

YIELD OF SUSCEPTIBLE AND RESISTANT PEPPER IN MICROPLOTS INFESTED WITH *MELOIDOGYNE INCOGNITA*

M. Di Vito, V. Cianciotta, and G. Zaccheo

Istituto di Nematologia Agraria, CNR, Via Amendola, 165/A, Bari, Italy.

ABSTRACT

Di Vito, M., V. Cianciotta, and G. Zaccheo. 1992. Yield of susceptible and resistant pepper in microplots infested with *Meloidogyne incognita*. *Nematropica* 22:1-6.

The relationships between a geometric series of 13 initial densities (P_i) of *Meloidogyne incognita* between 0 and 128 eggs and juveniles/cm³ soil and yields of a susceptible and a resistant genotype of sweet pepper (*Capsicum annuum*) were investigated in 40-L microplots. A Seinhorst model, $y = m + (1 - m)z^{(P_i - T)}$, was fitted to yield and plant weight for each genotype. In this model, y is the yield or plant weight, m is the minimum relative yield, and T is the tolerance limit. Both genotypes showed a tolerance limit of 0.3 eggs and juveniles/cm³ soil. Maximum growth suppression of the susceptible and resistant genotypes was 84% and 50%, respectively, and occurred in both genotypes at $P_i \geq 16$ eggs and juveniles/cm³ soil. Maximum nematode reproduction was 584-fold at the lowest P_i in microplots planted with the susceptible cultivar, Yolo Wonder, but was ≤ 1 at all P_i 's in microplots planted with the resistant Line 89422.

Key words: *Capsicum annuum*, *Meloidogyne incognita*, resistant and susceptible pepper, root-knot nematode, tolerance limit.

RESUMEN

Di Vito, M., V. Cianciotta y G. Zaccheo. 1992. Rendimiento de un pimiento susceptible y uno resistente en microparcelas infestadas con *Meloidogyne incognita*. *Nematropica* 22:1-6.

Las relaciones entre una serie geométrica de 13 densidades iniciales (P_i) de *Meloidogyne incognita* entre 0 y 128 huevos y juveniles/cm³ de suelo y los rendimientos de un genotipo susceptible y uno resistente de pimiento (*Capsicum annuum*) fueron investigadas en microparcelas con volúmenes de 40 L. Se utilizó un modelo de Seinhorst, $y = m + (1 - m)z^{(P_i - T)}$, para evaluar los rendimientos y pesos de las plantas para cada genotipo. En este modelo, y es el rendimiento o peso de la planta, m es el rendimiento mínimo relativo, y T es el límite de tolerancia. Ambos genotipos mostraron un límite de tolerancia de 0.3 huevos y juveniles/cm³ de suelo. La máxima supresión del crecimiento del genotipo susceptible y resistente fue 84% y 50%, respectivamente, y se encontró en ambos genotipos con una $P_i \geq 16$ huevos y juveniles/cm³ de suelo. La tasa máxima de reproducción de los nematodos fue de 584 veces en microparcelas plantadas con el cultivar susceptible Yolo Wonder con la P_i más baja. La tasa máxima fue ≤ 1 para todas las P_i en microparcelas plantadas con la línea resistente, 89422.

Palabras clave: *Capsicum annuum*, límite de tolerancia, *Meloidogyne incognita*, nematodo agallador, pimiento resistente y susceptible.

INTRODUCTION

Pepper (*Capsicum annuum* L.) is an important vegetable worldwide and is cultivated on 1 166 000 ha yielding 8 800 000 MT. In Italy, 16 000 ha each year are devoted to this crop producing 384 000 MT of peppers. Twenty percent of the hectareage is in greenhouses and 75% of the production is obtained from southern Italy (1).

Annually, the world yield loss due to nematode infestations was estimated to be

12.2% (13). Among nematode pests, *Meloidogyne incognita* (Kofoid & White) Chitwood is very noxious to sweet pepper and causes severe damage in infested fields of southern Italy (3). Microplot experiments have shown that yield suppression of susceptible sweet pepper cultivars occurs at initial densities (P_i) of *M. incognita* greater than 0.165 eggs and juveniles/cm³ soil (7,12,16). Moreover, yield losses of nematode-resistant cultivars of alfalfa (11)

and tomato (5) have been reported when these crops are cultivated in the presence of large population densities of *Meloidogyne hapla* Chitwood and *M. incognita*, respectively. Therefore, a microplot study was conducted in southern Italy to determine the effect of various population densities of *M. incognita* on the yield of a susceptible and a resistant sweet pepper and on the nematode population dynamics on these genotypes. The results of this experiment are presented in this paper.

MATERIALS AND METHODS

One hundred and ninety-six 30 × 30 × 50 cm microplots were placed 45 cm deep in a field at Bari, Italy. Microplots were contiguous along the row and spaced 90 cm apart between rows. They were filled with 40 L of sandy soil (89% sand, 4% silt, 7% clay, 2.3% organic matter) that had been fumigated 6 months earlier with 200 L/ha of 1,3 dichloropropene. To obtain inoculum for experimentation, *M. incognita* race 1 from Italy (15) was increased on sweet pepper cv. Marconi Giallo in a glasshouse. One thousand grams of nematode-infected pepper roots were finely chopped and ten 10-g root samples were removed from the root mass. The samples were individually processed by the NaOCl method (8,10) to obtain egg counts to quantify *M. incognita* in the total root mass. The roots then were thoroughly mixed with 50 kg fumigated soil to be used as inoculum. Appropriate amounts of inoculum and 10 g of a fertilizer (12% N, 24% P, 12% K) were thoroughly mixed in a concrete mixer with the soil of each microplot to give a range of population densities of 0, 0.031, 0.062, 0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 32, 64, or 128 eggs and juveniles of *M. incognita*/cm³ soil. Two sets of microplots, one for the susceptible cv. Yolo Wonder and other for the resistant Line 89422 were arranged in a ran-

domized complete-block design with seven replications. Line 89422 is a sweet pepper of the Istituto di Nematologia Agraria, Bari, Italy, obtained by crossing and selecting cv. Yolo Wonder with Line Tabasco of *C. frutescens* L., which is resistant to *M. incognita*, *M. javanica* (Treub) Chitwood, and *M. arenaria* (Neal) Chitwood (6).

Previous experiments (7,8) demonstrated that because of the small amount of roots used with inoculum, no clear growth effect could be attributed to the roots. Therefore, no check with nematode-free roots was included.

A 2-month-old seedling of Yolo Wonder or Line 89422 was transplanted in each microplot on 15 May. Appropriate procedures were followed for irrigation, fertilization, and disease, pest, and weed control. Fruits were harvested and weighed (as they matured) on 20 July, 30 July, and 20 August. Fresh top weights of the plants were determined at the last harvest.

A 2-kg soil sample, composite of 20 cores, was collected with a 2.5-cm-diam soil sampler from the top 30 cm of each microplot 1 day after the last harvest (21 August); 500 cm³ subsamples were processed by a modified Coolen's method (2,7) to estimate the final population and the reproduction rate of the nematode.

The Seinhorst model, $y = m + (1 - m)z^{(P_i - T)}$ was fitted to yield and plant weight data of each genotype (14). In this model, P_i is the initial population density and y is the ratio between the yield at P_i and that at $P_i \leq T$, where m is the minimum relative yield (y at very large P_i), z a constant < 1 with $z^{-T} = 1.05$, and T the tolerance limit (P_i at which no yield is lost). Also for each genotype, fruit size in grams was regressed against $\log (P_i + 1)$.

RESULTS AND DISCUSSION

Relationship between population densities of M. incognita and pepper yield: A

maximum of only 35 g of infested pepper roots were in each microplot with the largest population density. Therefore, it is assumed that plant growth, plant yield, and nematode population dynamics were only affected by the nematode population densities at planting and that effects of the presence of the roots was negligible.

Plant growth and yield were greatly reduced by *M. incognita*. Stunting was evident on susceptible Yolo Wonder throughout the season in microplots with $P_i > 32$ eggs and juveniles/cm³ soil. Stunting of the resistant Line 89422 was not obvious even at large inoculum levels. The time required for flowering and fruiting were not noticeably affected by the nematode. In heavily infested microplots, however, the susceptible genotype flowered poorly and produced small fruits.

For both genotypes, the Seinhorst model indicated $T = 0.3$ eggs and

juveniles/cm³ soil (Fig. 1). A similar tolerance limit (0.74 eggs and juveniles/cm³ soil) was measured for Yolo Wonder in glasshouse pots inoculated with *M. incognita* (4). The minimum relative yield of both genotypes was achieved at $P_i = 16$ eggs and juveniles/cm³ soil. The magnitude of the relative minimum yield of Line 89422 (50%) however, was three times that of Yolo Wonder (16%). Plant top weight curves were similar to those of fruit yield. The fruit size of Yolo Wonder decreased linearly ($P < 0.01$) with $\log(P_i + 1)$ and dropped from 90 g to 50 g between the lowest and highest P_i (Fig. 2). The fruit size of Line 89422 was not significantly reduced by P_i .

Population dynamics of M. incognita: On Yolo Wonder, a maximum reproduction rate of 584 occurred at the lowest P_i (0.031 eggs/cm³ soil) (Table 1); the reproduction rate decreased with increase in P_i but was

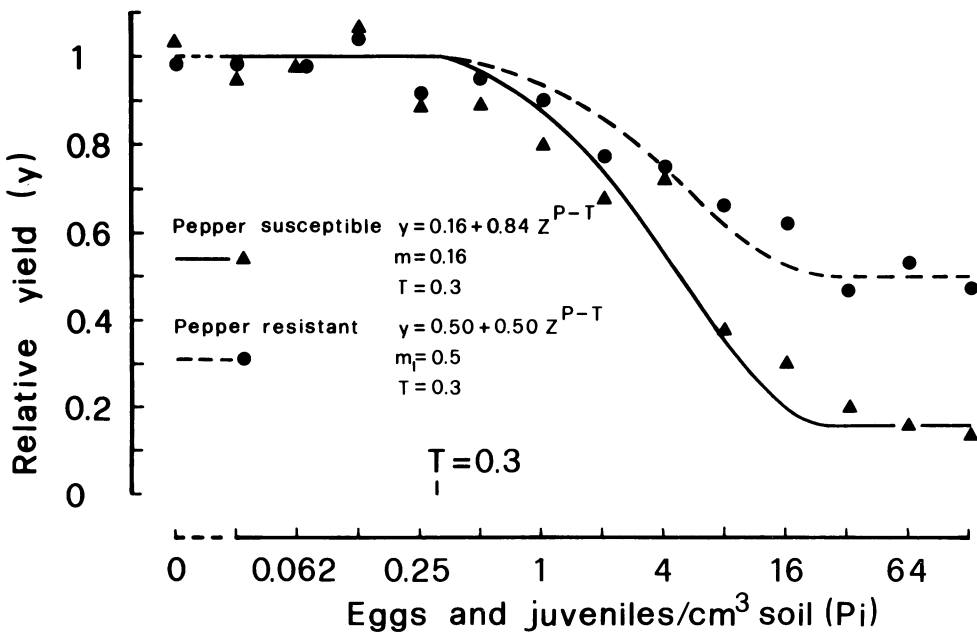


Fig. 1. Relationship between initial population densities (P_i) of *Meloidogyne incognita* race 1 and relative sweet pepper yield (y) of susceptible cv. Yolo Wonder and resistant Line 89422 grown in microplots for 3 months. Relative yield is based on total fruit weight per plant.

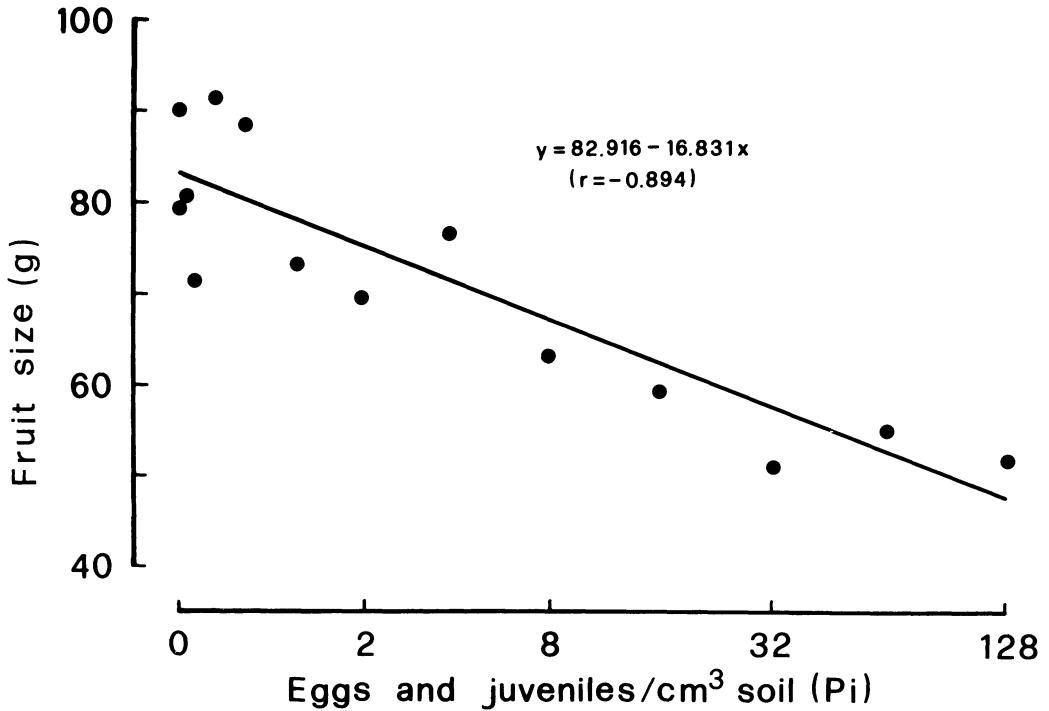


Fig. 2. Relationship between initial population densities of *Meloidogyne incognita* race 1 and average fruit weight of susceptible sweet pepper cv. Yolo Wonder grown in microplots for 3 months.

Table 1. Effect of *Meloidogyne incognita* race 1 initial densities (Pi) on final density (Pf) and reproduction rate on susceptible cv. Yolo Wonder and resistant Line 89422 of *Capsicum annuum* after 3 months.

Pi	Pf (Eggs and juveniles/cm ³ soil)		Pf/Pi (Reproduction rate)	
	Yolo Wonder	Line 89422	Yolo Wonder	Line 89422
0.031	18.1	0.03	583.9	0.96
0.062	14.3	0.04	236.6	0.64
0.125	17.6	0.1	140.8	0.80
0.25	82.1	0.2	328.4	0.90
0.5	83.1	0.0	166.2	0.00
1	86.3	1.0	86.3	1.00
2	147.2	0.0	73.6	0.00
4	132.3	1.1	33.1	0.27
8	158.8	0.7	19.8	0.08
16	163.4	1.0	10.2	0.06
32	136.8	1.7	4.3	0.05
64	165.0	1.4	2.6	0.02
128	142.1	2.8	1.1	0.02

greater than 1.0 for all Pi less than 128 eggs and juveniles/cm³ soil. In all microplots planted with Line 89422, the reproduction rate was ≤ 1 (Table 1).

The decline of *M. incognita* populations in microplots with high Pi and planted with Yolo Wonder, may have been due to reduced food supply for the nematodes due to poor plant growth at these population levels. In microplots planted with the resistant sweet pepper line, most of the nematode juveniles that penetrated the roots were unable to complete their development because of the hypersensitive plant reaction (9; and Di Vito, unpublished). Therefore the nematode population drastically declined resulting in low Pf.

The experiment confirmed the destructive effect of *M. incognita* on sweet pepper. The use of resistant pepper cultivars for controlling root-knot nematodes (*Meloidogyne* spp.) is very promising. It limits yield loss and greatly reduces the soil population density of the nematode, often to non-damaging levels for subsequent crops in a growing season. It is apparent however, that even highly resistant sweet pepper can suffer appreciable yield losses if initial population densities of *M. incognita* are high.

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LITERATURE CITED

- CARUSO, P. 1990. Peperone. Pp. 846–858 in V. V. Bianco and F. Pimpini, eds. *Orticoltura*. Patron Press: Bologna.
- COOLEN, W. A. 1979. Methods for the extraction of *Meloidogyne* spp. and other nematodes from roots and soil. Pp. 317–329 in F. Lamberti and C. E. Taylor, eds. *Root-knot Nematodes (Meloidogyne species) Systematics, Biology and Control*. Academic Press: New York.
- DI VITO, M. 1979. Status of research on the biology and control of the root-knot nematodes (*Meloidogyne* spp.) in Italy. Proceedings of the 2nd Research Planning Conference on Root-knot Nematodes, *Meloidogyne* spp., Athens, Greece, November 26–30, 1979. Pp. 135–138.
- DI VITO, M. 1986. Population densities of *Meloidogyne incognita* and growth of susceptible and resistant pepper plants. *Nematologia Mediterranea* 14:217–221.
- DI VITO, M., and H. M. R. K. EKANAYAKE. 1983. Relationship between population densities of *Meloidogyne incognita* and growth of resistant and susceptible tomato. *Nematologia Mediterranea* 11:151–155.
- DI VITO, M., and F. SACCARDO. 1986. Response of inbred lines of *Capsicum* to root-knot nematodes (*Meloidogyne* spp.). Proceedings of the VIth EUCARPIA Meeting on Genetics and Breeding on *Capsicum* and Eggplant, Zaragoza, Spain, October 21–24, 1986. Pp. 119–123.
- DI VITO, M., N. GRECO, and A. CARELLA. 1985. Population densities of *Meloidogyne incognita* and yield of *Capsicum annuum*. *Journal of Nematology* 17:45–49.
- DI VITO, M. N. GRECO, and A. CARELLA. 1986. Effect of *Meloidogyne incognita* and importance of the inoculum on the yield of eggplant. *Journal of Nematology* 18:487–490.
- HENDY, H., A. DALMASSO, and M. C. CARDIN. 1985. Differences in resistant *Capsicum annuum* attacked by different *Meloidogyne* species. *Nematologica* 31:72–78.
- HUSSEY, R. S., and K. R. BARKER. 1973. A comparison of methods of collecting inocula of *Meloidogyne* spp. including a new technique. *Plant Disease Reporter* 57:1025–1028.
- INSERRA, R. N., J. H. O'BANNON, M. DI VITO, and H. FERRIS. 1983. Response of two alfalfa cultivars to *Meloidogyne hapla*. *Journal of Nematology* 15:644–646.
- LINDSEY, D. L. and M. S. CLAYSHULTE. 1982. Influence of initial inoculum densities of *Meloidogyne incognita* on three chile cultivars. *Journal of Nematology* 14:353–358.
- SASSER, J. N., and D. W. FRECKMAN. 1987. A world perspective on nematology: the role of the Society. Pp. 7–14 in J. A. Veech and D. W. Dickson, eds. *Vistas on Nematology*. Society of Nematologists, Inc.: Hyattsville, Maryland, U.S.A.
- SEINHORST, J. W. 1965. The relationship between nematode density and damage to plants. *Nematologica* 11:137–154.

15. TAYLOR, A. L., and J. N. SASSER. 1978. Biology, Identification and Control of Root-knot Nematodes (*Meloidogyne* Species). Department of Plant Pathology, North Carolina State University, and U. S. Agency for International Development: Raleigh, North Carolina, U.S.A. 111 pp.
 16. THOMAS, S. H., and J. A. RYDER-WHITE. 1982. Effect of low inoculum levels of *Meloidogyne incognita* on three chile cultivars. Journal of Nematology 14:473 (abstract).
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