# EFFECT OF THE ROOT-KNOT NEMATODE, *MELOIDOGYNE JAVANICA*, ON THE GROWTH OF A PEACH (*PRUNUS PERSICA*) ROOTSTOCK IN POTS

**M. Di Vito[1], A.M. Simeone[2] and F. Catalano[1]**

[1] *Istituto per la Protezione delle Piante, Sezione di Bari, C.N.R., 70126 Bari, Italy*
[2] *Istituto Sperimentale per la Frutticoltura, MiPAF, 00134 Roma, Italy*

**Summary.** The effect of initial population densities of an Italian population of *Meloidogyne javanica* on the growth of a peach rootstock was investigated in 950 $cm^3$ plastic pots. Each pot was inoculated with 0, 0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512 or 1024 eggs and second stage juveniles/$cm^3$ soil and one seedling of the peach rootstock cv. GF 677 was transplanted into each pot. Data on height and fresh top weight of the plants were fitted to the Seinhorst model, $y = m + (1 - m)z^{P-T}$. Tolerance limits to the nematode were 0.85 and 0.57 eggs and second stage juveniles/$cm^3$ soil for fresh top weight and height, respectively. Minimum relative yields were 0.29 at $Pi \geq 64$ eggs and second stage juveniles/$cm^3$ soil for fresh top weight and 0.58 at $Pi \geq 32$ eggs and second stage juveniles/$cm^3$ soil for plant height. Maximum nematode reproduction rate was 6.2-fold at the smallest initial population density.

Peach [*Prunus persica* (L.) Brasch var. *persica*] is an important fruit crop in many temperate countries, being grown on >1.4 million ha world-wide and yielding >14.7 million t (FAO, 2004). Several species of plant parasitic nematodes have been reported to damage the crop (Di Vito, 1996; Pinochet *et al.*, 1996). They include the ring, *Criconemella xenoplax* (Raski) Luc *et* Raski, and the root-lesion *Pratylenchus vulnus* Allen *et* Jensen nematodes and the root-knot nematodes *Meloidogyne incognita* (Kofoid *et* White) Chitw., *M. javanica* (Treub) Chitw., *M. arenaria* (Neal) Chitw. and *M. hapla* Chitw. (Nyczepir and Halbrendt, 1993). It is also worthwhile mentioning that a new root-knot nematode species, *M. floridensis* Handoo, Nyczepir, Esmenjaud, van der Beek, Castagnone-Sereno, Carta, Skantar *et* Higgins was found in Florida parasitizing "Nemaguard", a peach rootstock resistant to *M. incognita* and *M. javanica* (Handoo *et al.*, 2004). The root-knot nematodes listed above are the most common and damaging nematodes to peach in most countries, causing an average yield loss of about 12% on a world basis (Di Vito *et al.*, 2002). Italy is a primary producer of peaches in the world (97,497 ha and >1.3 million t) (FAO, 2004). Root-knot nematode species are major pests in the main growing areas of Italy. Recent studies conducted in the United States indicate that the severity of damage caused by root-knot nematodes is affected by many factors, including initial population levels, growing media and genetic characteristics of peach rootstocks (Lu ZhenXiang *et al.*, 2000). Therefore, an experiment was undertaken in a screen-house to assess the effect of a range of initial population densities of *M. javanica* on the growth of the peach rootstock GF 677, in a sandy soil collected from a peach-growing area in southern Italy.

## MATERIALS AND METHODS

An Italian population of *M. javanica* was collected from a peach orchard at San Ferdinando di Puglia (Foggia province) and reared on tomato (*Lycopersicon esculentum* Mill.) cv. Rutgers in a glasshouse at 26 ± 3 °C. When large egg masses had formed, the roots were gently washed free of adhering soil and finely chopped (1-2 cm pieces). Ten sub-samples of 5 g were separately shaken for 4 min in jars containing 100 ml of 1% aqueous solution of sodium hypochlorite to dissolve the egg masses and the resulting suspension was sieved through a 70 µm sieve mounted on a 10 µm sieve (Hussey and Barker, 1973). Eggs remaining on the 10 µm sieve were gathered in a beaker and those in three 1-ml aliquots counted. The number of nematodes on the total amount of roots was estimated from these counts. The remaining infected roots were then thoroughly mixed with 3 kg of steam sterilized sandy soil and used as inoculum. Chopped, infested tomato roots were preferred as inoculum because they were found to be more efficient than suspensions of dispersed eggs (Di Vito *et al.*, 1986).

One hundred and twenty plastic pots were each filled with 950 $cm^3$ of steam sterilized sandy soil (sand 88%, silt 5%, clay 7% and organic matter 2.5%). Appropriate amounts of the inoculum were thoroughly mixed into the soil of each pot to give population densities of 0, 0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512 or 1024 eggs and second stage juveniles/$cm^3$ soil. Eight pots were inoculated with each population density.

Seedlings of the peach rootstock cv. GF 677, produced *in vitro* (Zuccarelli, 1979) and transferred to a glasshouse to acclimatize, were used. A single two-month-old plantlet, about 10 cm tall, was transplanted into each pot on 15 May 2004. The pots were arranged in a randomized block design on benches in a screen-house at 28 ± 5 °C.

Six months after transplanting, fresh top weight and height of the plants were recorded. The root systems were gently washed, weighed and gall indices were assessed according to a 0-5 scale, where 0 = no gall, 1 = 1-2 galls, 2 = 3-10, 3 = 11-30, 4 = 31-100 and 5 = more than 100 galls (Taylor and Sasser, 1978). To extract eggs and second stage juveniles of the nematode, the roots were blended in 1% sodium hypochlorite solution for 3 min and then centrifuged according to Coolen's method (Coolen, 1979). Eggs and second stage juveniles of the nematode were also extracted from soil by Coolen's modified method (Coolen, 1979; Di Vito *et al.*, 1985). The number of eggs and second stage juveniles in the soil plus those found in the roots of the same pot was considered as the final population density (*Pf*) per pot.

Data on the plant growth parameters were fitted to Senhorst's model (Seinhorst, 1965, 1979). Data on root gall indices were analysed by ANOVA and the means compared with Duncan's Multiple Range Test.

## RESULTS AND DISCUSSION

Environmental conditions in the screen-house during the experiment were suitable for both peach plant growth and nematode infestation and reproduction.

*Meloidogyne javanica* affected the growth of peach negatively (Figs 1 and 2). Symptoms of nematode attack were evident at an initial population density (*Pi*) of 8 eggs and second stage juveniles/cm$^3$ and consisted of a marked reduction of plant top growth.

Data on fresh top weight and height of plants fitted curves according to the model, $y = m + (1 - m)z^{Pi-T}$, proposed by Seinhorst (1965, 1979). In this model, $y$ is the relative yield (the yield at a given $P > T$ divided by the average yield at all $P \leq T$, with $y = 1$ at $P \leq T$), $m$ is the minimum relative yield (= $y$ at very large population densities), $P$ is the nematode population density at transplanting expressed as eggs and second stage juveniles/cm$^3$ soil, $T$ is the tolerance limit of the crop to the nematode (= value of $P$ up to which no crop damage occurs), and $z$ is a constant with $z^{-T} = 1.05$. After fitting the data to this model, values of tolerance limits, relative yields ($y$) at different population densities and minimum yields ($m$) were derived (Figs 1 and 2).

The tolerance limits of fresh top weight and height of peach plants challenged by *M. javanica* were 0.85 and 0.57 eggs and second stage juveniles/cm$^3$ soil, respectively. The minimum relative yields ($m$) were 0.29 at $Pi \geq 64$ eggs and second stage juveniles/cm$^3$ soil for plant fresh top weight and 0.58 at $Pi \geq 32$ eggs and second stage juveniles/cm$^3$ soil for plant height (Figs 1 and 2).

The maximum reproduction rate of the nematode (*Pf/Pi*) was 6.2-fold and was achieved at the smallest initial population density (0.125 eggs and second stage ju-

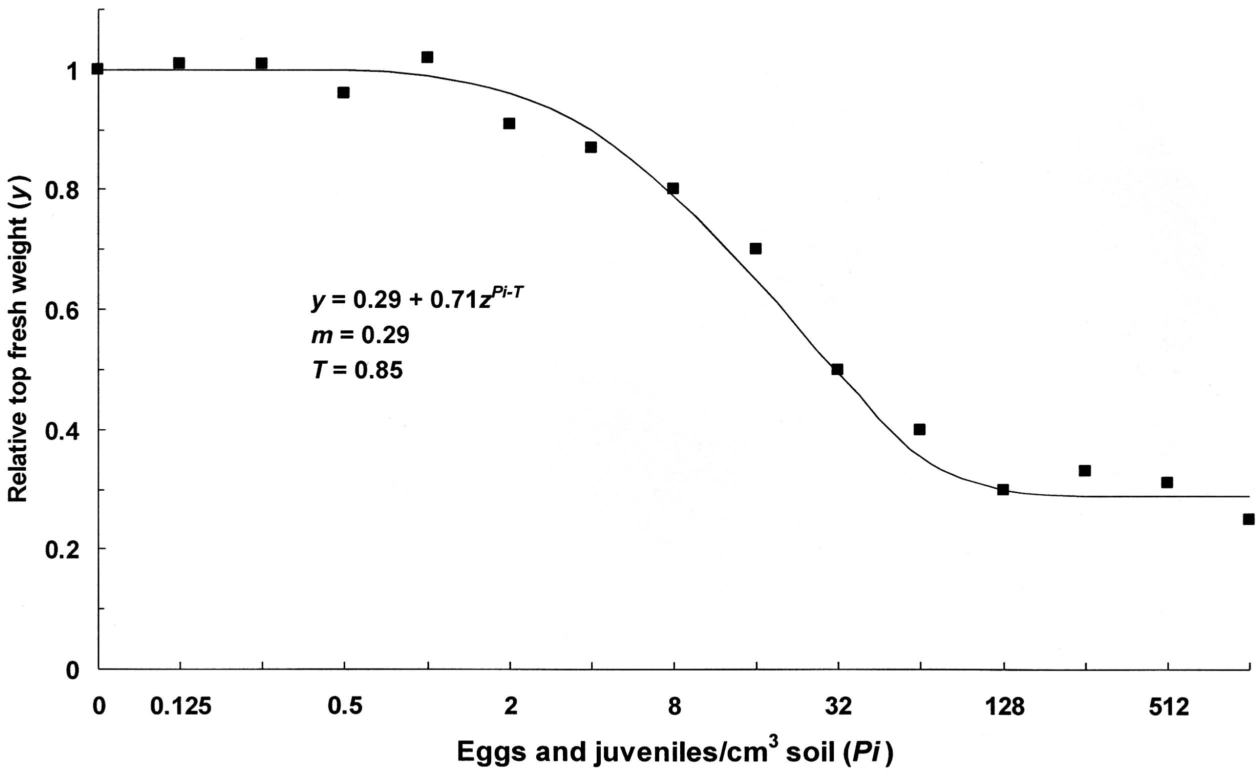


**Fig. 1.** Relationship between initial population densities (*Pi*) of an Italian population of *Meloidogyne javanica* and relative fresh top weight ($y$) of peach rootstock plants cv. GF 677 grown in pots maintained in a screen-house at 28 ± 5 °C.

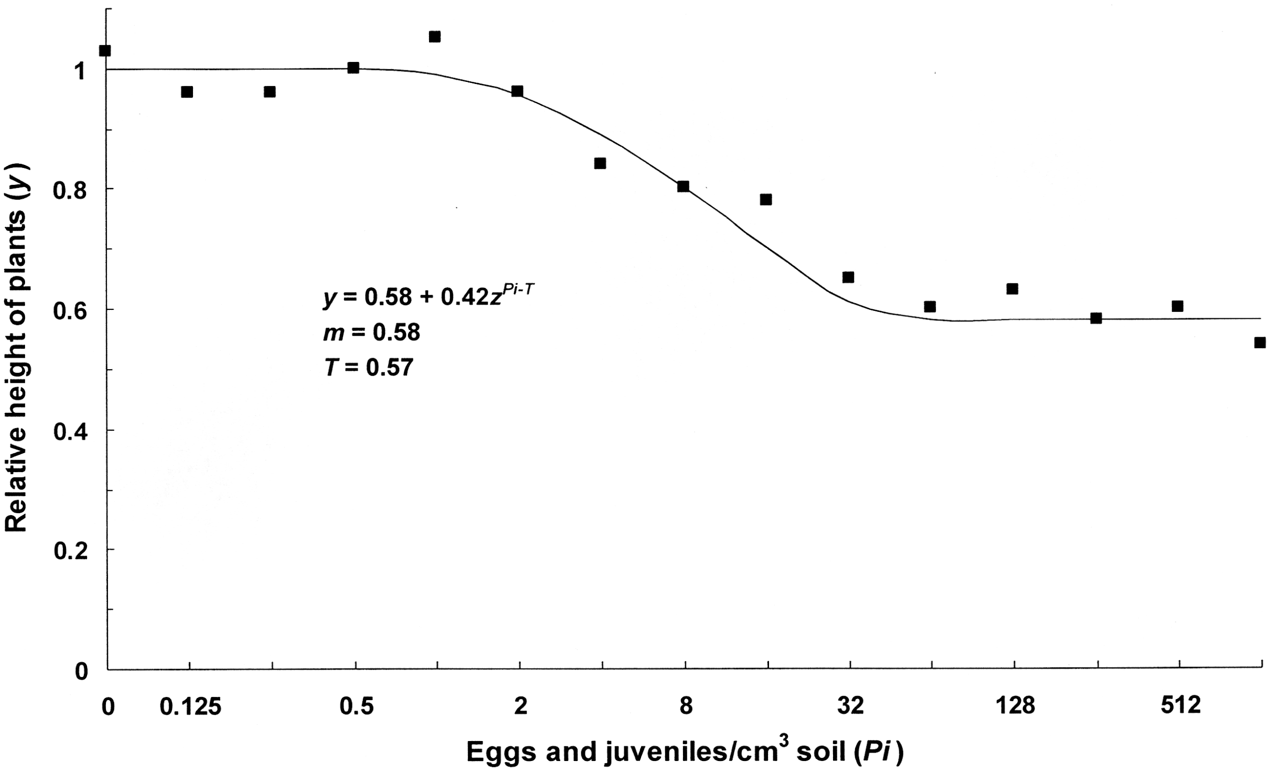


**Fig. 2.** Relationship between initial population densities (*Pi*) of an Italian population of *M. javanica* and relative height (*y*) of peach rootstock plants cv. GF 677 grown in pots maintained in a screen-house at 28 ± 5 °C.

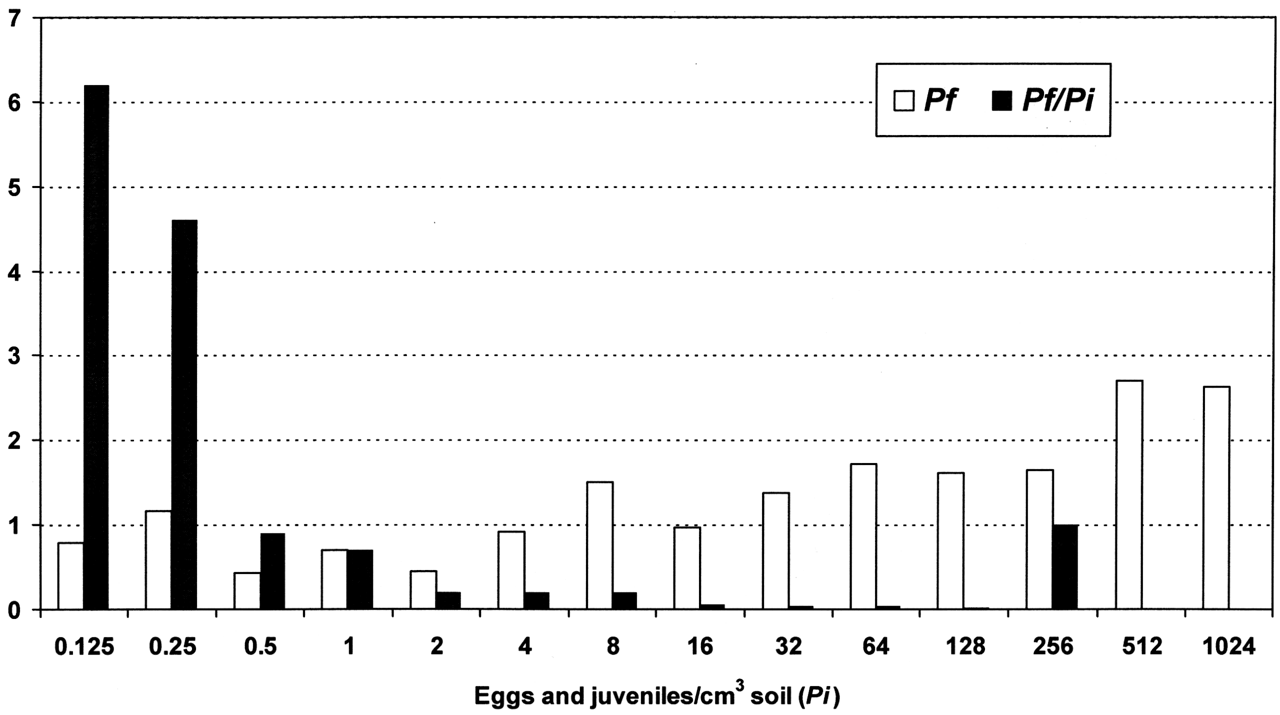


**Fig. 3.** Effect of different population densities of *M. javanica* at transplanting (*Pi*) on the nematode population at harvest (*Pf*) and its reproduction rate (*Pf/Pi*) in pots into which peach rootstock cv. GF 677 was transplanted.

veniles/cm$^3$ soil); the largest final population density (*Pf*) occurred in the pots inoculated with 512 eggs and second stage juveniles/cm$^3$ (Fig. 3). The root gall index was lowest (0.1) at the lowest initial population density and highest (5) at $Pi \geq 256$ eggs and second stage juveniles/cm$^3$ soil (Table I).

**Table I.** Effect of initial population densities of *Meloidogyne javanica* at transplanting on the root gall index of peach rootstock plants cv. GF 677 grown in pots.

| Eggs and second stage juveniles/cm$^3$ soil | Root gall index (0 – 5) |
|---|---|
| 0.125 | 0.1 A* |
| 0.25 | 1.3 B |
| 0.5 | 2.1 C |
| 1 | 3.2 D |
| 2 | 3.5 D |
| 4 | 3.6 D |
| 8 | 3.5 D |
| 16 | 3.5 D |
| 32 | 4.2 E |
| 64 | 4.2 E |
| 128 | 4.8 F |
| 256 | 5 F |
| 512 | 5 F |
| 1024 | 5 F |

* Means sharing a letter are not significantly different according to Duncan's Multiple Range Test (for P = 0.05).

Our results demonstrated that the Italian population of *M. javanica* is highly pathogenic to peach and, therefore, severe crop losses might be expected in infested fields. This is in contrast to the findings of Lu ZhenXiang *et al.* (2000), who did not observe growth reduction of peach cv. Lovell (a peach rootstock susceptible to root-knot nematodes) even at population densities of the nematode as large as 10,000 eggs/1200 cm$^3$. This discrepancy could be due to use of a different nematode population, a different peach rootstock cultivar and, perhaps, also to the different type of inoculum. Di Vito *et al.* (1986) demonstrated that inoculating eggs in egg masses (i.e. as chopped tomato roots), as in this experiment, instead of dispersed eggs as in the work by Lu ZhenXiang *et al.* (2000), causes much more severe damage.

As the tolerance limit of peach to root-knot nematodes is very low and peach trees can have a productive life of more than 10 years, the nematode population at transplanting, especially in sandy soils, should be very low or, better, absent. Even populations below the detection limit at transplanting time could become dangerous in a matter of a few months. Therefore, stringent nematode control measures should be adopted whenever the risk of root-knot nematode infection is foreseen.

Accepted for publication on 13 April 2005.

## LITERATURE CITED


Coolen W.A., 1979. Methods for extraction of *Meloidogyne* spp. and other nematodes from roots and soil. Pp. 317-330. *In*: Root-Knot Nematodes (*Meloidogyne* species) Systematics, Biology and Control (Lamberti F. and Taylor C.E., eds). Academic Press, London, U.K.

Di Vito M., Greco N. and Carella A., 1985. Population densities of *Meloidogyne incognita* and yield of *Capsicum annuum*. *Journal of Nematology, 17*: 45-49.

Di Vito M., Greco N. and Carella A., 1986. Effect of *Meloidogyne incognita* and importance of the inoculum on the yield of eggplant. *Journal of Nematology*, *18*: 487-490.

Di Vito M., 1996. Nematode pest management on fruit trees in the Mediterranean region. Third International Nematology Congress, Gosier, Guadeloupe (French West Indies), 7-12 July 1996, pp. 49.

Di Vito M., Battistini A. and Catalano L., 2002. Response of *Prunus* rootstocks to root-knot (*Meloidogyne* spp.) and root-lesion (*Pratylenchus vulnus*) nematodes. *Acta Horticulturae*, *592*: 663-668.

FAO, 2004. *Faostat Database Collections*. (http://faostat.fao.org/faostat/collections?subset=agriculture).

Handoo Z.A., Nyczepir A.P., Esmenjaud D., van der Beek J.G., Castagnone-Sereno P., Carta L.K., Skantar A.M. and Higgins J.A., 2004. Morphological, molecular and differential host characterization of *Meloidogyne floridensis* n.sp. (Nematoda: Meloidogynidae), a root-knot nematode parasitizing peach in Florida. *Journal of Nematology*, *36*: 20-35.

Hussey R.S. and Barker K.R., 1973. A comparison of methods of collecting inocula of M*eloidogyne* spp., including a new technique. *Plant Disease Report*, *57*: 1025-1028.

Lu ZhenXiang, Reghard G.L., Nyczepir A.P. and Beckman T.G., 2000. Inocula and media affect root-knot nematode infection of peach seedling roots. *Journal of American Pomological Society*, *54*: 76-78.

Nyczepir A.P. and Halbrendt J.M., 1993. Nematode pests of deciduous fruit and nut trees. Pp. 381-425. *In*: Plant Parasitic Nematodes in Temperate Agriculture (Evans K., Trudgill D.L. and Webster J.M., eds). CAB International, Wallingford, UK.

Pinochet J., Fernandez C., Alcaniz E. and Felipe A., 1996. Damage by a lesion nematode, *Pratylenchus vulnus*, to *Prunus* rootstocks. *Plant Disease*, *80*: 754-757.

Seinhorst J.W., 1965. The relationship between nematode density and damage to plants. *Nematologica*, *11*: 137-154.

Seinhorst J.W., 1979. Nematodes and growth of plants: formulation of the nematode-plant system. Pp. 231-256. *In*: Root-Knot Nematodes (*Meloidogyne* species) Systematics, Biology and Control (Lamberti F. and Taylor C.E., eds). Academic Press, London, U.K.

Taylor A.L. and Sasser J.N., 1978. *Biology, Identification and Control of Root-knot Nematodes* (*Meloidogyne* species). North Carolina State University Graphics, Raleigh NC, USA, 105 pp.

Zuccarelli G., 1979. Moltiplicazione in vitro dei portinnesti clonali del pesco. *Rivista Ortoflorofrutticoltura Italiana, 41 (2)*: 15-20.