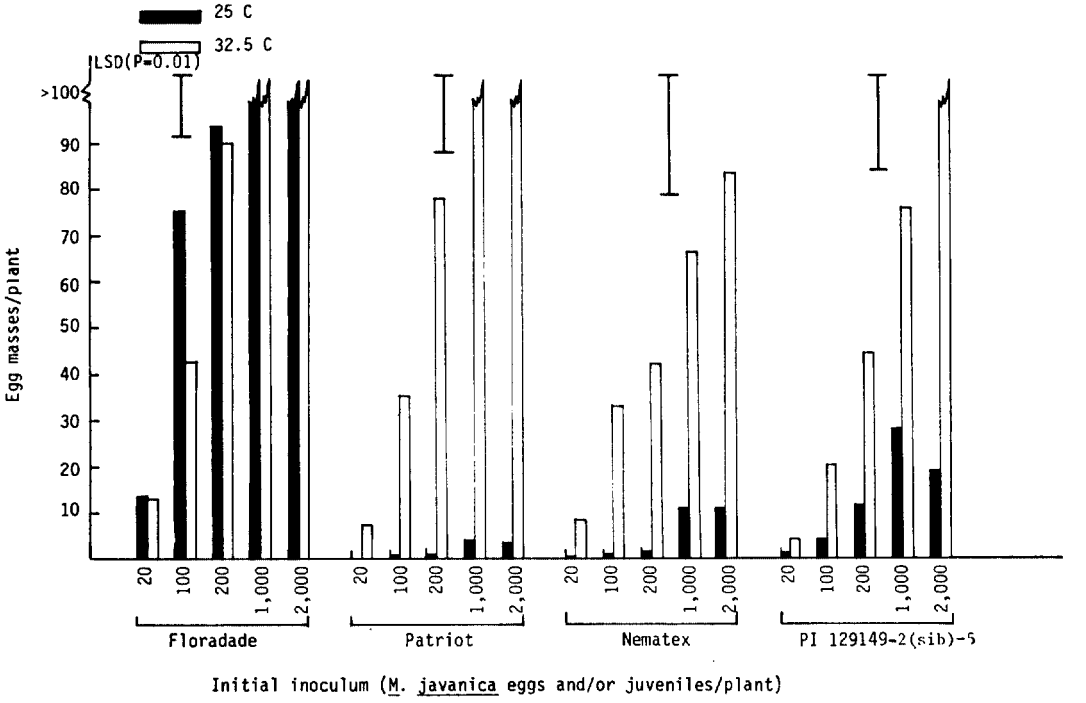

Fig. 2. Effect of temperature, five different inoculum densities, and four tomato genotypes on *Meloidogyne javanica* egg mass production 28 days after inoculation.

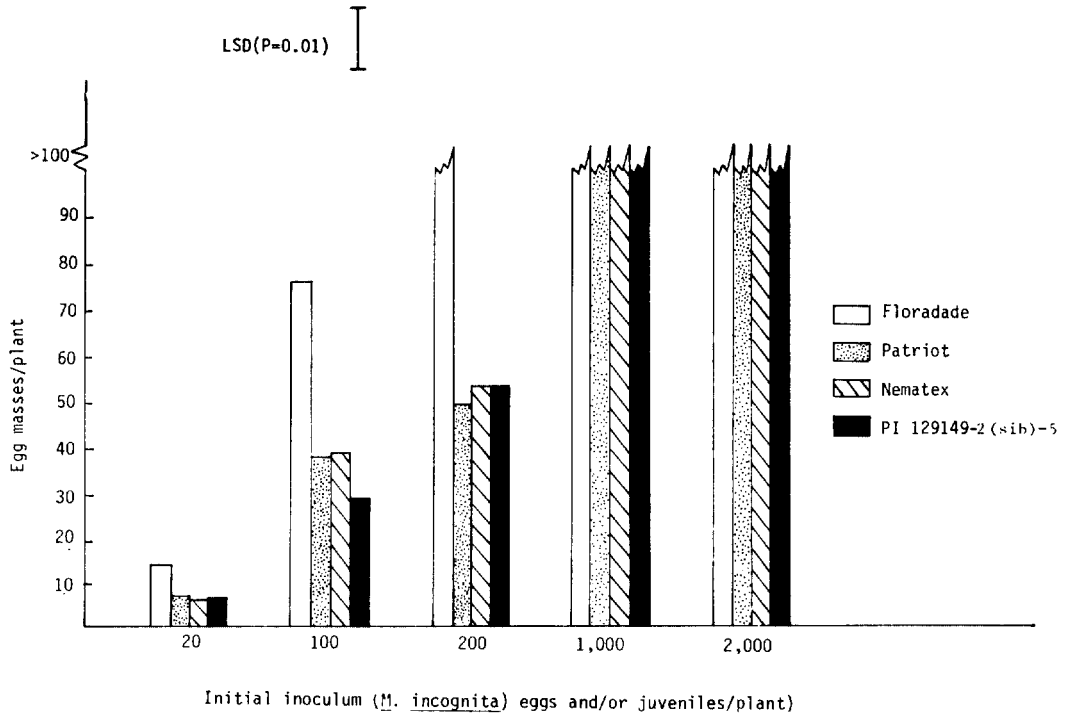

Fig. 3. Response of four tomato genotypes to five different inoculum levels of *Meloidogyne incognita* maintained at a constant soil temperature of 32.5 C as determined by the number of egg masses produced 28 days after inoculation.

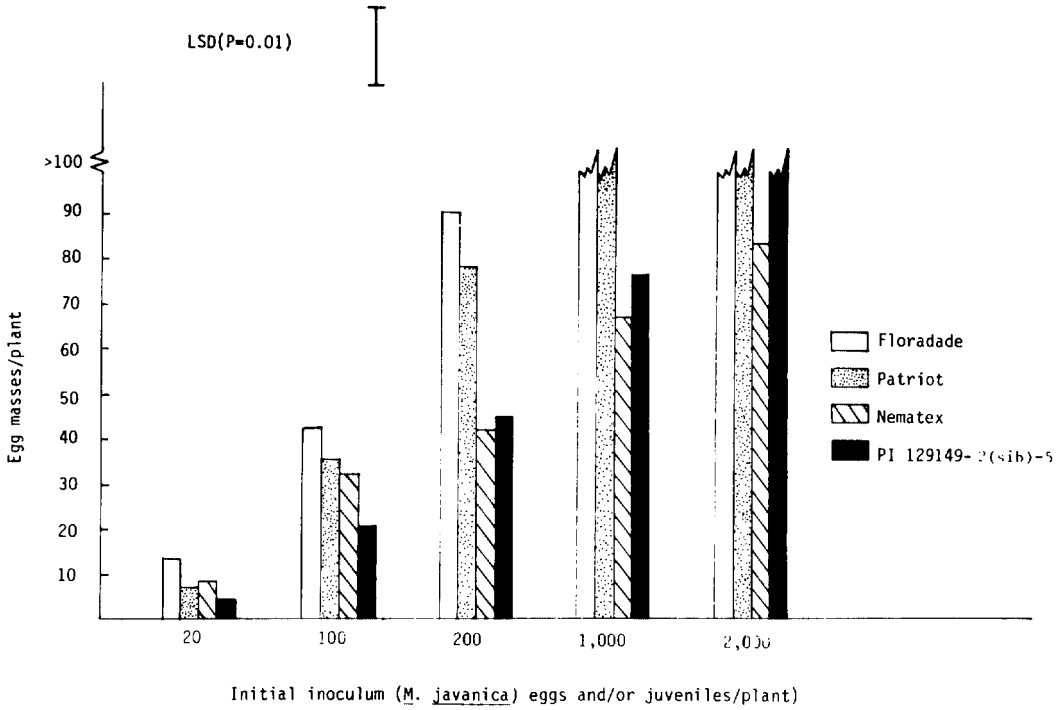

Fig. 4. Response of four tomato genotypes to five different inoculum levels of *Meloidogyne javanica* maintained at a constant soil temperature of 32.5 C as determined by the number of egg masses produced 28 days after inoculation.

significantly from Floradade, but not Patriot and Nematex. Those produced on Floradade and Patriot inoculated with 200 nematode units per plant did not differ statistically at 32.5 C. Nematex and PI 129149-2(sib)-5 produced similar numbers of egg masses and differed significantly from Floradade and Patriot. Similar results were obtained at the inoculum density of 1,000 nematode units per plant. However, in this case the number of egg masses produced on Floradade and Patriot was greater than 100. The number of egg masses per plant on the four tomato genotypes did not differ significantly at the highest inoculum density.

The concepts of host efficiency (resistance and susceptibility) and host sensitivity (tolerance and intolerance) have been characterized (1,2). According to these concepts, if nematode reproduction is diminished, the plant is showing resistance (host efficiency), whereas if the plant suffers yield loss, it is intolerant (host sensitivity). However, Wallace (6) is of the opinion that "in breeding plants for resistance, and in assessing the relative resistance of plant varieties, the rate of reproduction is the basic criterion. There are immune plants on which a particular nematode cannot reproduce at all, and there are susceptible ones on which it reproduces well. Between these extremes there is a spectrum of degree of resistance." The degree of resistance or susceptibility of a host can be assessed by establishing the relationship between the initial inoculum density and the final number of egg masses produced after one life cycle has occurred under controlled temperature conditions. With this view in mind, the data in Figures 3 and 4 suggest that an inoculum level of 200 nematode units per plant is the best density for screening tomatoes at 32.5 C. At this density, individual egg masses can be observed and the degree of resistance assessed. However, it doesn't give a measure of the host sensitivity.

It is suggested that the counting of individual egg masses is a useful technique for determining host suitability in tomato to root-knot nematodes at high temperature. Genetic selection for quantitative nematode resistance can be made feasible by this evaluation technique.

LITERATURE CITED

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

2. Barker, K. R., and T. H. A. Olthof. 1976. Relationships between nematode population densities and crop responses. Ann. Rev. Phytopathol. 14:327-353.

3. Dropkin, V. H. 1954. Infectivity and gall size in tomato and cucumber seedlings infected with Meloidogyne incognita var. acrita (root-knot nematode). Phytopathology 44:43-49.

4. Hussey, R. S., and K. R. Barker. 1973. A comparison of methods of collecting inocula of Meloidogyne spp., including a new technique. Pl. Dis. Rept. 57:1025-1028.

5. Lopez, R., and D. W. Dickson. 1977. Morfometria y respuesta de hospedantes diferenciales a tres poblaciones de Meloidogyne incognita y una de M. javanica. Agron. Costar 1:119-127.

6. Wallace, H. R. 1973. Nematode ecology and plant disease. London: Edward Arnold.

7. Walter, J. M. 1967. Hereditary resistance to disease in tomato. Ann. Rev. Phytopathol. 5:131-162.