Association of *Macroposthonia xenoplax* and *Scutellonema brachyurum* with the Peach Tree Short Life Syndrome[1]

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Abstract: High populations of both *Scutellonema brachyurum* and *Macroposthonia xenoplax* were detected in the root zones of peach trees growing at sites where peach tree short life occurred. Both nematodes responded to changes in tree health, with the highest numbers detected under the most vigorous trees; both populations declined as tree vigor declined. Few of either species were detected 6 months after trees died. The nematode populations were inversely correlated with each other. More *M. xenoplax* were recovered during cool, wet weather, but moisture seems more important than temperature in influencing population levels. Most *S. brachyurum* were recovered during hot, dry weather. *Key words:* ring nematode, shield nematode, bionomics.

Peach tree short life (PTSL) is a devastating disease complex of peach in the southeastern United States. It is characterized by sudden collapse of peach trees (*Prunus persica* L. Batsch) before, during, or just after bloom, but complete tree death is sometimes slow. The immediate cause of death usually is cold injury (13,16,18), bacterial canker caused by *Pseudomonas syringae* Van Hall (15), or a combination thereof. However, healthy peach trees resist cold injury and the effects of parasitism by *P. syringae*. Thus, predisposition by various physical (2,3,4) and biological agents (11,12, 13,14,15,18) is important in development of the disease syndrome. Recent control programs (1,14,19) have emphasized the removal or correction of predisposing factors,

Received for publication 12 January 1980.

[1]Contribution No. 1742 of the South Carolina Agricultural Experiment Station and published with approval of the director. This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the USDA or other institutions mentioned nor does it imply registration under FIFRA. Mention of a trademark or proprietary product does not constitute a guarantee of the product by the U.S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

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and implementation of such programs has increased tree growth (6,7,13,19) and productivity (Zehr, unpublished) while reducing tree losses from short life (3,5,6,13,19).

In South Carolina, preplant and post plant fumigation of PTSL sites with high population of ring nematodes (*Macroposthonia xenoplax* [Raski] de Grisse and Loof) prolongs tree life (3,6,7,14,19), improves root health and vigor (Zehr, unpublished), and increases cold hardiness (13,14). Thus, ring nematodes appear to be important as predisposing agents for PTSL. Fumigation also helps to control bacterial canker (5) and reduces defoliation associated with infection by *Xanthomonas pruni* (Smith Dowson) (14). Recently, Lownsbery et al. demonstrated that peach trees parasitized by ring nematode were highly susceptible to bacterial canker (12).

In some PTSL sites in South Carolina, high populations of *Scutellonema brachyurum* Sher have been observed (9, Zehr, unpublished). Such populations are concomitant with *M. xenoplax,* but occasionally *S. brachyurum* occurs in the absence of ring nematodes. In an experiment of the effects of certain cultural practices on cold hardiness of 'Coronet' peach (13), the effects on populations of these two nematodes were monitored also. Results are reported herein. Kraus Sch and Lewis (9) have published a follow up study of this work.

MATERIALS AND METHODS

A 2-yr-old commercial peach orchard on a Norfolk loamy sand was selected as the test site. The orchard was an old peach site but had been row-cropped to cotton and soybeans for 7 yr before 'Coronet' trees on seedling rootstock were planted. In the spring of 1972, 10–20% of the trees died of apparent cold injury and many more were severely weakened, as shown by yellow leaves and stunted growth. In soil assays 1,120 *M. xenoplax* and 640 *S. brachyurum* per 100 cm^3 of soil were found. Feeder roots of all trees were limited and necrotic.

In a completely random design experiment (17) each of 100 surviving trees received one of five treatments (20 trees/treatment). The treatments were as follows: (i) fumigation with DBCP (1,2-dibromo-3-chloropropane) at 48 to 65 liters/ha; (ii) fall application of 0.9 kg of nitrate soda (16% N) per tree; (iii) a combination of the nitrogen application and soil fumigation; (iv) fall pruning; and (v) nontreated control. DBCP was hand injected 15 cm deep with a MacLean Hand Fumigun (Namco, Milpitas, Calif.) (14) and the injection pore sealed by tamping the soil over the pore. The soil fumigation treatments were made in October 1972 and in May 1973. The fall-pruned trees were pruned 15 November, while all remaining trees were pruned in February.

Soil samples for nematode assays were taken with a garden trowel at the drip line to a depth at which feeder roots were present, usually 8–12 cm deep. A core of soil 4–5 cm in diameter was removed parallel to the root. Two samples of about 500 cm^3 were taken from opposite sides of the tree, combined in a plastic bag, transported to the laboratory in an ice chest, and stored in a refrigerator at 4 C until assayed. Each soil sample was thoroughly mixed, a 100 cm^3 subsample was removed, and the nematodes were separated from the soil by centrifugal-flotation (8). Nematode populations were determined before fumigation, 30 d after fumigation, and frequently during the test.

Climatic data were obtained from the National Oceanic and Atmospheric Administration, National Weather Service Office/Agriculture (NOAA) weather station at Johnston, SC, located about 10 km from the test site. All data were analyzed statistically with the appropriate analysis of variance and regression correlation for a completely random design (17).

RESULTS

Relatively large populations of *M. xenoplax* and *S. brachyurum* were found in the orchard. The largest numbers of *M. xenoplax* were found in winter and spring (Fig. 1), and populations were always relatively large except when the soil was very dry. The largest numbers of *S. brachyurum* were found in September and the smallest numbers in mid-winter; otherwise the population was fairly constant (Fig. 1).

In mid-March 1973 cold injury apparently caused substantial tree injury and death. Some trees died within 2 wk after leaf emergence, while others declined

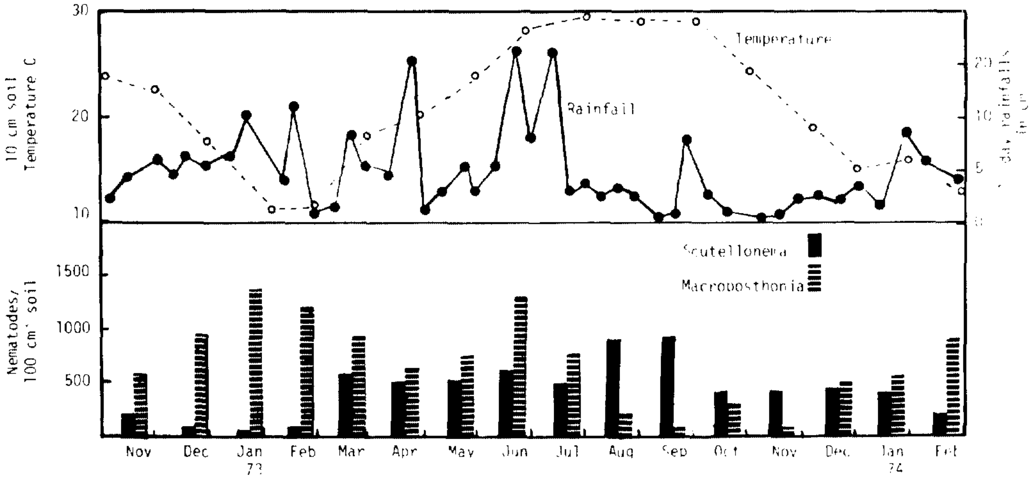

Fig. 1. Influence of soil temperature, precipitation, and nematode interaction on *Macroposthonia xenoplax* and *Scutellonema brachyurum*, November 1972 to February 1974.

slowly from March through August. Numerous water sprouts appeared during the summer from some trees that were killed to the soil line. Water sprouts did not develop in the slowly declining trees. Populations of both nematodes declined sharply under trees that were killed, but when water sprouts were produced after dieback, the population of both nematodes increased (Table 1). However, their numbers did not reach the levels associated with apparently healthy trees. Populations of *M. xenoplax* dropped sharply, followed by slow decline throughout the summer in soils from those trees that slowly declined from March to August but produced no water sprouts. During the spring and summer, populations of *S. brachyurum* also declined when associated with trees of low vigor, but the decline was not rapid. The levels of *S. brachyurum* declined sharply following summer discing (September 1973) of weeds and

Table 1. Effects of tree health on populations of *Macroposthonia xenoplax* and *Scutellonema brachyurum*.

Tree condition	No. nematodes/100 cm³ of soil*					
	Jan.	Feb.	Apr.	June	Oct.	Dec.
			M. xenoplax			
Healthy	1,260a	1,560a	530a	1,400a	28a	400a
Scion dead by June: water sprouts	1,280a	520b	500a	580b	20a	200b
Scion dead by June: no water sprouts	1,080b	530b	340b	170c	8b	0c
			S. brachyurum			
Healthy	100a	340a	430a	850a	1,650a	576a
Scion dead by June: water sprouts	80a	385a	580a	655b	852b	220b
Scion dead by June: no water sprouts	120a	275a	206b	230c	150c	68c

*Counts are means from five trees. Means in same column followed by same letter are not significantly different at $P = .05$ according to the new Duncan's multiple-range test.

grasses in the orchard, but no such response was observed for *M. xenoplax* (Table 2). The correlation coefficient between the two nematode population was r = –71.

The effects of the five treatments on nematode numbers are shown in Table 2. Soil fumigation reduced the numbers of both *M. xenoplax* and *S. brachyurum* when compared with numbers in nonfumigated soils. Nematode control was usually best where the soil fumigation treatment was applied alone. Except where soil was fumigated, nematode numbers generally were not related to treatment. However, fall pruning in 1973 and addition of nitrogen in 1972 seemed to stimulate an increase in ring nematode populations.

DISCUSSION

In this orchard *M. xenoplax* was the most abundant plant-parasitic nematode, and peach appeared to be its primary host. When trees died, ring nematode populations declined rapidly. This nematode was more responsive to soil moisture than to soil temperature: the highest populations were found in mid-winter, when soil moisture was high, and a very large population was detected during a hot, rainy period in late June 1973. Smallest populations were always detected during periods when the soil became very dry. Certainly some of these differences are associated with the poor recovery of *M. xenoplax* from dry soil (10), and assays made in August and late October 1973 were from dry soil. However, *M. xenoplax* populations sometimes were high when rainfall was low.

Field observations supported the conclusions of Lownsbery et al. (11,12) that peach roots are injured and tree health impaired when ring nematodes are present. Numerous white feeder roots were found frequently after rainy weather, but within another 30 to 60 d only necrotic roots were observed in unfumigated soil, especially during the winter months. Much less necrosis was associated with roots in fumigated soils. The significant increase in nematodes following fall pruning in 1973 might indicate that roots of fall-pruned trees are more attractive than roots of unpruned trees for nematode feeding and reproduction. However, we did not detect any improvement in root health or root numbers in fall-pruned versus unpruned trees.

We did not obtain evidence that *S. brachyurum* was parasitizing the peach trees in this orchard. However, we believe this is

Table 2. Effects of five cultural treatments on numbers of *Macroposthonia xenoplax* and *Scutellonema brachyurum* in soil surrounding peach roots.

Treatment	No. nematodes/100 cm³ of soil†					
	Feb. 73	Apr. 73	June 73	Sep. 73	Oct. 73	Jan. 74
	M. xenoplax					
Control	940	540	733	38	251	514
Fall pruning	980	540	637	47	184	1,126*
Nitrogen‡	1,110	472	888	43	227	378
Fumigation§	460*	284*	258*	1**	19**	4**
Combination‖	515*	257*	114*	11**	30**	27**
	S. brachyurum					
Control	522	472	460	843	350	350
Fall pruning	480	428	565	907	399	560
Nitrogen	347	402	561	372	279	390
Fumigation	280*	187*	258*	129*	51**	10**
Combination	358	198*	241*	303*	53**	58**

†Values are means for 20 trees.
‡Application of 0.9 kg of sodium nitrate/tree on 15 Nov. 1972 and 1973.
§Fumigation with DBCP on 6 Oct. 1972 and 12 May 1973.
‖Combination treatment consisted of nitrogen and fumigation with DBCP.
*Data significantly different from control at $P = 0.05$ level using analysis of variance.
**Data significantly different from control at $P = 0.01$ level using analysis of variance.

the case, because Kraus Sch and Lewis (9) in a follow-up study provided evidence that this nematode increases on peach. They also found that soybean and cotton were good hosts of this nematode, so high populations of *S. brachyurum* may have developed during the rotation period. This study provides circumstantial evidence that this nematode may feed on peach roots because nematode numbers declined sharply with tree death (Table 1). Largest counts were found under vigorous trees when soil moisture was low, temperature was high, and few weeds were present. However, populations dropped rapidly in late September 1973 after discing to control weeds and grass. These data are difficult to interpret but may indicate that this nematode feeds on some of the weeds as well as peach. Significant root damage occurs during discing, and the population decline may simply reflect an obligate parasite's response to such damage. Studies should be conducted to determine if cotton and soybean rotation is a wise practice for peach land.

The inverse correlation between the populations of these two nematodes may mean that the nematodes compete for a common food base or that they are favored by different environmental conditions. The series of population changes that occurred during the summer of 1973 suggests competition for the same host, but sometimes the populations appeared to respond to environmental stress. For example, with the advent of cool weather and higher soil moisture, *S. brachyurum* declined while *M. xenoplax* increased rapidly. In late summer, when precipitation decreased, *S. brachyurum* increased rapidly while *M. xenoplax* declined.

This study supports previous findings that *M. xenoplax* is injurious to peach trees. The data show that ring nematodes are numerous during both summer and winter when moisture is abundant. This study also indicates that peach may serve as a host for *S. brachyurum*. Large populations of *S. brachyurum* were found during periods when ring populations are either declining or not detected. With concomitant nematode populations, peach roots may be under constant stress. When these stress conditions were corrected in fumigated soil, trees had greater cold hardiness, vigor, and less bacterial leaf spot (14,18) than did trees growing in nonfumigated soil.

LITERATURE CITED

1. Brittain, J. A., and R. W. Miller. 1976. Managing peach tree short life in South Carolina. Clemson Coop. Ext. Srv. Cir. 568.
2. Clayton, C. N., and J. Barker. 1973. Nematodes attacking cultivars of peach in North Carolina. J. Nematol. 5:267-271.
3. Chandler, W. 1969. Reduction in mortality of peach trees following preplant soil fumigation. Plant Dis. Rep. 53:49-53.
4. Chitwood, B. G. 1949. Ring nematode (Criconematinae) a possible factor in decline and replanting problems of peach orchards. Proc. Helminthol. Soc. Wash. 16:6-7.
5. English, H. 1961. Effects of certain soil treatments on the development of bacterial canker in peach trees. Phytopathology 51:65 (Abstr.).
6. Foster, H. H., C. E. Gambrell, W. H. Rhodes, and W. P. Byrd. 1972. Effects of preplant nematicides and resistant rootstocks on growth and fruit production of peach trees in Meloidogyne spp. infested soils of South Carolina. Plant Dis. Rep. 56: 229-230.
7. Hayden, R. A., E. F. Savage, and V. E. Prince. 1968. Growth of young peach trees as affected by preplant fumigation treatment. J. Am. Soc. Hort. Sci. 93:119-127.
8. Jenkins, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Dis. Rep. 48:692-693.
9. Kraus Sch, H. and S. Lewis. 1979. Scutellonema brachyurum: Host plants and pathogenity on cotton. Plant Dis. Reptr, 63:688-691.
10. Lawrence, E. G., and E. I. Zehr. 1978. Improvement of techniques for determining populations of Macroposthonia xenoplax populations in dry soil. Phytopathology 68:1102-1105.
11. Lownsbery, B. F., H. English, E. H. Moody, and F. J. Shick. 1973. Criconemoides xenoplax experimentally associated with a disease of peach trees. Phytopathology 63:994-997.
12. Lownsbery, B. F., H. English, G. R. Noel, and F. J. Shick. 1977. Influence of Nemoguard and Lovell rootstocks and Macroposthonia xenoplax on bacterial canker of peach. J. Nemaol. 9:221-224.
13. Nesmith, W. C., and W. M. Dowler. 1976. Cultural practices affect cold hardiness and peach tree short life. J. Am. Soc. Hort. Sci. 101:116-119.
14. Nesmith, W. C., and W. M. Dowler. 1975. Soil fumigation and fall pruning related to peach tree short life. Phytopathology 65:277-280.
15. Petersen, D. H., and W. M. Dowler. 1965. Bacterial canker of stone fruits in the southeastern states. Plant Dis. Rep. 49:279-281.
16. Savage, E. F. 1970. Cold injury as related to cultural management and possible protective devices for dormant peach trees. Hort Science 5:425-426.
17. Steel, R. G., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., New York.
18. Taylor, Jack, J. A. Biesbrock, F. F. Hendrix, Jr., W. M. Powell, J. W. Daniell, and F. L. Crosby.

1972. Peach tree decline in Georgia. Georgia Agric. Exp. Stat. Res. Bull. No. 77.

19. Zehr, E. I., R. W. Miller, and F. H. Smith. 1976. Soil fumigation and peach rootstocks for protection against peach tree short life. Phytopathology 66:689-694.