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Influence of *Criconemella xenoplax* and Pruning Time on Short Life of Peach Trees

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Abstract: Influences of *Criconemella xenoplax* and pruning dates were studied in field microplots with 'Nemaguard' peach cuttings on a site not previously planted to peaches. Trees with or without *C. xenoplax* were pruned beginning in December 1984 or March 1985. Peach tree short life (PTSL) did not occur in the absence of *C. xenoplax.* PTSL occurred earlier in December-pruned than in March-pruned inoculated trees. Results confirm that "old" peach sites are not required for PTSL to occur. Pruning Nemaguard and 'Lovell' greenhouse-grown seedlings reduced the root mass of both stocks and stimulated Nemaguard, but not Lovell, shoot regrowth. Numbers of *C. xenoplax* per gram of dry root were greater on pruned than on unpruned seedlings.
Key words: *Criconemella xenoplax,* peach, pruning, *Prunus persica,* ring nematode.

Peach tree short life (PTSL) is usually associated with "old" orchard sites that have been repeatedly replanted to peaches (*Prunus persica* (L.) Batsch), time of pruning, the presence of the ring nematode (*Criconemella xenoplax* (Raski) Luc & Raski), and poor management practices (1,11). Prolonging tree life in the southeastern United States can be accomplished if several research-based management practices, known as the "10-point Program," are followed (1,10). Late winter pruning and preplant and postplant soil fumigation are two practices in the 10-point program. Trees pruned in October–January exhibit greater tree mortality from PTSL than those pruned in succeeding months (1,10). December pruning decreases cold hardiness, vigor, and tree survival (3). In spite of these recommendations, however, many peach growers in Georgia still prune in November or December for more effective labor management. Under greenhouse conditions, pruning in the presence of a high initial population density of *C. xenoplax* resulted in reduced root mass and death of some 'Nemaguard' peach seedlings (5). Soil fumigation is recommended to control *C. xenoplax,* which predisposes trees to PTSL (7,13), and trees in fumigated soil exhibit improved vigor, increased tree survival, and greater cold hardiness than those not treated with a nematicide (3).

Both late pruning and fumigation reduce tree susceptibility to cold injury, the most common cause of tree death in the Southeast. The importance of each factor, individually or combined, in the development of PTSL on soil never planted to peaches is unknown. Therefore, the objective of this study was to determine 1) the occurrence of PTSL as it relates to the presence of *C. xenoplax* and (or) pruning time, 2) if "old" peach land is a prerequisite for the development of PTSL, and 3) the relationship between *C. xenoplax* and pruning on 'Lovell' and Nemaguard seedlings in the greenhouse.

MATERIALS AND METHODS

Microplots: Twenty-four "closed-end" lysimeter-type microplots (1.2 m d and 1.2 m deep) were established in June 1983 on a non-PTSL site with no previous record of having been planted to peaches (6). Experimental design was a 2 × 2 factorial in a randomized complete block. Treatments consisted of *C. xenoplax* addition to the loamy sand soil (82% sand, 13% silt, 5% clay; 1.2% organic matter), an uninfested control, and pruning times of December or March. Nematode and pruning treatments also were initiated in 1984 and 1985, respectively. Trunk diameters were measured 17.4 cm above the soil line in January, and nematode populations were monitored annually (6). Trees were fertilized each year and watered by trickle irrigation.

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TABLE 1. Population density of *Criconemella xenoplax* (Cx) and development of peach tree short life (PTSL) in field microplots as related to pruning time.

Year	Treatment† (No. nemas/100 cm³ soil)			Incidence of PTSL			
				Dec-pruned		Mar-pruned	
	Cx	Check		Cx	Check	Cx	Check
1985	2,408	0		0/6‡	0/6	0/6	0/6
1986	4,385	0		1/6	0/6	0/6	0/6
1987	2,208	0		2/5	0/5	0/5	0/6
1988	3,036	0	14 Mar	5/5**	0/5	0/5	0/6
			31 May	5/5	0/5	3/5	0/6

** Difference significant at $P \leq 0.01$ between treatments on a particular date according to Fisher's Exact Test.
† Initial nematode inoculum was 5,000 *C. xenoplax* per plot.
‡ Numerator represents cumulative number of trees dead from PTSL; denominator represents total number of trees per treatment.

The occurrence of PTSL symptoms and tree death were recorded over time. Statistical comparisons among pruning–nematode treatments on a particular date was by Fisher's Exact Test.

Greenhouse: Stratified Lovell and Nemaguard peach seed were planted in 15-cm-d plastic pots containing approximately 1,500 cm³ steam-pasteurized loamy sand (86% sand, 10% silt, 4% clay; 1.2% organic matter) as previously described (5). When the seedlings were 2 weeks old they were inoculated with approximately 10,000 *C. xenoplax* juveniles and adults per 1,500 cm³ soil. The nematode isolate, extraction, and inoculation procedures were as previously described (5). Half the seedlings were pruned to a height of 18 cm above the rim of the pot 90 days after inoculation. Treatments were replicated five times and arranged in a randomized split-split plot design on benches in an air-conditioned greenhouse (25 ± 5 C). Rootstock cultivar represented the main plot treatment, nematode the subplot treatment, and pruning the sub-subplot treatment. Plants were watered daily and fertilized every 2 weeks (4). After 6 months the study was terminated and the following data were collected: dry root weight (dried at 70 C in aluminum foil until no more loss in weight occurred), shoot length increase of new terminal growth of pruned seedlings, shoot length of unpruned seedlings measured from 18 cm above the pot rim and *C. xenoplax* population density (Pf). Nematodes were extracted from 100 cm³ soil as previously described (5) and counted. Data were analyzed using analysis of variance (ANOVA). The experiment was repeated once.

TABLE 2. Effect of rootstock cultivar and pruning on length of shoot growth of peach in the greenhouse 180 days after inoculation.

Cultivar	Pruning†	Shoot length‡ (cm)
Lovell	Yes	5.0
	No	15.0
Nemaguard	Yes	39.7
	No	23.8

† Seedlings were pruned to a height of 18 cm 90 days after inoculation.
‡ Measurement of new terminal growth of pruned seedlings or shoot length of unpruned seedlings measured from 18 cm above the rim of the pot.

RESULTS

Microplots: The population densities of *C. xenoplax* within inoculated plots were relatively stable from 1985 until 1988 (Table 1). No other plant-parasitic nematodes were present, and *C. xenoplax* was not detected in the controls. In 1986 and 1987 one December-pruned, *C. xenoplax*-inoculated tree exhibited typical PTSL symptoms (7) and died (Table 1). In 1987, one tree each in the December-pruned and March-pruned, inoculated and December-pruned control were seriously injured by faulty drainage, as indicated by standing water, and were removed from the test. On 14 March 1988, the three remaining December-pruned, *C. xenoplax*-inoculated trees exhibited PTSL symptoms. Trunk damage, indicated by intercellular leakage and staining of the outer bark tissue, was evident at this time on the three trees. Droplets of fluid were observed leaking from lenticels on one tree. The characteristic sour-sap odor associated with PTSL was evident, and these three trees died before full bloom. Disease symptoms occurred earlier in December-pruned ($P \leq 0.01$) than in March-pruned, inoculated trees (Table 1). The five remaining March-pruned, *C. xenoplax*-inoculated trees appeared healthy through full bloom, but three did not set fruit and exhibited typical PTSL foliar symptoms (1) as leaves began to develop. Trunk damage could not be seen until bark was removed to the cambium. Sour-sap odor was prevalent and two of the three trees collapsed and died by 15 April; the third one died in May. No control trees died from PTSL. Trunk diameter in January 1988 did not differ among treatments.

Greenhouse: The mean population density of *C. xenoplax* in nematode-inoculated pots was greater ($P \leq 0.01$) on Nemaguard than on Lovell rootstock (61,500 and 29,600 *C. xenoplax* per 100 cm^3 soil, respectively) after 6 months. Pruning had no effect on nematode reproduction. There was a significant ($P \leq 0.01$) interaction of rootstock and pruning on length of shoot growth (Table 2). Pruning stimulated shoot regrowth of Nemaguard but not Lovell. Root mass of pruned seedlings (7.6 g) was less ($P \leq 0.01$) than unpruned seedlings (12.1 g), regardless of rootstock. The number of *C. xenoplax* per gram of dry root for nematode-inoculated pots was greater ($P \leq 0.05$) than pruned (7,816) than for unpruned (4,101) plants. None of the interactive effects involving nematode treatments were significant.

Discussion

Symptoms and time of appearance of PTSL were similar to a previous microplot experiment (7) and to those observed in commercial orchards. These data also elucidate earlier findings (3,8,11) implicating nematodes, pruning dates, and (or) site selection with incidence of PTSL. December pruning in the presence of *C. xenoplax* hastened the occurrence of PTSL symptoms by 2 years, with 40% of these trees dead by the time they were 3 years old. Peach growers in South Carolina and Georgia would have decided to remove an orchard with this percentage of tree death because it would not be economical to manage. When trees were 4 years old, the remaining December-pruned, inoculated trees exhibited symptoms and tree death earlier than March-pruned, inoculated trees, but 60% of the latter died from PTSL later that spring.

Pruning time alone was not related to the incidence of PTSL, since tree death was encountered only in the presence of *C. xenoplax*. These data show the importance of *C. xenoplax* association in the disease. Effective control of the nematode might allow for some adjustment in pruning time by the grower. However, a study (2) of the effect of pruning dates on tree survival on a known PTSL site that had been preplant and postplant fumigated with 1,3-dichloropropene or 1,2-dibromo-3-chloropropane (DBCP), respectively, showed that October–December pruning resulted in highest tree death. These results appear to contradict those of the microplot study where PTSL was more closely associated with *C. xenoplax* than with pruning time or site. In the data presented here, however, no *C. xenoplax* was detected in the uninfested control microplots during the experiment, whereas in Lawrence et al. (2), postplant soil fumigation applied at the beginning and once again during the 4-year test period served to reduce but not eliminate the *C. xenoplax* population (Zehr, pers. comm.).

The data shown here demonstrate that "old" peach sites are not necessary for PTSL to occur and that *C. xenoplax* is the most critical component. Pruning by itself on non-PTSL sites increases cold injury to trees but does not kill them (8,11). *Criconemella xenoplax* is a major factor that conditions trees to injury or death by cold. Based on a previous study utilizing these trees, we demonstrated that peach leaf senescence was delayed in the presence of *C. xenoplax* (6). Feeding by *C. xenoplax* apparently disrupts host physiology of Nemaguard trees.

Nemaguard, 'Halford', and Lovell are the most widely recommended peach rootstocks in the Southeast. Trees on Nemaguard are more susceptible to PTSL than those on the other two rootstocks. Nemaguard was a better host for *C. xenoplax* than Lovell in the greenhouse, and its susceptibility might explain why Lovell trees survive longer than Nemaguard on a PTSL site. The two rootstocks also reacted differently to greenhouse pruning, with Nemaguard shoot growth being stimulated following pruning. Nemaguard has been reported (12) to exhibit a higher absolute growth rate than Lovell, but pruning accelerated shoot growth of Nemaguard. This may explain why Nemaguard trees on PTSL sites succumb to cold injury when pruned in December, but it does not explain the *C. xenoplax* role in conjunction with pruning and tree death.

Pruning decreased dry root weight of both rootstocks, relative to unpruned seedlings, a phenomenon that occurs under field conditions (9). Also the number of *C. xenoplax* per gram of dry root was greater for pruned than for unpruned seedlings. This may explain why the response to nematodes was magnified in greenhouse-grown plants (5) and perhaps also in field-grown trees. Pruning caused root die-back to maintain a balanced root–shoot ratio. If the concurrent *C. xenoplax* population remained stable, many nematodes were available to parasitize new roots as the tree began to initiate growth, thus adding to stress of young trees. Still unexplained are reasons why above-ground tissue is injured by cold, while the primary root system retains the potential to produce vigorous suckers in summer. This effect may be caused by phytohormone imbalance, an area of research currently under investigation.

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