Plant-Parasitic Nematodes in Orchards of the Okanagan Valley of British Columbia, Canada

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ABSTRACT

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Plant-parasitic nematodes were identified from 194 samples of soil and roots of apple, peach, pear, apricot, cherry, and prune orchards in the Okanagan Valley of British Columbia. Seven species of nematodes usually associated with damage to fruit trees were found. *Paratylenchus projectus* was found in 20% and *Pratylenchus penetrans* in nearly 80% of the samples. The greatest prominence values of *P. penetrans* were in apple and cherry orchards. *Xiphinema occiduum*, a new vector of nepoviruses, was detected in several orchards.

In many orchards, growth of young fruit trees planted on sites of removed mature trees is often retarded. The syndrome, reported in many countries, is called a replant disease, and the possible causes have been studied and reviewed recently (2,8,16). The root-lesion nematode (*Pratylenchus penetrans* Filipjev & Sch. Stekhoven) is responsible for a form of replant disease called "nonspecific" (NSARD) when no other pathogens can be implicated or when controlling the nematodes controls the disease (6,7,11–13). In 1955, Mulvey (10) surveyed the nematode populations in the Okanagan fruit orchards and nurseries, finding *P. penetrans* to be the most prevalent species, but population densities in the soil or roots were quite low. Replant problems are common in the Okanagan Valley of British Columbia and Washington State (2,3,14). However, when orchard soils are tested in the greenhouse, the growth response of young trees to nematicides is often poor compared with that obtained by treating soils with phosphate fertilizers or biocides (2,14). This nematological survey of the orchards of the Okanagan Valley of British Columbia determined the distribution and prominence of nematodes and points to their possible involvement, if any, in the replant disease.

MATERIALS AND METHODS

During May and June 1984, 194 samples of soil and roots were taken from 58 apple, 32 peach, 11 cherry, 5 apricot, 4 plum, and 4 pear orchards. In each orchard, one or more groups of five trees were selected from poor or good growth areas or at random. Soil was taken at the drip line to a depth of 20 cm in each of four quadrants of each tree with either a sampling tube 2.5 cm in diameter or a needle-nose shovel. Samples were stored at 15 C, and nematodes were extracted within 2 wk. Each sample was mixed thoroughly, and active nematodes were extracted for 7 days from 50 cm^3 of soil in baermann pans 20 cm in diameter. Root samples were washed, and 1 g of fine roots from each sample was placed in a misting chamber, where nematodes were extracted for 7 days.

Roots and soil extracts were stored at 4 C when necessary, and nematode genera in each sample were determined and counted. The nematodes from 24 samples were then killed in hot water and fixed in 2% formaldehyde. Specific determinations were made from glycerine and lactophenol mounts at the Biosystematics Research Institute, Ottawa. The prominence value (PV) (an ecological importance index) was calculated for each species (PV = average density $\sqrt{\text{frequency}}$).

RESULTS

Seven species of plant-parasitic nematodes potentially damaging to the trees were present (Table 1). The root-lesion nematode (*P. penetrans*) was detected most frequently, but *Paratylenchus projectus* was also found frequently, and this is reflected in their relatively high PVs. The other species were found in low densities and less frequently (Table 1). The distribution of *P. penetrans* in the different fruit trees and over the areas of the Okanagan Valley is shown in Figure 1 and Table 2. The greatest PVs for the root-lesion nematode were in Osoyoos and Kelowna. The nematode was more often in rhizosphere soil than in the roots of the six fruit tree species. Forty-one percent of apple rhizosphere soils and 30% of soil from other fruit trees showed densities above 50/50 cm^3. PVs in the roots were higher because average densities were also higher per gram of roots than per 50 cm^3 of soil, but it is important to note that the two units are not related. The higher PV in apple and cherries indicated the more susceptible status of these crops compared with pear, apricot, and prune.

In addition to the seven species of plant-parasitic nematodes known to be pathogenic on several host crops, we found eight species of *Tylenchida* whose status as plant parasites is not known: *Boleodorus thyllactus* Thorne, *Tylenchus hamatus* Thorne & Malek, *T. dubius* Butschli, *Ditylenchus myceliophagus* Goodey, *D. valveus* Thorne & Malek, *Lelenchus* sp. Meyl, *Cephalenchus* sp. (Goodey) Golden, and *Coslenchus* Siddiqui.

Table 1. Genera and species of plant-parasitic nematodes, their frequency, maximum density, and prominence value (PV) in fruit tree rhizosphere soil in British Columbia

Nematode	Frequency	Maximum density[a]	PV[b]
Paratylenchus projectus Jenkins	20.7	210	165
Criconemella xenoplax Raski	2.1	30	22
Tylenchorhynchus dubius Thorne	2.6	40	36
Helicotylenchus digonicus Perry, Darling, & Thorne	6.7	80	61
Pratylenchus penetrans			
Soil	78.2	490	601
Roots	66.0	970	1,490
Meloidogyne sp. Goeldi	0.5	20	14.3
Xiphinema occiduum Ebsary, Potter, & Allen	1.5	12	4.9

[a] Maximum density of nematodes per 50 cm^3 of soil, or per gram fresh weight of roots.
[b] Prominence value = average density $\sqrt{\text{frequency}}$.

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DISCUSSION

The results of this survey expand on some of the findings by Mulvey (10) in 1955. We detected *P. projectus* in all areas sampled except Kaleden and Winfield, whereas the earlier survey mentions *Paratylenchus* sp. only in Summerland, Osoyoos, and Vernon. In 1981, Mai and Abawi (8) pointed out the widespread distribution of *Paratylenchus* spp. in fruit orchards of the northeastern United States and their possible involvement in the replant disease syndrome. *Helicotylenchus digonicus* was found in six of the areas sampled, whereas no species of this genus were recorded in the earlier survey (10). On the other hand, Mulvey (10) mentions the presence of *Pratylenchus minyus* Sher & Allen in Vernon, Kelowna, Summerland, Penticton, and Osoyoos, whereas we only could find *P. penetrans* in these areas. The population densities of *P. penetrans* in soil or roots in the 1984 survey were much greater than those obtained in 1955: densities as high as 490 in 50 cm^3 of soil and 970/g of roots compared with a maximum of 18/g of roots cited in the earlier survey.

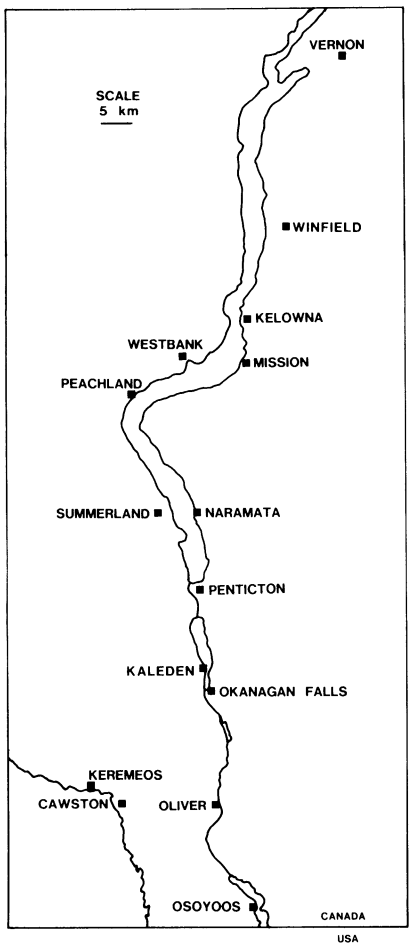

Fig. 1. Map of the Okanagan Valley in southern central British Columbia.

The greater population densities of *P. penetrans* extracted in 1984 are similar to those from earlier surveys in Quebec or in New York State (9,17). In Quebec, only 21% of the apple rhizosphere soil samples contained more than 50 *P. penetrans* per 50 cm^3. In the 1984 survey of the Okanagan, 27% of the apple soil samples were in that range. The techniques of extraction differed in the surveys of 1955 and 1984. The length of time of nematode extraction, whether in baermann pans or in the mist chamber, was 7 days in the latter survey as compared with 24 hr in the former. It is possible, however, that the more intensive growing methods practiced in orchards today, such as high-density planting systems or more balanced fertilization and pesticide application programs, could cause greater root-lesion nematode densities in rhizosphere soil and roots of mature trees.

The relationships of high root-lesion nematode densities in soil and roots to the replant disease syndrome have been examined (1,7,11). In our survey, 54% of samples from orchards with stunted trees had levels higher than 50 *P. penetrans* per 50 cm^3, whereas 46% of samples were below that level. Jaffee et al (7) showed that even though 50 *P. penetrans* per 50 cm^3 of orchard soil could be the primary causal agent, another pathogenic factor, which could be a nonparasitic rhizosphere organism, was involved. In the Okanagan Valley of Washington State, nematode densities were found negligible and treatment with nematicidal fumigants was not as effective as with general biocides like methyl bromide or formaldehyde (2,3). In British Columbia, Slykhuis and Li (14) suggested that fertilization with ammonium phosphate or formaldehyde treatment of most replant-diseased soils stimulated a growth response of apple seedlings.

The *Xiphinema americanum* Cobb populations recorded by Mulvey (10) in Summerland, Kelowna, and Vernon have since been redescribed as *X. occiduum* (4). We extracted *X. occiduum*, a new vector of Nepoviruses (T. C. Vrain, *unpublished*), in several orchards, but no virus diseases were evident in these orchards. Its presence in the Okanagan Valley orchards is not as widespread as that of *X. americanum* or *X. rivesi* in Quebec orchards (17) or in the northeastern United States (5), where they transmit tomato ringspot virus associated with Prunus stem pitting disease of peach and apple union necrosis and decline (15). These virus diseases have not been detected in the Okanagan Valley. However, cherry rasp leaf virus transmitted by *X. americanum* (sensu lato) is present in a few orchards where several weeds are hosts to the virus and the nematodes.

Table 2. Frequency, maximum density, and prominence value (PV) of *Pratylenchus penetrans* in orchards of the Okanagan Valley of British Columbia

		Soil[a]			Roots[a]		
		Frequency	Maximum density	PV[b]	Frequency	Maximum density	PV[b]
Crop							
Apple	(127)[c]	76.4	490	669	69.8	971	1,593
Peach	(40)	77.5	140	379	57.5	468	997
Pear	(4)	75.0	130	664	66.7	90	445
Apricot	(6)	100.0	60	450	50.0	57	200
Cherry	(12)	91.7	273	747	66.7	733	1,138
Prunes	(4)	75.0	90	548	50.0	67	304
Area							
Vernon	(14)	85.7	130	385	64.3	709	1,318
Winfield	(6)	66.7	100	735	83.3	303	832
Kelowna	(38)	71.1	490	945	73.7	861	2,032
Westbank	(15)	66.7	40	196	53.3	339	584
Summerland	(33)	81.2	140	405	60.6	604	1,048
Naramata	(7)	85.7	273	1,007	57.1	733	1,802
Penticton	(21)	81.0	200	675	76.2	339	956
Kaleden	(11)	90.9	240	707	63.6	970	1,763
Oliver	(17)	70.6	180	392	41.2	235	450
Keremeos	(6)	66.7	40	245	50.0	79	426
Osoyoos	(26)	88.5	350	679	80.8	956	2,034

[a] Nematodes extracted from 50 cm^3 of soil or from 1 g fresh weight of root.
[b] PV = average density $\sqrt{\text{frequency}}$.
[c] Numbers of samples examined per crop or per area given in parentheses.

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