DYNAMICS OF CONCOMITANT POPULATIONS OF PRATYLENCHUS VULNUS AND MELOIDOGYNE INCognita ON PEACH

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ABSTRACT


The effect of the interaction between Meloidogyne incognita and Pratylenchus vulnus on nematode reproduction and vegetative growth of Lovell peach was studied in field microplots. Pratylenchus vulnus suppressed the population density of M. incognita second-stage juveniles, whereas the presence of M. incognita did not affect the population density of P. vulnus in soil. Above-ground tree growth, as measured by trunk diameter 12 and 24 months following inoculation, was reduced in the presence of M. incognita. Differences in root growth as related to nematode treatment were detected 26 months after inoculation. Root growth was reduced in the presence of the two nematode species together than P. vulnus alone, but not when compared to M. incognita alone. There was a greater negative impact on vegetative growth of peach seedlings growing in M. incognita-infested soil than in P. vulnus-infested soil.

Key words: Interaction, Meloidogyne incognita, microplot, pathogenicity, peach, population dynamics, Pratylenchus vulnus, Prunus persica, root-knot nematode, root-lesion nematode.

INTRODUCTION

Information on interactions between migratory endoparasitic and sedentary endoparasitic nematodes in peach [Prunus persica (L.) Batsch] is limited. Research has focused on a single nematode species and its role in association with the peach disease under study. Information on interactions between different plant-parasitic nematodes cohabiting the same orchard is essential to understanding their com-
bined impact on disease so that an appropriate management strategy can be implemented. In Georgia and South Carolina it is not uncommon to find several economically important plant-parasitic nematode genera within the same peach orchard, such as root-knot (Meloidogyne spp.) and root-lesion (Pratylenchus spp.) nematodes (Nyczepir et al., 1985). Root-knot and root-lesion nematodes are important pathogens of peach in the United States and other parts of the world (Nyczepir and Esmenjaud, 2008). In South Carolina peach orchards, M. incognita and M. javanica were found in 95% and 5% of orchards sampled, respectively (Nyczepir et al., 1997). Meloidogyne spp. can cause stunted growth, loss of vigor, and early defoliation of one to two-year-old peach trees when recommended management practices are not followed. At least nine Pratylenchus spp. [P. penetrans, P. pratensis, P. brachyurus, P. zeae, P. convallariae, P. neglectus, P. thornei, P. sefaensis, and P. vulnus] have been found associated with peach throughout the world, but P. vulnus is the species of primary concern in California and the southeastern United States (Nyczepir and Esmenjaud; 2008). In California, P. vulnus damage to peach rootstocks is estimated to cause approximately 16% reduction in marketable fruit size and yield (McKenry, 1989). In the southeastern United States, limited investigations have been conducted on P. vulnus, which until recently was not considered as important a pathogen on peach as Mesocriconema xenoplax (Raski) Loof & de Grisse [=Cri conemoides xenoplax (Raski) Loof and de Grisse] or Meloidogyne spp. (Nyczepir and Pinochet, 2001). In Georgia, P. vulnus was first reported to be associated with reduced peach tree vigor and rapid deterioration and reduction of feeder roots (Fliegel, 1969), which are characteristic symptoms reported by others (Marull and Pinochet, 1991; McKenry, 1989). Furthermore, in field microplots, P. vulnus (GA-peach isolate) was associated with reduced peach tree growth of ‘Guardian®’, ‘Lovell’, and ‘Nemaguard’ rootstocks (Nyczepir and Pinochet, 2001). Pratylenchus vulnus, which destroys the root cortical parenchyma cells, is also known for producing avenues for secondary infection by bacteria and fungi (Marull and Pinochet, 1991). Therefore, managing Meloidogyne spp. and P. vulnus is essential for establishment and optimizing yield of a peach orchard. The current pre-plant nematicide recommendation for managing these two plant-parasitic nematodes in the southeastern United States includes fumigation with Telone II (1,3-D) or Vapam (metam-sodium) (Horton et al., 2009).

The combined impact of parasitism by a sedentary endoparasitic and a migratory endoparasitic nematode on growth of peach is unknown. This study assesses the effects and interactions between M. incognita and P. vulnus on peach vegetative growth and nematode reproduction.

MATERIALS AND METHODS

Nematode source and inoculum

Pratylenchus vulnus, which originated from a peach orchard in Byron, Georgia was reared monoxenically on carrot (Daucus carota L.) disk cultures (Moody et al., 1973) and incubated at 22°C for multiplication. The Meloidogyne incognita isolate, originating from a commercial peach orchard in Warner Robins, Georgia, was cultured on tomato (Lycopersicon esculentum Mill. cv. Rutgers) in the greenhouse. Root-lesion nematode inoculum was prepared by macerating the nematode-infested carrot disks in water in a commercial blender for four times at 5-s intervals. The nematode/carrot suspension was then concent-
P. vulnus-M. incognita interaction on peach: Nyczepir

Field microplot experiment

The effects of the interactions between M. incognita and P. vulnus on peach vegetative growth and nematode reproduction were evaluated in field microplots. Approximately 3-month old Lovell peach seedlings were planted singly in bucket microplots (Barker, 1985) (25-cm-diam × 31-cm-deep) containing 15,000 cm³ of steam pasteurized soil (86% sand, 10% silt, 4% clay, pH 6.1, 0.54% OM) in February 2003. Microplots were established in a shaded area (30% shade) in the field at the USDA, ARS Southeastern Fruit and Tree Nut Research Laboratory, Byron, Georgia.

In March 2003, one month after seedling survival was evident, the following nematode treatments were added per microplot: i) 2,500 M. incognita eggs (Mi); ii) 2,500 P. vulnus adults and juveniles (Pv); iii) 2,500 P. vulnus adults and juveniles + 2,500 M. incognita eggs (Pv + Mi); and iv) a nontreated control. The initial population density of 2,500 M. incognita or 2,500 P. vulnus per microplot is equivalent to 17 M. incognita eggs/100 cm³ soil or 17 P. vulnus juveniles or adults/100 cm³ soil, respectively. The soil in each microplot was infested with the respective nematode inoculum in 40 ml total solution added to two furrows (10 cm long × 3 cm wide × 7 cm deep) around each seedling. The experiment consisted of a 2 × 2 factorial with single tree replications per treatment arranged as 10 randomized complete blocks. Tree-trunk diameters were measured 7.5 cm above the soil line in March 2004 and 2005. Plants were watered as needed and fertilized with Osmocote [14-14-14 (N-P-K)]. The study was terminated approximately 26 months (May 2005) after soil infestation and nematode population densities in roots and soil were quantified. Nematode population density in soil was determined from five cores (2.5-cm-diam × 23-cm deep) that were collected from each microplot. Nematodes were counted following extraction from a 100-cm³ subsample with a semi-automatic elutriator (Byrd et al., 1976) and centrifugal-flotation (Jenkins, 1964). Pratylenchus vulnus in roots were extracted by randomly cutting a 5 gram fresh weight part of the root system and placing it on a fine screen in a Seinhorst mistifier chamber (Hopper, 1970) for 9 days at 23°C. After extracting the nematodes from the roots, the dry root weight (dried at 70°C in aluminum foil until no more loss in weight occurred) of each tissue extraction sample was determined. Meloidogyne incognita eggs in roots were estimated by randomly cutting a 5-gram fresh weight part of the root system and extracting eggs with a NaOCl solution as mentioned above. After extracting the eggs from the roots, the dry root weight (dried at 70°C in aluminum foil until no more loss in weight occurred) of each tissue extraction sample was determined. The remaining root systems were dried on greenhouse benches to a constant weight and then combined with the tissue extraction sample weights for total dry weight.

Statistical analysis

All data were subjected to a general linear model procedure of SAS (SAS Institute, Cary, NC). An analysis of variance was performed on the final soil population density (Pi) of P. vulnus in the two treatments that initially received P. vulnus and P. vulnus +
**RESULTS AND DISCUSSION**

The presence of *P. vulnus* contributed to the suppression ($P \leq 0.05$) in population density of *M. incognita* second-stage juveniles (J2) on Lovell peach 26 months after inoculation (Table 1), but did not affect the reproduction potential of *M. incognita* in peach as measured by number of eggs per plant or number of eggs per gram dry root. In contrast, the presence of *M. incognita* did not detectably affect the population density of *P. vulnus* in soil and/or roots.

Three explanations for the suppression in nematode reproduction by one nematode species on another may be attributed to i) a reduction or alteration of suitable feeding sites on the root; ii) other factors than availability of feeding sites (e.g., plant growth regulators), or iii) environmental factors (e.g., soil temperature). Nematode feeding sites on roots differ between a sedentary endoparasite, such as the root-knot nematode, and a migratory endoparasite, such as the root-lesion nematode. *Meloidogyne* spp. penetrate at the root tip, establishes themselves, and feed within the vascular cylinder region for the remainder of their life cycle (de Guiran and Ritter, 1979). In contrast, the root-lesion nematode feeds in the root cortex, moving through and between the parenchyma cells which result in visible necrotic lesions (Castillo and Vovlas, 2007). The visible necrotic lesions are believed to result from

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nematode</th>
<th><em>M. incognita</em></th>
<th><em>P. vulnus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J2/100 cm$^3$ soil</td>
<td>Eggs/plant</td>
<td>Eggs/g dry root</td>
</tr>
<tr>
<td><em>M. incognita</em> (Mi)</td>
<td>128 a$^{**}$</td>
<td>88 ns</td>
<td>33 ns</td>
</tr>
<tr>
<td>Mi + Pv</td>
<td>20 b</td>
<td>80</td>
<td>74</td>
</tr>
<tr>
<td><em>P. vulnus</em> (Pv)</td>
<td>4,269 ns$^{**}$</td>
<td>4,456 ns</td>
<td>91 ns</td>
</tr>
<tr>
<td>Mi + Pv</td>
<td>3,312</td>
<td>3,517</td>
<td>175</td>
</tr>
</tbody>
</table>

Data are means of 10 replications, except for *M. incognita* which had four replications.

$^{**}$Significant at $P \leq 0.05$; ns = $P > 0.05$ according to ANOVA.

$^{*}$Initial population density of *M. incognita* = 17 eggs/100 cm$^3$ soil, *P. vulnus* = 17 juveniles or adults/100 cm$^3$ soil, and Mi + Pv = 17 Mi + 17 Pv/100 cm$^3$ soil.

Data were transformed \( \log_{10}(x+1) \) before analysis and nontransformed data are shown in table.
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A combination of both secretion of cell-wall degrading enzymes and mechanical force from the stylet (i.e., pressure from labial region and thrusting) of Pratylenchus spp. It seems that, as a result of direct or indirect competition for feeding sites, the more aggressive nematode may influence reproduction of the cohabiting nematode. On soybean and olive, M. incognita suppressed reproduction of P. brachyurus and P. vulnus, respectively (Herman et al., 1988; Lamberti et al., 2001). However, on tomato P. penetrans and M. incognita mutually suppressed reproduction when they both were present (Estores and Chen, 1972). It appears that the inhibitory effects of P. penetrans on M. incognita in tomato were due to competition for feeding sites, whereas suppression of P. penetrans by M. incognita implicated factors other than feeding sites; such as production or translocation of plant-growth regulators in response to parasitism by root-knot nematode. Similarly, M. chitwoodi populations were influenced in the presence of P. neglectus, but the outcome differed with soil temperature and host (Umesh and Ferris, 1994). The presence of P. neglectus suppressed M. chitwoodi populations in barley at 15°C, but not 20 or 25°C, whereas in potato P. neglectus suppressed M. chitwoodi populations at 25°C, but not 15 or 20°C. In the present study, P. vulnus suppressed the population density of M. incognita J2 in peach and appears to be the more aggressive nematode specie and competitor in this nematode-nematode host-parasite relationship.

Differences in Lovell tree growth as related to nematode treatment were detected 12, 24, and 26 MAI (Table 2). Main nematode treatment effects for above-ground differences (i.e., trunk diameter) indicated that the presence of M. incognita reduced (P ≤ 0.05) mean trunk diameter at 12 and 24 MAI. The presence of P. vulnus had no effect on above-ground tree growth. The interaction between M. incognita and P. vulnus was also significant (P ≤ 0.05) for trunk diameter on both sampling dates. At 12 MAI, the combined nematode treatment (Pv + Mi) was less than P. vulnus alone, but it was not less than M. incognita alone, which resulted in a significant interaction for trunk diameter. At 24 MAI, the combined treatment (Pv + Mi) was greater than P. vulnus alone, but again not less than M. incognita alone.

Differences in peach root growth (i.e., dry root weight) as related to nematode treatment were detected 26 months after inoculation (Table 2). Main treatment effects indicate that the presence of M. incognita or P. vulnus reduced (P ≤ 0.01) root growth (Table 2). The interaction between M. incognita and P. vulnus was also significant (P < 0.01) for dry root weight. Although the combined nematode treatment (Pv + Mi) was less than P. vulnus alone, it was not less than M. incognita alone, which resulted in a significant interaction for dry root weight. Our results indicate that above-ground tree growth is less with trees growing in the presence of M. incognita than P. vulnus, even though P. vulnus reduced peach root growth.

In summary, there appears to be a greater negative impact on vegetative growth of peach seedlings growing in M. incognita-infested soil than in P. vulnus-infested soil. However, even though M. incognita affected peach tree growth more than P. vulnus, both nematodes are still considered economically important pathogens to the peach industry in the southeastern United States and that preplant nematode samples need to be collected and analyzed for their presence prior to orchard establishment. Such a basic and important practice will allow growers to make the proper nematode management decisions so that they can obtain a well-established and profitable orchard.
Table 2. Trunk diameter and dry root weight of Lovell peach seedlings grown in field microplots with *Meloidogyne incognita* and *Pratylenchus vulnus* alone and in combination.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Trunk diameter (mm)</th>
<th>Dry root weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12 MAI †</td>
<td>24 MAI</td>
</tr>
<tr>
<td>Treatment mean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>13.89</td>
<td>20.16</td>
</tr>
<tr>
<td><em>P. vulnus</em> (Pv) †</td>
<td>11.97</td>
<td>16.36</td>
</tr>
<tr>
<td><em>M. incognita</em> (Mi) †</td>
<td>11.32</td>
<td>13.91</td>
</tr>
<tr>
<td>Pv + Mi †</td>
<td>11.91</td>
<td>16.68</td>
</tr>
<tr>
<td>Main effect mean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pv ‒</td>
<td>12.60</td>
<td>18.07</td>
</tr>
<tr>
<td>+</td>
<td>11.94</td>
<td>16.52</td>
</tr>
<tr>
<td>Mi ‒</td>
<td>12.93</td>
<td>18.26</td>
</tr>
<tr>
<td>+</td>
<td>11.61</td>
<td>15.75</td>
</tr>
<tr>
<td>Significance for:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pv (+) vs. Pv (‒)</td>
<td>ns ‡</td>
<td>ns</td>
</tr>
<tr>
<td>Mi (+) vs. Mi (‒)</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Pv × Mi</td>
<td>*</td>
<td>**</td>
</tr>
</tbody>
</table>

Data are means of 10 replications, except for *M. incognita* which had five and four replications at 24 and 26 MAI, respectively.

†MAI = Months after inoculation.
‡Initial population density of *M. incognita* = 17 eggs/100 cm³ soil, *P. vulnus* = 17 juveniles or adults/100 cm³ soil, and Mi + Pv = 17 Mi + 17 Pv/100 cm³ soil.

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