Creating a Short Life Site for Prunus Rootstock Evaluation on Land with No Innate Mesocriconema xenoplax Population

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Abstract. Peach tree short life (PTSL) is associated with the presence of ring nematode, 
Mesocriclona xenoplax, and poor orchard management practices. Finding a noncommercial field site to evaluate rootstocks for PTSL resistance is increasingly difficult. The time needed to create a PTSL test site was investigated. In 1994, a site not planted in peaches for >80 years was identified in Byron, Ga. Analysis of preplant soil samples revealed that there were no M. xenoplax on the site. One-third of the land was planted to peach and infested with 1600 ring nematodes per tree in Spring 1994 (P2) and another one-third in Spring 1995 (P1). The remaining one-third of the land received no trees or ring nematode infested with 1600 ring nematodes per tree in Spring 1994 (P2) and another one-third in 100 cm3 soil) than in F2 (221 ring nematode/100 cm3 soil) plots, whereas populations in

In the southeastern United States, the productive life span of peach trees does not exceed 6 to 10 years on some sites (Brittain and Miller, 1978). Tree death has been attributed to a disease complex termed peach tree short life (PTSL) as reported by Savage and Cowart (1942). The external symptoms of PTSL are similar to those of any plant deprived of an adequate root system (Taylor et al., 1970). Bacterial canker (Pseudomonas syringae pv. syringae van Hall) (Weaver et al., 1974), cold injury (Prince, 1966), or a combination of both are thought to be the final agents of tree death in the PTSL complex (Brittain and Miller, 1978). However, the ring nematode [Mesocriconema xenoplax (Raski) Loof & de Grisse] (Nyczepir et al., 1983), rootstock (Yadava and Doud, 1994; Zehrel et al., 1976), scion cultivar (Beckman et al., 1994), cultural practices (Weaver et al., 1974), planting site (Weaver et al., 1974; Yadava and Doud, 1996), and weather (Prince, 1966) are factors that weaken trees and/or predispose them to PTSL.

In closed-end field microplots, peach trees died of cold injury after 4 years of parasitism by M. xenooblax, while trees in uninfested soil survived (Nyczepir et al., 1983). Subsequently, in the absence of M. xenoplax, pruning time and tree death 2 years after inoculation were closely correlated with nematode population size (Nyczepir, 1990). Such evidence indicates that PTSL is truly a nematode-associated problem and the presence of M. xenoplax is required for PTSL to occur. Under South Carolina field conditions, a nematode treatment threshold of ≥50 M. xenoplax per 100 cm3 soil is recommended in peach orchards for prolonging tree life on PTSL sites, whereas in Georgia the nematode treatment threshold is ≥1 M. xenoplax per 100 cm3 soil (Davis et al., 1996; Nyczepir and Halbrendt, 1993). In North Carolina, it was estimated that PTSL tree death was likely at average cumulative population densities of 38–83 M. xenoplax per 100 cm3 soil, with greatest percentage of tree death occurring with an increasing ring nematode population (Ritchie, 1988).

The association of PTSL with “old” peach sites has led to the hypothesis that certain predisposing factors persist in old peach orchard sites that make new trees more susceptible to this disease complex (Weaver et al., 1974). However, it has been demonstrated that old peach sites are not a prerequisite and that the presence of M. xenoplax is the most critical biotic component for PTSL development (Nyczepir, 1990). Furthermore, Nyczepir and Okie (1996) substantiated a common pattern in that severity of PTSL on a given site increased after each successive peach planting following a build-up of the M. xenoplax population.

The objective of this research was to determine the time needed to create a PTSL test site for Prunus rootstock evaluation on land with no innate population of M. xenoplax.

Materials and Methods

Site. The experiment was initiated at the USDA, ARS Southeastern Fruit and Tree Nut Research Laboratory, Byron, Ga. The study was conducted on a Norfolk loamy sand, fine loamy, siliceous, thermic, typic Paleudults soil (86% sand, 8% silt, 6% clay; 1.3% organic matter) that had been cleared of 80-year-old pecan trees in 1985, and had no known history of peach production. Since soil pH was 6.1, no preplant liming was required. This site laid fallow for 9 years until establishment of this experiment in 1994. The test site (0.25 ha) was subsoiled down the tree row to a depth of 38 cm, disked, and rotovated in Oct. 1993. Glyphosate (4.5 kg ha−1 a.i.) was used for weed control prior to peach planting in Feb. 1994.

The initial soil population density (P) of M. xenoplax was determined in Feb. 1994, from nine soil cores (2.5-cm-inch diameter × 30-cm depth) collected from each of the 12 replicates throughout the test site. The soil cores were composited and nematodes were extracted from a 100-cm3 soil subsample with a semi-automated elutriator (Byrd et al., 1976) and centrifugation (Jenkins, 1964). The soil remaining after the initial extraction was then placed into 10-cm-diameter plastic pots and Nemaguard peach (good host for M. xenoplax) was planted to bioassay M. xenoplax not detected by elutriation and centrifugation. Four and one-half months later, nematodes were extracted from this soil as described above and planted with 'Sunsplash' scion on Nemaguard rootstock at a tree spacing of 6.1 × 1.2 m between rows and trees, respectively. Each plot had 10 trees, with one on each side for uninoculated borders and eight in the center for inoculation with M. xenoplax. In Mar. 1994, rootstock inocula consisting of 800 M. xenoplax adults and juveniles in 100 mL tap water were added to two furrows (11 cm long × 7 cm wide × 8 cm deep), one on either side of each of the center trees (i.e., 1600 nematodes per tree). Furrows were covered with soil following nematode inoculation. Treatment plots P1 and F2 were left unplanted and uninoculated in 1994, and were treated with glyphosate to control weeds. In Jan. 1995, P1 plots were planted with ‘Sunsplash’ scion on Nemaguard rootstock and inoculated as described above with M. xenoplax in Mar. 1995. However, F2 plots remained unplanted, uninoculated, and

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only managed for weeds. Trees were not irrigated, and were grown as recommended by the Georgia Cooperative Extension Service.

Final planting. In Nov. 1995, all trees were removed from both P2 and P1 plots. Care was taken not to transport soil among the plots during tree removal and throughout the remainder of the study. The population density of *Mesocriconema xenoplax*, prior to replanting P1, P2, and F2 plots back with ‘Redhaven’ scion on Nemaguard rootstock, was determined in Jan. 1996 from eight soil cores collected from within each replicate. The eight soil cores were composited and nematodes extracted from a 100-cm³ soil subsample as described above. In Jan. 1996, all plots were planted with ‘Redhaven’ trees on Nemaguard rootstock at a tree spacing of 6.1 × 1.2 m. Each plot had 10 trees, two for outside borders of nematode-free trees and eight in the center as experimental trees. Nonbearing and bearing trees were not irrigated, and were culturally maintained as recommended by the Georgia Cooperative Extension Service. Trees were pruned in Jan. 1997 and then in Dec. 1998 and 1999 to encourage PTSL-induced tree death (Okie et al., 1994).

*Mesocriconema xenoplax* population density was monitored beneath the canopy of each tree in Dec. 1996, Apr. and Dec. 1997, Mar. and Dec. 1998, Mar. and Dec. 1999, and Apr. 2000, from one soil core collected from inside the drip line of each of the eight test trees of every treatment replicate. The eight soil cores were composited and nematodes extracted as described above.

Trunk diameter was measured at 20 cm above the soil line in Jan. 1997, 1998, 1999; and Feb. 2000. Tree mortality from PTSL was recorded in Apr. 1997 and 1998, and May 1999 and 2000.

Nematode data were transformed to log₁₀((x+1)) values and subjected to analysis of variance (ANOVA) using the general linear model (GLM) procedure of SAS (SAS Institute, 1988). Actual numerical nematode data were used for presentation in tables. ANOVA was also performed to determine treatment effect on trunk diameter. For evaluating final planting, nematode population and trunk diameter means were compared using Fisher’s protected least significant difference (L.S.D.) test following a significant F test. Peach tree survival data for each experimental unit were analyzed for each sampling date using ANOVA. Only significant differences (P ≤ 0.05) were discussed unless stated otherwise.

**Results and Discussion**

**Preliminary planting.** No *Mesocriconema xenoplax* was detected in any preplant samples from the 12 plots or in the soil bioassayed with Nemaguard peach in the greenhouse, indicating the absence of *M. xenoplax* in this test site. The nematode population density in Jan. 1996, following establishment of P2, P1, and F2 plots, but just prior to replanting peach trees, was higher (P ≤ 0.05) in P2 plots than in either P1 or F2 (Table 1). This is not surprising since trees in P2 plots had larger root system than trees in the P1 plots as a result of a longer growing period since it is the first time that: 1) no differences were found among other planting treatments and 2) *M. xenoplax* population density in F2 plots was lower than in P2 and P1 plots, which showed no differences between them. This indicated a transition in the *M. xenoplax* population density among the three preliminary planting regimes since it is the first time that: 1) no differences were found among other planting treatments and 2) *M. xenoplax* was detected in F2 plots. Extreme care was taken during sampling and orchard management operations to prevent cross-contamination of *M. xenoplax* among the treatment plots during this experiment. One explanation as to why ring nematodes became established in F2 plots may be the result of subsoiling that occurred during site preparation of the planting rows. Subsequently, over time the roots among adjacent treatment plots eventually grew down the subsoil furrow, which facilitated nematode movement and establishment of *M. xenoplax* in the F2 plots from adjacent P2 and/or P1 plots.

**Final planting.** Nematode populations were the highest (P ≤ 0.05) in P2 plots, intermediate in P1, and undetectable in F2 plots after 11 and 15 months (Dec. 1996 and Apr. 1997), respectively, of establishing peach trees in all plots (Table 1). In Dec. 1997 (23 months after orchard establishment), the *M. xenoplax* population density in F2 plots was lower than in P2 and P1 plots, which showed no differences between them. This indicated a transition in the *M. xenoplax* population density among the three preliminary planting regimes since it is the first time that: 1) no differences were found among other planting treatments and 2) *M. xenoplax* was detected in F2 plots. Extreme care was taken during sampling and orchard management operations to prevent cross-contamination of *M. xenoplax* among the treatment plots during this experiment. One explanation as to why ring nematodes became established in F2 plots may be the result of subsoiling that occurred during site preparation of the planting rows. Subsequently, over time the roots among adjacent treatment plots eventually grew down the subsoil furrow, which facilitated nematode movement and establishment of *M. xenoplax* in the F2 plots from adjacent P2 and/or P1 plots.

Twenty-six months after orchard establish-
Table 2. Effect of three preliminary planting regimes (P2, P1, and F2) on trunk diameter of ‘Redhaven’ trees on Nemaguard on a Byron, Ga., site not in peaches for ≥80 years (n = 12).

| Treatment | Jan. 1997 | Jan. 1998 | Jan. 1999 | Feb. 2000 |
|-----------|-----------|-----------|-----------|-----------|
| P2        | 26.3 a    | 51.2 a    | 61.7 a    | 66.3 ab   |
| P1        | 27.0 a    | 52.3 a    | 64.4 a    | 70.1 a    |
| F2        | 24.0 a    | 45.4 b    | 56.1 b    | 61.8 b    |

Table 3. Effect of three preliminary planting regimes (P2, P1, and F2) on development of peach tree short life (PTSL) of ‘Redhaven’ trees on Nemaguard on a Byron, Ga., site not in peaches for ≥80 years (n = 12).

| Treatment | Apr. 1997 | Apr. 1998 | May 1999 | May 2000 |
|-----------|-----------|-----------|----------|----------|
| P2        | 0 a       | 0 a       | 0 a      | 4 a      |
| P1        | 0 a       | 0 a       | 0 a      | 16 a     |
| F2        | 7.1 b     | 22 b      | 41 b     | 64 b     |

These differences in tree growth expressed as an increase in trunk diameter were detected 12 months (Jan. 1997) after orchard establishment; however, in Jan. 1998 and 1999 (after 24 and 36 months, respectively), tree growth was the lowest (P ≤ 0.05) for trees in P2 plots than for trees in P1 and F2 plots. In Feb. 2000 (49 months after orchard establishment), the population density of *M. xenoplax* in P1 plots was higher than in P2 plots. The nematode populations in P2 plots did not significantly differ from those detected in P1 or F2 plots.

Differences in trunk diameter were detected among the preliminary planting regime treatments on three of the four sampling dates (Table 2). No differences in tree growth were detected as an increase in trunk diameter were detected 12 months (Jan. 1997) after orchard establishment; however, in Jan. 1998 and 1999 (after 24 and 36 months, respectively), tree growth was the lowest (P ≤ 0.05) for trees in P2 plots than for trees in P1 and F2 plots. In Feb. 2000 (49 months after orchard establishment), the population density of *M. xenoplax* in P1 plots was higher than in P2 plots.

In our previous study (Nyczepir and Okie, 1996), we were unable to observe PTSL tree death on a virgin site in 6 years despite infesting the soil with *M. xenoplax* at planting. However, 37% of replanted trees in the subsequent planting died from PTSL within 3 years. In the present study, a 1-year preliminary peach planting (P1) with *M. xenoplax* resulted in minimal PTSL tree death (16%) within 4 years in the subsequent planting, whereas a 2-year preliminary planting of peach (P2) was sufficient to produce > 40% PTSL tree death during the same period of time. It appears that development of PTSL varies with exposure of trees to the cumulative population of *M. xenoplax*.

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Table 2. Effect of three preliminary planting regimes (P2, P1, and F2) on trunk diameter of ‘Redhaven’ trees on Nemaguard on a Byron, Ga., site not in peaches for ≥80 years (n = 12).

| Treatment | Jan. 1997 | Jan. 1998 | Jan. 1999 | Feb. 2000 |
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| P1        | 27.0 a    | 52.3 a    | 64.4 a    | 70.1 a    |
| F2        | 24.0 a    | 45.4 b    | 56.1 b    | 61.8 b    |

Table 3. Effect of three preliminary planting regimes (P2, P1, and F2) on development of peach tree short life (PTSL) of ‘Redhaven’ trees on Nemaguard on a Byron, Ga., site not in peaches for ≥80 years (n = 12).

| Treatment | Apr. 1997 | Apr. 1998 | May 1999 | May 2000 |
|-----------|-----------|-----------|----------|----------|
| P2        | 0 a       | 0 a       | 0 a      | 4 a      |
| P1        | 0 a       | 0 a       | 0 a      | 16 a     |
| F2        | 7.1 b     | 22 b      | 41 b     | 64 b     |