SUSCEPTIBILITY OF VARIOUS TOMATO LINES TO A POPULATION OF *MELOIDOGYNE INCOGNITA*

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ABSTRACT

Acosta, N. and J. A. Negrón. 1982. Susceptibility of various tomato lines to a population of *Meloidogyne incognita.* Nematropica 12:173-180.

Comparative growth response and susceptibility of tomato cultivar Rutgers and nine tomato lines developed in Puerto Rico to a race 4 population of *Meloidogyne incognita* were studied in two greenhouse tests. In the first test eight, five-week old seedlings per line or cultivar were planted in steam-sterilized soil and inoculated with 10,000 eggs and second stage juveniles of *M. incognita* per plant. Thirty days after inoculation data on gall index, number of eggs from roots, and on larvae from 3.7 g of roots and 250 cm^3 of soil, and dry shoot weight were recorded. In the second test, 3,000 *M. incognita* eggs per plant and three replicates per treatment were used and similar data collected, 45 days after inoculation. Results from both experiments indicated that line 290 F_8 was resistant to the *M. incognita* population, whereas Rutgers was highly susceptible. Histological studies from roots of line 290 F_8 demonstrated few small giant cells with reduced number of nuclei present. Many well developed giant cells containing many nuclei were observed in Rutgers and the remaining susceptible tomato lines.

Additional key words: root-knot nematode, plant breeding, giant cells, resistant cultivars.

RESUMEN

Acosta, N. y J.A. Negrón. 1982. Susceptibilidad de varias líneas de tomate a una población de *Meloidogyne incognita.* Nematrópica 12:173-180.

Se establecieron dos experimentos de invernadero con el propósito de comparar el crecimiento y la susceptibilidad del cultivar Rutgers de tomate (susceptible a *M. incognita*) y el de nueve líneas desarrolladas en Puerto Rico a la raza 4 de una población de *Meloidogyne incognita* de Isabela. En el primer experimento se usaron plántulas de tomate de 5 semanas de edad, ocho por tratamiento. Estas fueron sembradas en suelo esterilizado al vapor e inoculadas con 10,000 huevos de *M. incognita*/ planta. Treinta días después de la inoculación se tomaron datos sobre índice de nodulación, número de huevos en las raíces y de larvas recobradas de 3.7 g de raíces y 250 cm^3 de suelo, además del peso seco del follaje.

En el segundo experimento se usaron 3,000 huevos de *M. incognita* por planta y tres replicaciones por tratamiento y los datos fueron tomados 45 días después de la inoculación. Los resultados de ambos experimentos fueron similares e indicaron que la línea 290 F_8 era resistente a la población de *M. incognita*, mientras que Rutgers era altamente susceptible. Estudios histológicos de raíces de la línea 290 F_8 mostraron pocas células gigantes de un tamaño más pequeño que el normal con un número reducido de núcleos mientras se encontraron muchas células gigantes bien desarrolladas y con muchos núcleos en las demás líneas susceptibles y en el cultivar Rutgers.
Palabras claves adicionales: nemátodo nodulador, fitomejoramiento, índice de nodulación, células gigantes.

INTRODUCTION

Tomatoes [*Lycopersicum esculentum* Mill.] (13) are among the most widely cultivated vegetables in Puerto Rico (1). Production during 1979-80 (1) was 2,257,220 kg. Yet, Puerto Rico produces only 16% of the tomatoes consumed locally. During 1978-79, around 1,037,484 kg of this crop were imported (1) from the United States.

Production of high quality tomatoes in Puerto Rico should be increased. Development of a good sized, firm fruited tomato variety resistant to plant diseases and nematodes is a must. In Puerto Rico, *Meloidogyne spp., Rotylenchulus spp.* and *Pratylenchus spp.* are important nematode genera associated with vegetable crops (21).

Considerable experimental data exists demonstrating that nematodes especially *Meloidogyne spp.*, are pathogenic to tomatoes and cause yield reductions (2,3,12,15,17,21,24,25). Nematodes cause severe root deterioration, resulting in poor growth of the plant and depressed productivity. Yield increases on tomatoes were the result of 80% nematode control with ethoprop 10G (unpublished, Acosta, 1981).

The detrimental effects of nematodes are usually increased by stress-related environmental factors such as temperature (14,19), photoperiod (19), salinity (7), soil texture (5,20) and others that alter plant physiology. Among these, temperature is particularly important affecting nematode movement, rate of growth and reproduction, and host suitability.

Resistance of a plant to root-knot nematodes could be expressed in various ways: hypersensitive reactions, reduced numbers of syncytia with few nuclei, failure of second stage juveniles to complete development, death of the nematodes, and reduced number of adult females (15,24). Phenolic compounds and chlorogenic acid content are higher in resistant tomato varieties than in susceptible ones (16,22). The magnitude of the expressions of host resistance to root-knot can be governed by soil temperatures. High soil temperature (38° C) can break tomato resistance to root-knot nematodes as is the case in tropical regions (23).

In order to compare the degree of resistance of nine tomato lines developed

in Puerto Rico with the tomato cultivar Rutgers (susceptible) to race 4 population of *M. incognita* from Isabela, two tests were conducted in the greenhouse.

MATERIALS AND METHODS

Two greenhouse experiments were established during June 1979 and 1980 to determine the relative susceptibility of nine tomato lines developed in Puerto Rico, to a race 4 population of *M. incognita* from Isabela. The tomato cultivar Rutgers (susceptible) was also included.

In the first test, five-week old seedlings from each line and cv. Rutgers were planted in 15-cm diameter plastic pots containing 1,350 cm^3 of a methyl bromide treated soil (60% sand, 14% clay and 26% silt) with pH=6.8. The inoculum level used included 10,000 *M. incognita* eggs and second stage juveniles per pot, while the control received supernatant (suspension with microorganisms, but free of nematodes).

Inoculum of race 4 *M. incognita* was obtained from a root-knot monospecific population from Isabela that had been maintained and increased on tomato cv. Homestead 94 in the greenhouse. Eggs and second stage juveniles were extracted from roots according to the method described by Hussey and Barker (10). The eggs were counted and the volume of the suspension adjusted in order to add 10,000 eggs and second stage juveniles to each plant.

Eight plants per treatment were placed on a greenhouse bench for 30 days. Throughout the study, soil temperatures were recorded at a depth of 6.5 cm twice daily before watering ($\bar{x}$=29° C). Plants were irrigated when necessary and fertilizer 10-10-10 was applied monthly. Data on gall index, number of juveniles in 3.7 g of roots and 250 cm^3 of soil, number of eggs and dry shoot weight were recorded. Final nematode numbers from roots and from soil were assayed using a mist chamber (18) and a modification of the method of Christie and Perry (4), respectively. A similar procedure was followed in the second test, but only 3,000 *M. incognita* eggs per plant and three replicates per line and cultivar were included. Data were recorded 45 days after inoculation.

At harvest, nematode infected and healthy root pieces from inoculated and uninoculated plants, respectively, were examined histologically (11). The purpose of this examination was to observe and describe general symptoms of infected roots and compare those of the nine tomato lines with symptoms on Rutgers (susceptible). Roots were stored in small jars containing formalin-aceto-alcohol (FAA). Root segments were cut into 1-cm sections dehydrated in tertiary butyl alcohol and embedded in 47-56° C paraplast. Roots were sectioned longitudinally at a thickness of 15 and 20 μm with a rotary microtome. Sections were mounted on glass slides and stained with safranin O and fast green (11) for microscopic examination.

RESULTS AND DISCUSSION

Tomato line 290 F_8 had a significantly lower gall index (Tables 1 and 2) and

Table 1. Means of gall indices, number of *M. incognita* eggs and juveniles from roots and soil and dry shoot weight of tomato cv. Rutgers and 9 tomato lines, 30 days after inoculation (1979).[x]

Tomato	Gall index (0-5)	Number		Dry shoot wt.
		Eggs	Juveniles[y]	% reduction[z]
290 F_8	3.2 A	132.0 A	60.0 A	-5.7 G
105 F_4	5.0 B	2485.0 A	128.0 A	0.7 DEF
182 F_6	5.0 B	2028.0 A	160.0 A	3.5 BCD
138 F_6	5.0 B	3199.0 A	96.0 A	7.1 AB
209 F_6	5.0 B	4914.0 A	52.0 A	5.2 ABC
94 F_4	5.0 B	3022.0 A	48.0 A	3.5 BCDE
222 F_6	5.0 B	4230.0 A	100.0 A	8.8 AB
277 F_7	5.0 B	3332.0 A	128.0 A	0.9 BCDEF
141 F_6	5.0 B	5234.0 A	32.0 A	5.5 ABC
Rutgers	5.0 B	2340.0 A	144.0 A	10.0 A

[x]Means of eight replications; gall index based on the following scale:0=1-2, 2=3-10, 3=11-30, 4=31-100, 5=greater than 100 galls. Column means followed by the same letter are not significantly different at the 5% level, according to Duncan's multiple range test.

[y]Juveniles extracted from 3.7 g of roots and 250 cm^3 of soil.

[z]Based on comparison between inoculated and uninoculated plants, (Dry shoot wt. inoculated plants-dry shoot wt. check plants ÷ dry shoot weight check plants x 100).

higher dry shoot weight of inoculated plants than the remaining lines and Rutgers (Table 1); it also had a lower number of eggs and juveniles. This was probably due to the fact that in most of the lines and Rutgers the root system was greatly deteriorated suggesting that these lines and cultivars may be very intolerant of *M. incognita* infection. Based on data from percent reduction of dry shoot and minimal reproduction of the parasite, it appears that line 290 F_8 is resistant and lines 277 F_7 and 105 F_4 are moderately resistant, whereas Rutgers and lines 222 F_6 and 138 F_6 appeared to be highly susceptible to the *M. incognita* population from Isabela. Apparently, soil temperature ($\bar{x}$ =29°C) played an important role in symptom expression and nematode reproduction. The remaining lines were intermediate in susceptibility.

Recent studies of population development of root-knot nematodes on tomato also have shown a wide range in susceptibility and resistance among cultivars. Edongali and Ferris (7) found differences in the response of tomato cultivars to a population of *M. incognita* under salinity regimes. At low salt

Table 2. Means of gall indices, number of eggs and juveniles of *M. incognita* from roots and soil of tomato cv. Rutgers and 9 tomato lines, 45 days after inoculation. (1980).[x]

Tomato	Gall index (0.5)	Number	
		Eggs	Juveniles[y]
290 F_8	3.0 A	1417.0 A	347.0 B
105 F_4	4.3 B	26666.0 A	10907.0 AB
182 F_6	4.7 B	42550.0 B	10667.0 AB
138 F_6	5.0 B	42867.0 B	11787.0 AB
209 F_6	5.0 B	37700.0 B	31893.0 A
94 F_4	5.0 B	34517.0 B	26843.0 A
222 F_6	5.0 B	40136.0 B	9440.0 AB
277 F_7	5.0 B	39044.0 B	31360.0 A
141 F_6	5.0 B	45658.0 B	8213.0 AB
Rutgers	5.0 B	27467.0 A	14960.0 AB

[x]Means of three replications. Column means followed by the same letter are not significantly different at the 5% level, according to Duncan's multiple range test.

[y]Juveniles extracted from 3.7 g of roots and 250 cm^3 of soil.

concentrations, significant differences on final numbers of nematodes recovered were found among cultivars. Ogbuji (17) found that populations of *M. arenaria, M. javanica* and *M. incognita* were pathogenic to different cultivars of tomato. Hadisoeganda and Sasser (9) tested various tomato cultivars against *M. incognita* and confirmed the resistance of cvs. Anahu, Atkinson, Healani, Nemared, Patriot, Rossol and susceptibility of others using egg mass index. These findings and ours emphasize the fact that tomato cultivars vary considerably in their susceptibility, and relative resistance to populations of *M. incognita.* Cook (6) and Barker and Olthof (3) define resistance as a minimal host damage and reproduction of the parasite and said that resistance and susceptibility are based on host suitability.

Histological examination of root sections from line 290 F_8 showed few small giant cells with reduced number of nuclei located around the head of female nematodes in the feeding area of the vascular system (Fig. 1). Well developed giant cells containing many nuclei were observed from root sections of cv. Rutgers and susceptible lines (Fig. 1).

Roots of healthy tomato plants have a central diarch protostele surrounded by pericycle-parenchyma cells which are encircled by cortex parenchyma cells as described by Fahn (8). The morphology of these plants was compared with

that of infected plants where it showed collapse of vascular vessels, hyperplasia, hypertrophy and giant cells (Fig. 1).

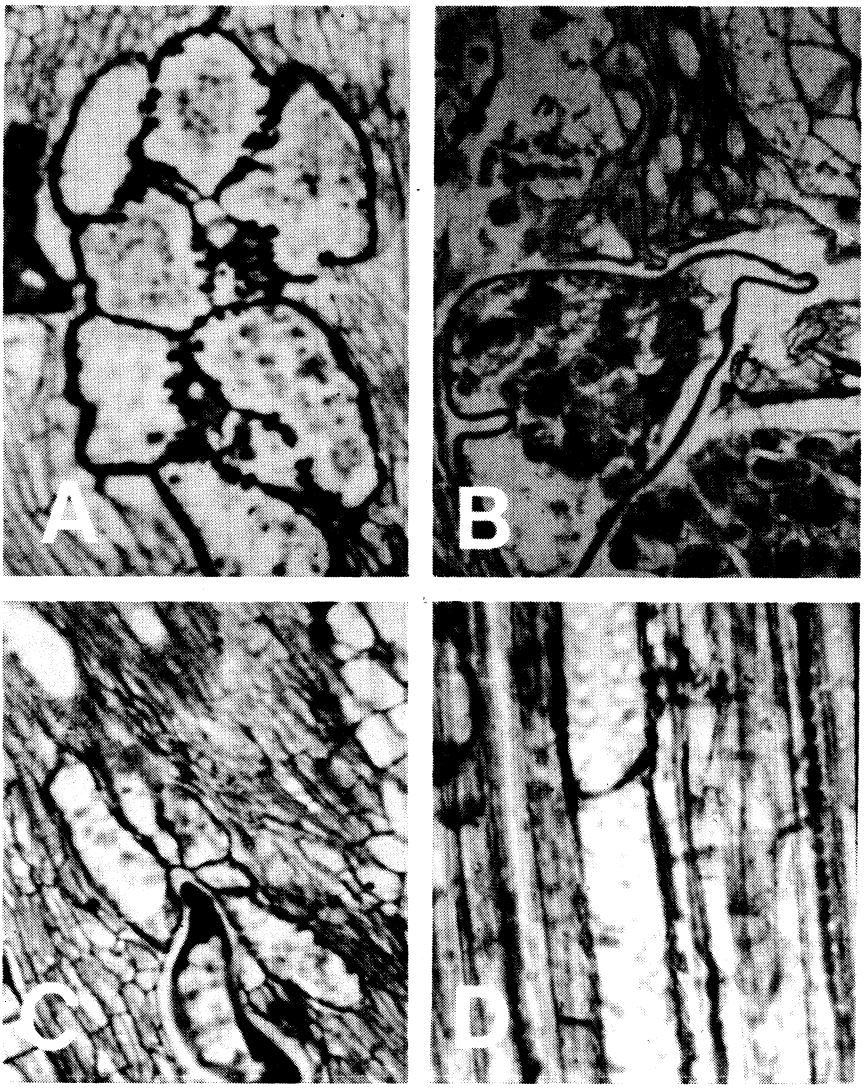
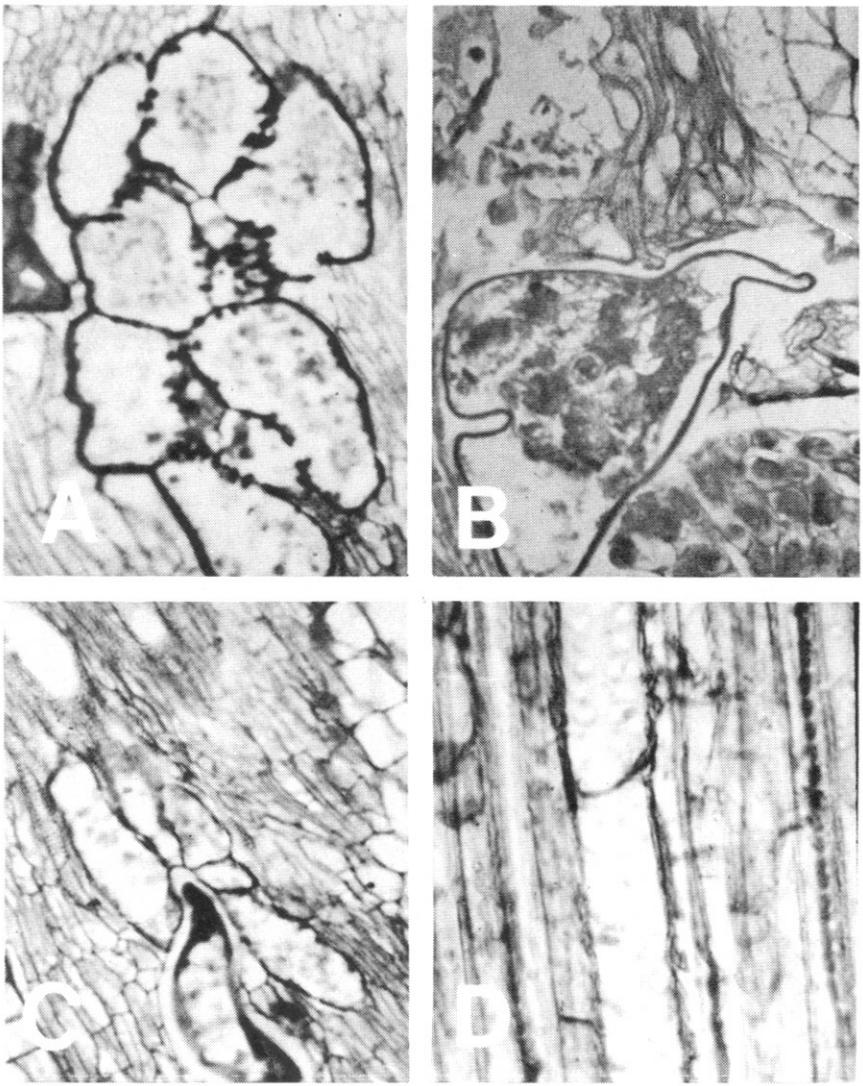


Fig. 1. Longitudinal sections of healthy and Meloidogyne incognita infected tomato roots. A) Seven will developed giant cells containing many nuceli from susceptible cv. Rutgers. B) A well developed *Meloidogyne* female in the vascular cylinder of a susceptible tomato line. C) Five small giant cells with reduced number of nuclei and a small female present in tomato line 290 F_8 and D) Healthy root section of line 290 F_8.



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