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DOI 10.2478/s11687-006-0031-z

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HELMINTHOLOGIA, 43, 3: 168 – 170, SEPTEMBER 2006

Influence of the root-knot nematode *Meloidogyne incognita* r. 1 on growth of grapevine

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Summary

The effect of *Meloidogyne incognita* race 1 at different population densities (0, 0.0625, 0.125, 0.25,... 256 eggs and juveniles/cm^3 soil) on the growth of a rootstock (1103 Paulsen) and a cv. Italia of grapevine was studied in glasshouse experiment. One-year-old, self-rooted plants were transplanted into 1,200 cm^3 plastic pots containing soil infested by *M. incognita* race 1 at different inoculum levels. Reproduction of *M. incognita* race 1 was significantly higher on cv. Italia than on the rootstock 1103 Paulsen. Tolerance limits (*T*) of 1.28 and 0.78 eggs and juveniles/cm^3 soil were estimated respectively for 1103 Paulsen and Italia. Minimum relative plant growth of 0.55, 0.80 and 0.85, respectively for shoot length and node number increase and fresh top weight, were estimated for 1103 Paulsen; whereas values of 0.25, 0.50 and 0.60 were assessed for the cv. Italia. Nematode equilibrium density was 33.6 and 137.8 eggs and juveniles/cm^3 soil, on 1103 Paulsen and Italia, respectively.

Key words: *Meloidogyne incognita* race 1; pathogenicity; grapevine; rootstock; cultivar

Introduction

Presence of root-knot nematodes, *Meloidogyne* spp., was frequently recorded on grapevine (*Vitis vinifera* D.C), either in Europe (Katalan-Gateva & Choleva-Abadjeva, 1977; Koliopanos & Vovlas, 1977) and in other vine districts of the world (Lamberti *et al*., 2005).
Attack of these nematodes may cause a lower growth and an early senescence of the plant, resulting in a reduction of crop yield (Sasanelli, 1995). However, the damage is strictly related to nematode population densities in the soil and to the grapevine cultivars.
The relationship between soil nematode population density and crop yield losses was analytically described by Seinhorst (1965; 1979). This model could be more generally extended to describe plant growth reduction caused by nematode attack on young fruit tree species.
The relationship between nematode population density and grapevine growth was already described for *Xiphinema index* (Di Vito *et al*., 1985), whereas few data are available on the growth response of grapevine to root-knot nematodes (Brown *et al*., 1993).
Therefore, a glasshouse experiment was undertaken to evaluate the effect of different population densities of *Meloidogyne incognita* (Kofoid *et* White) Chitwood on the growth of a rootstock and a cultivar of grapevine.

Materials and Methods

An Italian isolate of *M. incognita* race 1 was previously reared on tomato (*Lycopersicum esculentum* Mill.) cv. Rutgers. Two months after inoculation, the infected roots were finely chopped and the number of eggs and juveniles (J2) was estimated by processing ten root samples of 10 g each with a 1 % aqueous solution of sodium hypochlorite (Hussey & Barker, 1973). Infected roots were used as inoculum. Appropriate amounts of this inoculum were thoroughly mixed with 4 Kg of sterilised sandy soil (pH 7.2; sand > 99 %, silt < 1 %, clay < 1 %, and organic matter = 0.75 %) to give a range of population densities of 0, 0.0625, 0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 32, 64, 128 or 256 eggs and J2/cm^3 soil. Each of these mixtures was used to fill ten plastic pots (1,200 cm^3), which were then arranged in a randomized block design on benches in a glasshouse at 25 ± 2ºC.
A one-year-old self rooted plants of the hybrid grapevine rootstock 1103 Paulsen (*V. berlandieri* Planchon x *V. rupestris* Scheele) and cv. Italia were transplanted into each pot. All plants were pruned to leave only one shoot.
Four months after transplanting, the plants were uprooted and shoot length, number of nodes and fresh top weight were recorded. The effect of nematodes on plant growth was assessed by calculating the percentage increase of

shoot length and number of nodes with respect to their initial values at transplanting. The final population densities (*Pf*) of the nematode were determined from the soil and roots. Nematodes in soil were extracted by processing 500 cm^3 soil with the modified Coolen's method (Coolen, 1979). Eggs and J2 were extracted from each root system in a blender containing 1 % aqueous solution of NaOCl for three periods of 20 sec (Hussey & Barker, 1973; Marull & Pinochet, 1991). Nematodes and root debris, collected on the 5 µm-pore sieve, were centrifuged at 2,000 rpm for five minutes in magnesium sulphate solution of 1.16 specific gravity. Eggs and J2 were then counted and final nematode population density (*Pf*) in each pot was calculated as the total nematodes recovered from soil and roots.

Results and Discussion

Grapevine plant growth was affected by the attack of *M. incognita* race 1. Symptoms (stunting and yellowing) were evident thirty days after transplanting in pots infested with ≥ 64 eggs and J2/cm^3 soil and at the end of the experiment roots were heavily infested by numerous and large galls with egg masses. Data of fresh top weight, and percentage increase of shoot length and number of nodes were consistent with the model proposed by Seinhorst (1965; 1979):

$$y = m + (1- m)\, z^{(P-T)} \quad \text{(i)},$$

where *y* (relative plant growth) is the ratio between the values of plant growth parameters (percentage increase of shoot length and number of nodes and fresh top weight) at a given *P* and that at $P \leq T$, *m* = the minimum relative plant growth (*y* at very large *P*), *z* = a constant < 1, with $z^{-T} = 1.05$, *P* = initial population density and *T* = the tolerance limit (*P* value above which plant growth reduction is expected).

In 1103 Paulsen rootstock, fitting the data to the above model gave the same tolerance limit of 1.28 eggs and J2/cm^3 soil for plant top fresh weight, percentage increase of shoot length and node number (Fig. 1 A). Values of the minimum relative plant growth were 0.55, 0.80 and 0.85, respectively for shoot length and node number increase and fresh top weight at $Pi \geq 86$ eggs and J2/cm^3 soil.

In cv. Italia, a tolerance limit of 0.78 eggs and J2/cm^3 soil was assessed for the three parameters, whereas *m* values were 0.25, 0.50 and 0.60 at $Pi \geq 64$ eggs and J2/cm^3 soil (Fig. 1 B).

The above values of tolerance limits are higher than those observed in annual horticultural crops (Sasanelli, 1994). A more difficult penetration of nematode juveniles in the lignified root tissues and/or a different biochemical response of plant cell to nematode invasion could be hypothesized to explain the higher resistance of grapevine.

The relationship between initial (*Pi*) and final (*Pf*) nematode population densities on rootstock 1103 Paulsen and cv. Italia is in Fig 2. The data agree with the Seinhorst's (1970) model:

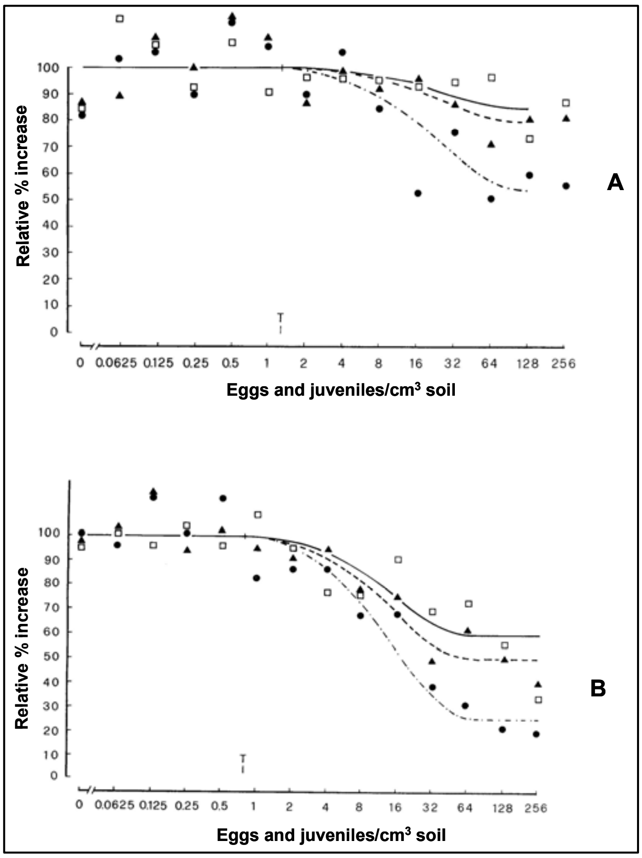

Fig. 1. Relationship between initial population density of *Meloidogyne incognita* race1 and relative percentage growth increase of the grapevine rootstock 1103 Paulsen (A) and cv. Italia (B)

(A) □ = % increase of shoot length, $y = 0.55 + 0.45 \times 0.962^{(P-T)}$, *T* = 1.28 eggs and juveniles (J2)/ cm^3 soil; ▲ = % increase of node number, $y = 0.80 + 0.20 \times 0.962^{(P-T)}$, *T* = 1.28 eggs and J2/ cm^3 soil; ● = plant fresh top weight, $y = 0.85 + 0.15 \times 0.962^{(P-T)}$, *T* = 1.28 eggs and J2/cm^3 soil; (B) □ = % increase of shoot length; $y = 0.25 + 0.75 \times 0.939^{(P-T)}$, *T* = 0.78 eggs and J2/cm^3 soil; ▲= % increase of node number; $y = 0.55 + 0.45 \times 0.939^{(P-T)}$, *T* = 0.78 eggs and J2/ cm^3 soil; ● = plant fresh top weight, $y = 0.55 + 0.45 \times 0.939^{(P-T)}$, *T* = 0.78 eggs and J2/cm^3 soil

$$Pf = ay\,({}^{e}\log q^{-1})(1-q^{Pi}) + s\,(1-x)Pi \quad \text{(ii)}$$

in which *Pf* and *Pi* are as above; *a* = maximum multiplication rate (for *Pi* tending to 0); *q* = a constant < 1; *y* = the ratio between the root weight at a given *Pi* and that in the absence of the nematode; *s* = the proportion of the eggs that do not hatch in the absence of the host roots and *x* = the proportion of eggs that hatch in the presence of host roots. *Pf* of *M. incognita* race 1 fits to the model (ii) if it is assumed that *s* = 0.1 and *x* = 1. The reproduction rate (*Pf/Pi*) was 16 and 1.318 at the lowest *Pi* for 1103 Paulsen and Italia respectively, and decreased as *Pi* increased. An equilibrium density of the nematode of 33.6 and 137.8 eggs and J2/cm^3 soil was also estimated (Fig 2 A and B).

Results from this experiment confirmed the pathogenic effect of *M. incognita* race 1 on grapevine plants and indicated that plant growth can be severely reduced, both

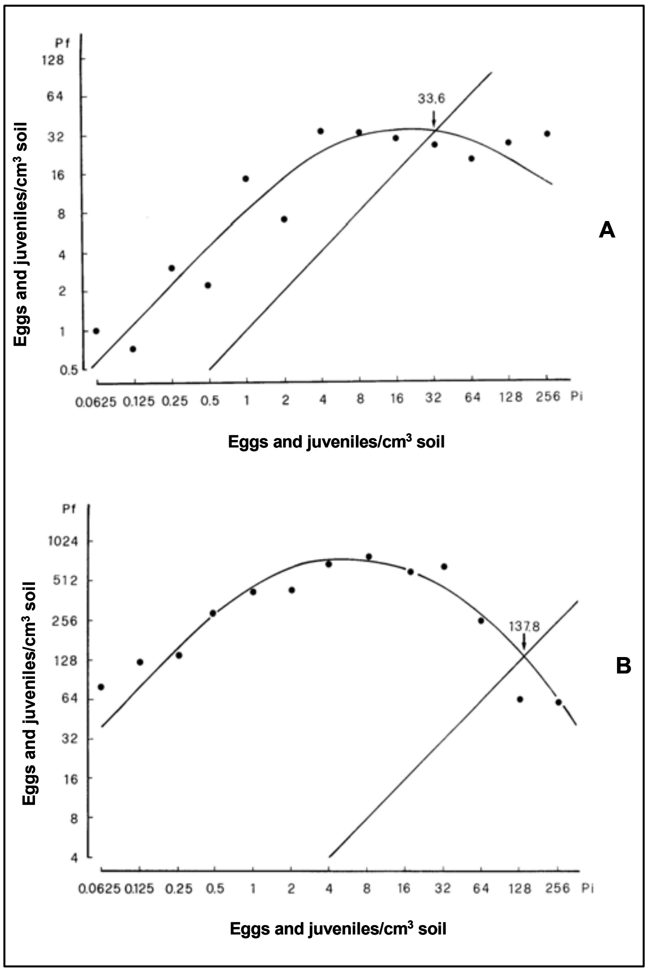

Fig. 2. Relationship between initial (*Pi*) and final (*Pf*) population density of *Meloidogyne incognita* race 1 on grapevine rootstock 1103 Paulsen (A) and cv. Italia (B)

in nurseries and fields infested by this nematode. Values of *T* and *m* may be also used for a quick estimation of possible grape growth reduction by the mean of Tables of nematode-pathogenicity (Sasanelli, 1994). However, the severity of the attack may vary according to the susceptibility of the rootstock or cultivar. The rootstock 1103 Paulsen and cv. Italia were susceptible to *M. incognita* race1, but nematode reproduction on the rootstock was about eighty times lower than on cv. Italia. Therefore, the use of resistant or, at least, less susceptible grapevine reproductive material could be recommended to reduce damages from nematode attack.

Acknowledgements

We thank Mr. V. Radicci for his technical assistance in the glasshouse experiment.

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RECEIVED JUNE 9, 2005 ACCEPTED JULY 29, 2006