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Plant-Parasitic Nematodes Associated with Grapevines, *Vitis vinifera,* in Oregon Vineyards[1]

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Abstract: A survey of vineyards in western Oregon was conducted in 1994 and 1995 to determine the association of plant-parasitic nematodes with vine health. Seventy vineyards in four regions of western Oregon (16 to 21 vineyards per region) were sampled. The regions were the northern, middle, and southern Willamette Valley, and southern Oregon. Vineyards were selected and partitioned into blocks by variety, age of planting, crop history, and soil characteristics. *Mesocriconema xenoplax, Xiphinema americanum, Pratylenchus* spp., and *Paratylenchus* spp. were recovered from more than 85% of the vineyards; only 10% of vineyards had detectable populations of *Meloidogyne hapla. Mesocriconema xenoplax* and *X. americanum* were found in 20% and 8% of vineyard blocks, respectively, at population densities reported to cause moderate yield loss in California. *Mesocriconema xenoplax* was found at greatest population densities in vineyards older than 10 years and on former *Prunus* orchard sites in the northern Willamette Valley. Populations of *Mesocriconema xenoplax* and *X. americanum* were associated with both healthy and stunted vines. The long-term impact of *M. xenoplax, X. americanum,* and other nematodes on Oregon vineyard production has not yet been determined.

Key words: dagger nematode, distribution, grape, *Meloidogyne hapla, Mesocriconema xenoplax,* ring nematode, *Vitis vinifera, Xiphinema americanum.*

Since the first commercial vineyard was planted in western Oregon in 1962, winegrape plantings have increased to more than 3,000 ha. The industry is composed of more than 400 commercial vineyards, most less than 40 ha, which supply grapes to small, local wineries that produce premium wines. The region is well-suited for winegrape production because of a mild, Mediterranean climate and an absence of major pest and disease problems. The discovery of grape phylloxera, an aphid-like pest of grape, in 1990 prompted the Oregon Department of Agriculture to initiate a survey to determine its distribution and impact. Areas symptomatic of grape phylloxera, circular to elliptical patches of declining or poorly growing vines, were located by aerial inspection of vineyards. Analysis of soil samples collected from these areas indicated that grape phylloxera was found in only a few of the declining areas. Soil samples from symptomatic areas in 15 vineyards also were assayed for plant-parasitic nematodes. Results of this initial survey suggested that populations of *Mesocriconema, Xiphinema,* and *Pratylenchus* spp. may be present at damaging levels in some Oregon vineyards (Griesbach, pers. comm.).

Plant-parasitic nematodes are commonly found in vineyards in all regions of the world and are often associated with areas of low vine vigor. *Meloidogyne* spp. have a cosmopolitan distribution and are a major production constraint (Arredondo, 1992; deKlerk and Loubser, 1988; Jenser et al., 1991; Kanyagia, 1988; Raski et al., 1973; Wang and Zhang, 1994). Applications of nematicides prior to planting and in established vineyards may be required to maintain the productivity of vines growing in *Meloidogyne*-infested soils (Raski, 1988). The root-lesion nematode, *Pratylenchus vulnus,* causes economic loss in California (Raski et al., 1973) and Australia (Meagher, 1969; Whiting et al., 1987), but other *Pratylenchus* spp. have not been associated with yield reduction (Bird and Ramsdell, 1985; Ramsdell et al., 1996). The dagger nematodes, *Xiphinema index* and *X. americanum,* are pathogenic on grape (Nigh, 1965; Raski and Radewald, 1958) and also vector nepoviruses that affect

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grapevines (Hewitt et al., 1958; Ramsdell and Meyers, 1974). *Mesocriconema xenoplax* (=*Criconemella xenoplax*) was the most common plant-parasitic nematode found in vineyards in Spain (Pinochet and Cisneros, 1986), Germany (Weischer, 1961), France (Scotto La Massese et al., 1973), Switzerland (Güntzel et al., 1987), and Michigan, USA (Bird and Ramsdell, 1985). *Mesocriconema xenoplax* was associated with unhealthy plants in vineyards (Ambrogioni et al., 1980; Klingler and Gerber, 1972; Meagher, 1969) and caused extensive root damage in greenhouse studies (Klingler, 1975; Santo and Bolander, 1977). Other genera reported in vineyards, *Paratrichodorus* (Bird and Ramsdell, 1985; Meagher, 1969), *Paratylenchus* (Meagher, 1969; Raski et al., 1973), *Helicotylenchus* (Güntzel et al., 1987; Meagher, 1969; Pinochet and Cisneros, 1986), *Longidorus* (Meagher, 1969), and *Tylenchulus* (Meagher, 1969; Raski et al., 1973), either are not widely distributed or cause minimal crop loss. In many cases, the relationship between nematode population densities and plant health is obscure and may depend on the age of the vines, the cultivar, and the presence of other stresses, such as water stress, poor soil, stresses caused by diseases or pests (Ferris and McKenry, 1975), or rootstock. However, management guidelines for damage on grape in California have been developed based on population densities of nematode species, site characteristic, and cropping history (McKenry, 1992).

Since adequate information was not available to assess the impact of plant-parasitic nematodes on the young winegrape industry in Oregon, a survey of vineyards was conducted in 1994 and 1995. The objectives of the survey were to: (i) identify the genera of plant-parasitic nematodes present and their geographic distributions in Oregon; (ii) relate plant health to the population densities of the nematodes found; and (iii) relate site characteristics, such as cropping history, soil type, and viticultural practices, to the abundance of nematode species.

Materials and Methods

The state was partitioned into four regions for the survey, each with distinct combinations of climate, edaphic factors, and land-use histories (Fig. 1). Three regions were in the Willamette Valley, which has moderately dry, mild summers (average August daily maximum and minimum temperatures of 27 °C and 14 °C, respectively) and extremely wet, mild winters. Most vineyards are located on hillsides on heavily leached clay-loam soils. Native vegetation was Douglas-fir forest. The northern Willamette Valley (Washington and Yamhill counties) has the greatest concentration of vineyards, and many were planted on hillsides in old *Prunus* orchard sites. In the mid-Willamette Valley (Marion and Polk counties), vineyards were planted on old pasture, grass seed fields, and *Prunus* orchard sites. The majority of vineyards in the southern Willamette Valley (Benton and Lane counties) were planted on old pasture sites. The fourth region, southern Oregon (Douglas, Jackson, and Joesphine counties), has dry, hot summers (average August daily maximum and minimum temperatures of 32 °C and 12 °C, respectively) and mild, wet winters. Many vineyards are on valley floors on a variety of soil types, including clays, silty loams, and clay-loams. Native vegetation was ponderosa pine forest and mixed oak grassland. Vineyards were situated on old pasture or hay fields and oak scrub sites.

In May and June 1994 and 1995, 70 vineyards were surveyed, with 16 to 21 vineyards representing each region. Vineyard sizes ranged from 2 to 100 ha, but the majority of vineyards surveyed were 10 to 25 ha. Vineyards were selected to represent the diverse range of geographic, topological, age, edaphic, and management factors in each region. Two to six blocks, each of 1 to 2 ha, were sampled in each vineyard. The blocks were characterized according to vine age and variety, prior land use, soil type, slope aspect, ground cover, drainage patterns, irrigation, and management regimes, including the use of nematicides. These data were obtained from our observations, information provided by the grower, and from topographic and soil maps. The occurrence of other diseases and pests also was recorded.

Standard practice in Oregon vineyards is to reduce the crop load to ca. 1,000 kg/ha

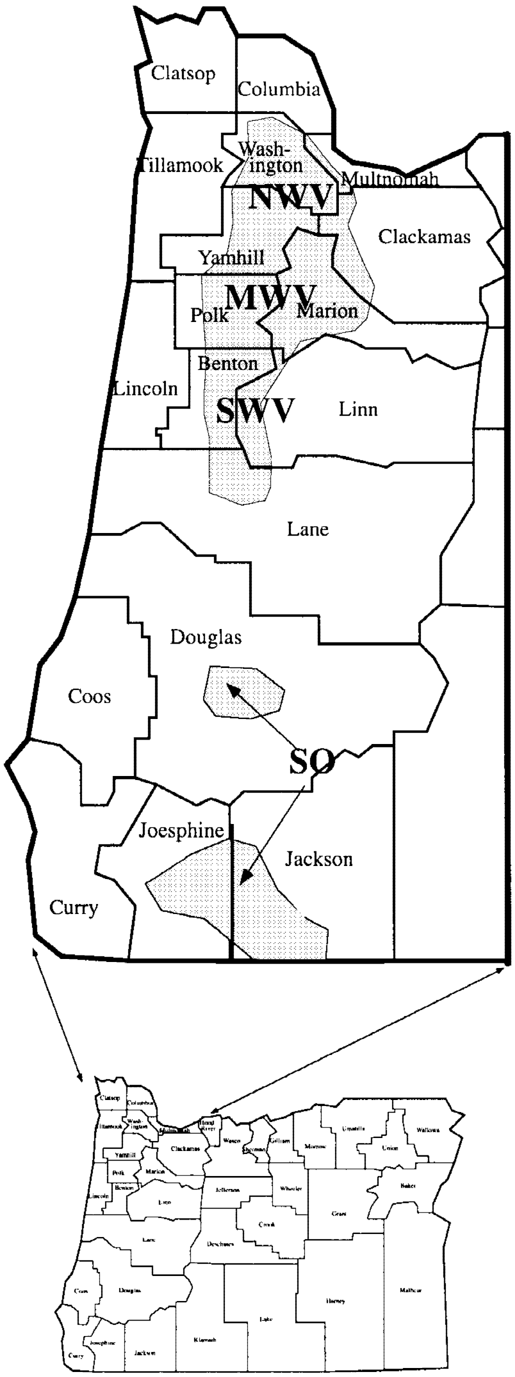

FIG. 1. Distribution of winegrape production (shaded areas) in western Oregon counties. Regions surveyed for plant-parasitic nematodes during 1994 and 1995 were: Washington and Yamhill counties in northern Willamette Valley (NWV); Polk and Marion counties in the mid-Willamette Valley (MWV); Benton and Lane counties in southern Willamette Valley (SWV); and Douglas, Joesphine, and Jackson counties in southern Oregon (SO). Seventy vineyards were surveyed: 16 in NWV, 21 in MWV, 16 in SWV, and 17 in SO.

by pruning, thinning fruit, and restricting irrigation and fertilizers; therefore, large yield differences among vineyards were not common. Therefore, the health and yield of vines in this study was based on observations made by the grower or manager. Although these data were qualitative, they represent the expectations that growers had for yield under a specific management regime and on a specific site. Blocks samples in each vineyard were selected to represent a range of differences in vigor or yield when such differences were indicated by the grower.

Soil cores (2.5 × 45 cm) were collected near 20 to 30 vines evenly distributed along four transects through each block. The transects crossed the rows at regular intervals, which produced a 'W' pattern in the block with each leg of the 'W' representing approximately 25% of the block. Each core was taken 30 to 45 cm from the base of the vine, and the cores from each block were combined to create one composite sample. Nematodes were extracted from 250 g soil with wet sieving, sucrose flotation, and centrifugation modified from Jenkins (1964). After sieving the sample, 50% of the water was drawn off and replaced with 2.6 M sucrose solution, the pellet was resuspended, and the sample was centrifuged at 420*g* for 30 sec. This method is efficient for extracting *Mesoceronema* and *Meloidogyne* spp. (Barker, 1985), and we found it comparable to the sieving-Bearmann for extracting *Xiphinema* (unpubl. data).

Plant-parasitic nematodes in each sample were identified to genus and counted. A subsample of individuals of each genus were heat-killed and identified to species. For samples containing *Meloidogyne* second-stage juveniles, 250 g soil was mixed with potting soil (1 sand:2 loam) and planted with a tomato cv. Rutgers plants. After 3 months, the roots were washed and examined for galls. *Meloidogyne* females were collected, and perineal patterns were examined to identify the species.

To rank the nematode species that may have the most potential to cause economic loss in Oregon vineyards, population densities of the nematode species we collected were compared to the densities reported to cause moderate damage (10 to 25% yield loss) to grapes in California (CDL) (McKenry, 1992). In-depth data analysis was performed only on data for species found at densities equal to or greater than the CDL.

Data analysis: Categorical data such as soil type, cultivar, vegetation history, and ground cover were grouped into classes. For example, vineyards in the northern, middle, and southern Willamette Valley were assigned values of one, two, or three, respectively. The vineyard blocks were then sorted into classes by the assigned numbers and further sorted within each class by the population density of each nematode genus. The frequency of blocks within specific ranges of nematode population densities was calculated for each class. The ranges of population densities used in the analyses for the two most common plant-parasitic nematodes were: 0, 1–25, 26–125, 126–250, 251–500, and greater than 500 *Mesocriconema*/250 g dry soil, and 0, 1–10, 11–50, 51–100, and greater than 100 *Xiphinema*/250 g soil. Data were analyzed by block rather than vineyard because of the great heterogeneity of characteristics between blocks in a vineyard (age, soil, vegetation history, etc.).

The relationship between population densities and site characteristics also was analyzed with a multiple regression approach (PROC GLM, SAS Institute, Cary, NC). The dependent variable, natural log of nematode population density + 1, was regressed with the qualitative variables (geographic area, vegetation history, soil type, and cultivar) and fitted as discrete effects; age and ground cover were fitted as continuous effects. The models were then reduced with a backstep method (Neter and Wasserman, 1974).

Results

Seven genera of plant-parasitic nematodes were collected in the survey (Table 1). *Xiphinema americanum* sensu lato was found in 94% of the vineyards and 78% of the blocks surveyed. Population densities of *X. americanum* greater than the CDL (50 nematodes/250 g soil) were found in 8% of the blocks. *Mesocriconema xenoplax* was collected in 81% and 61% of vineyards and blocks surveyed, respectively, and was found at densities greater than the CDL (125/250 g soil) in 20% of the blocks. *Meloidogyne hapla* was collected in only 10% of the vineyards and 7% of blocks, with population densities exceeding the CDL (50 nematodes/250 g soil) in 1% of the blocks. *Pratylenchus crenatus* and *P.*

Table 1. Occurrence and population densities of plant-parasitic nematode taxa in vineyards surveyed in western Oregon during 1994 and 1995.

Nematode	Infested vineyards[a]	Infested blocks[b]	Population density categories[c]	Population distribution: Vineyards[a]	Population distribution: Blocks[b]
Criconemella xenoplax	57	142	>500	10	17
			>250	27	33
			>125[d]	29	47
Xiphinema americanum	66	182	>100	4	7
			>50[d]	13	18
Pratylenchus spp.	61	157	>100	0	0
Paratylenchus spp.[e]	60	173	>250	12	13
			>100	28	38
Meloidogyne hapla	7	18	>100	1	1
			>50[d]	3	3
Hemicycliophora similis	2	4			
Helicotylenchus pseudorobustus	2	7			

[a] Seventy vineyards were surveyed.
[b] Soil samples were collected in 234 blocks, each 2 to 5 ha; 2–6 blocks per vineyard.
[c] Nematodes per 250 g soil.
[d] "High population" density that was reported to cause moderate damage (10 to 25% yield loss) in established vineyards in California (McKenry, 1992).
[e] No *P. vulnus* were observed in the survey.

neglectus were common, being collected in more than 80% of the vineyards, while *P. penetrans* was rarely collected. *Pratylenchus vulnus* was not found in Oregon vineyards. *Paratylenchus* spp. also were found in 80% of the vineyards, but population densities were low—less than 250/250 g of soil and far below CDL. *Hemicycliophora similis* and *Helicotylenchus pseudorobustus* were collected in only two southern Oregon vineyards.

The 70 vineyards surveyed represent 17% of Oregon vineyards and were well-distributed between the four regions (Fig. 1), with 21% to 34% of the blocks from each region (Table 2). The frequency of population density classes in the four regions is presented in Figure 2. *Mesocriconema xenoplax* was collected in more than 70% of the vineyards in northern Willamette Valley and southern Oregon, but 42% of blocks in northern Willamette Valley had population densities greater than 125 nematodes/250 g soil compared to 9% of blocks in southern Oregon. By contrast, *M. xenoplax* was collected in only 39% of the vineyards in southern Willamette Valley and at lower population densities than in other regions. Population densities of *X. americanum* also tended to be higher in the northern Willamette Valley (Fig. 2). *Paratylenchus* spp. were found less frequently and at lower population densities in southern Willamette Valley and

TABLE 2. Number and frequency of vineyard blocks with various site characteristics in vineyards surveyed for plant-parasitic nematodes in western Oregon.

Parameter	Site characteristic	Vineyard blocks Number[a]	Vineyard blocks Percentage
Location	Northern Willamette Valley	48	21
	Middle Willamette Valley	79	34
	Southern Willamette Valley	50	21
	Southern Oregon	56	24
Age (years)	<5	40	17
	5–10	79	34
	11–15	65	28
	16–20	18	8
	>20	32	13
Ground cover	Grass and volunteer vegetation, full cover	69	29
	Grass, full cover	45	19
	Grass and herbicide in plant row	32	14
	Mixed and other[b]	29	13
	Volunteer vegetation and herbicide in plant row	24	10
	Cultivated and herbicide in plant row[c]	22	9
	Cultivated and volunteer vegetation in plant row	13	6
Vegetation history	Hay and pasture	128	54
	Orchard	68	29
	Row and small fruit crops	15	6
	Grain and grass seed	13	6
	Woodland	11	5
	Other	1	<1
Cultivars	Pinot Noir	62	26
	Chardonnay	49	21
	Pinot Gris	20	9
	Riesling	20	9
	Mixed cultivars	20	9
	Cabernet	7	3
	Pinot Blanc	6	3
	Other[d]	50	

[a] Soil samples were collected in 234 blocks, each 2 to 5 ha, 2–6 blocks per vineyard.

[b] Several ground covers in the block, small grain, or clean cultivation.

[c] Area between the vine rows was disced during the growing season for weed control; herbicide was applied in a 1-m band in the vine row to prevent weed growth.

[d] Each of the following cultivars was represented in five or fewer vineyard blocks: Gewürstaminer, Muscat, Mueller Thurgau, Chenin Blanc, Sauvignon Blanc, Merlot, Pinot Blanc, Sumal.

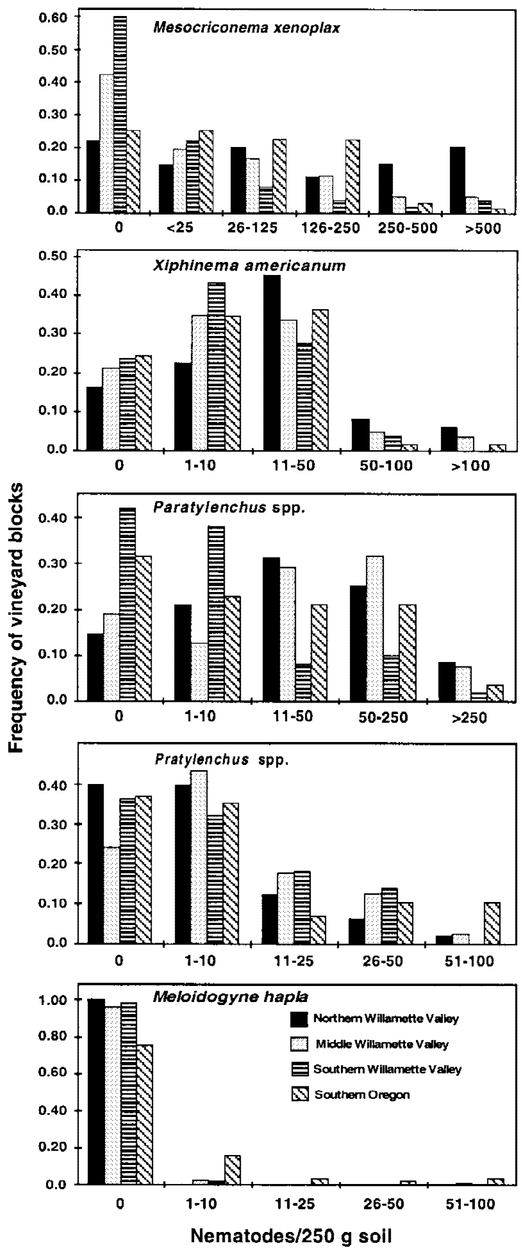

FIG. 2. Frequencies of population densities for five genera of plant-pathogenic nematodes observed in vineyards in four regions of western Oregon. The frequencies represent the proportion of blocks in each region in which nematode populations were within the specified density classes.

southern Oregon than in the other regions. *Meloidogyne hapla* was found in less than 3% of blocks in the Willamette Valley, but it was collected in 22% of blocks surveyed in southern Oregon. *Pratylenchus* spp. were at lower population densities in southern Willamette Valley and southern Oregon than in the other two regions.

Seventy-nine percent of the vineyard blocks were less than 16 years old (Table 2). There was an apparent relationship between planting age and population densities of *M. xenoplax* (Fig. 3). The frequency of vineyards in which *M. xenoplax* was not found decreased from 55% for vineyards less than 5 years old to 5% in blocks greater than 16 years old, and 29% of blocks older than 16 years had population densities above 125 nematodes/250 g soil. A similar trend of higher population densities in older blocks was observed with *X. americanum* (Fig. 3). Conversely, there was no apparent relationship between population densities of *Pratylenchus* and *Paratylenchus* spp. and vineyard age (Fig. 3).

The majority of the vineyards (54%) were planted on sites previously in pasture or hay, and 29% were on previous *Prunus* orchards (Table 2). The frequency of blocks with population densities of *M. xenoplax* greater than 125/250 g of soil was greater in vineyards planted on orchard sites than on sites with other vegetation histories (Fig. 4). The frequency distribution of *X. americanum* population density classes was similar for sites previously in orchard and pasture-hay (Fig. 4). *Meloidogyne hapla* was collected in 15% of the sites previously cropped to pasture-hay and 2% of the orchard sites (Fig. 4). Population densities of *Pratylenchus* spp. tended to be greater in vineyards previously cropped with row and small fruit crops and hay and pasture sites (Fig. 4). Population densities of all plant-parasitic nematode genera were lowest on sites previously cropped in grass or grain.

The cultivars Pinot Noir, Chardonnay, Pinot Gris, and White Riesling represented 38%, 19%, 13%, and 9% of the total vineyard acreage in Oregon, respectively, and 65% of the vineyard blocks surveyed (Table 2). The mean ages were 12, 12, 14, and 6 years for Pinot Noir, Chardonnay, White Riesling, and Pinot Gris vineyards, respectively. Ninety-four percent of the Pinot Gris blocks had population densities of *M. xeno-*

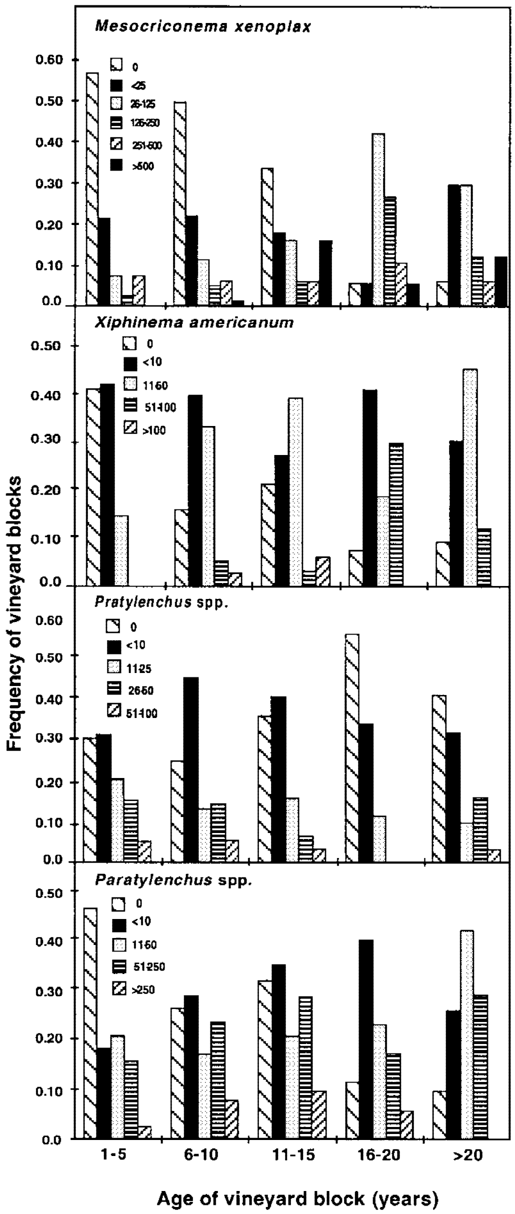

FIG. 3. Frequencies of population densities of four genera of plant-pathogenic nematodes in vineyards of different age classes in western Oregon. The frequencies represent the proportion of vineyard blocks of each age-class in which nematode populations were within the specified density classes.

plax less than 125/250 g soil, while 30% of blocks planted with the other three cultivars had *M. xenoplax* populations greater than 125/250 g soil (Fig. 5). Similarly, densities of *X. americanum* greater than 50/250 g of soil were found in Pinot Noir, Chardonnay, and Riesling blocks but not in Pinot Gris blocks. More than 98% of the blocks were planted with self-rooted cultivars; therefore, no observations of nematode × rootstock interactions could be made.

Ground-cover management ranged from clean cultivation to complete cover of volunteer vegetation (commonly 60–70% grass

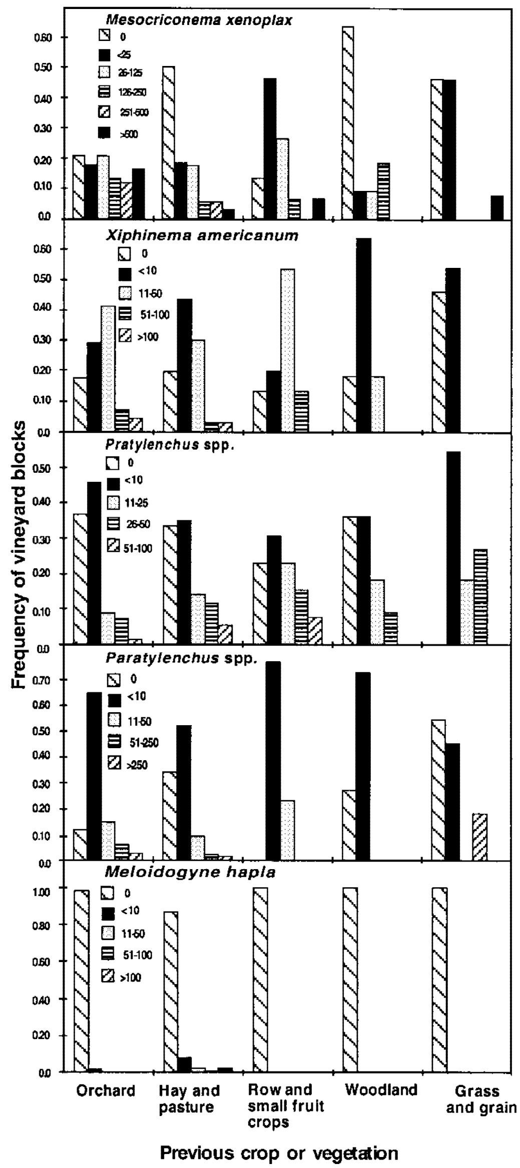

FIG. 4. Frequencies of population density classes of five genera of plant-pathogenic nematodes in western Oregon vineyards with different vegetation histories. The frequencies represent the proportion of vineyard blocks of each vegetation history in which nematode populations were within the specified density class.

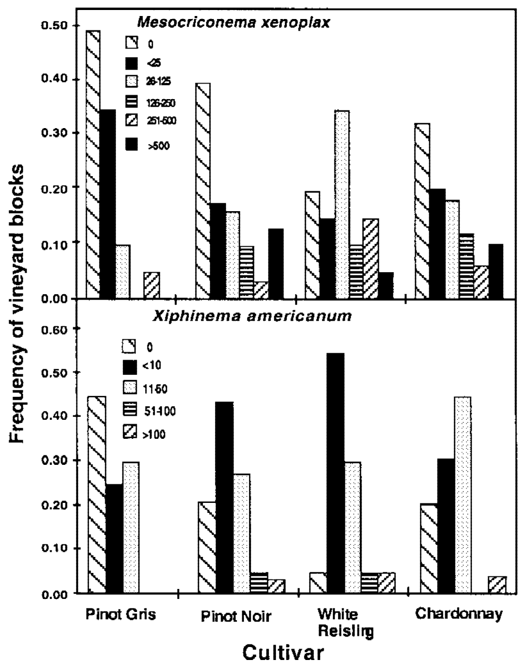

FIG. 5. Frequencies of population densities of *Mesocriconema xenoplax* and *Xiphinema americanum* under the major winegrape cultivars grown in western Oregon. The frequencies represent the proportion of vineyard blocks planted in each cultivar in which nematode populations were within the specified density classes.

and 30–40% broadleaf weedy species) (Table 2). The frequency distributions of *M. xenoplax* and *X. americanum* population density classes was similar for all ground covers except cultivated blocks with volunteer vegetation in rows (Fig. 6), which had low population densities of these two species. The majority of vineyards (83%) were situated on well-drained, fine-textured soils. The only apparent relationship between soil type and the distribution of nematode genera was that *X. americanum* was found at higher population densities in silt loam and clay loam than in sandy or silty clay soils. Similarly, other site-management data, such as irrigation, drainage, soil fertility, and yield, were incomplete and data were not included in the analyses.

Results of regression models developed for *M. xenoplax* and *X. americanum* data were in agreement with these observations. Two variables, vegetation history and vineyard age, were highly significant ($P > 0.001$) in the *M. xenoplax* model; the other variables were not significant. Since age is a continuous effect, it can be summarized with the slope, which was 0.1006. For *X. americanum*, the final model included geographical area, soil type, and ground cover, although ground cover was not significant at the 5% level.

DISCUSSION

Among the seven genera of plant-parasitic nematodes found in this survey, three species have been reported to cause economic loss in other grape production areas of the world. *Mesocriconema xenoplax* appears to have the greatest potential to impact winegrape production in Oregon. The feeding of *M. xenoplax* on grape causes a rapid local darkening and destruction of root tissue that results in a stunted root system with fewer feeder roots (Klingler and Gerber, 1972; Santo and Bolander, 1977). This species is widely distributed in Oregon and of-

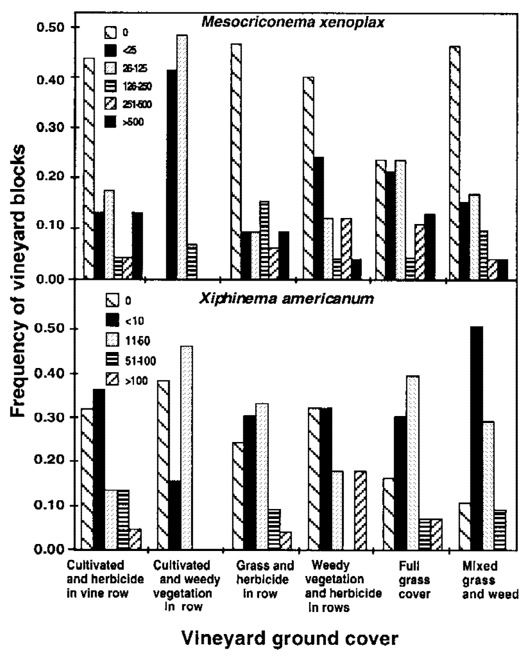

FIG. 6. Relationship of ground covers in western Oregon vineyards and the occurrence of *Mesocriconema xenoplax* and *Xiphinema americanum*. The frequencies represent the proportion of vineyard blocks planted with each ground cover in which nematode population densities were within the specified density classes.

ten was found at population densities that exceed levels reported to cause damage in California (McKenry, 1992) and Washington (G. Santo, pers. comm.) vineyards. *Xiphinema americanum* also has been reported to be pathogenic to grape, causing darkening and excessive branching of the root system (Nigh, 1965). In the current survey, *X. americanum* was collected in the greatest number of vineyards, but was rarely found at population densities reported to cause damage in other regions. In contrast, *Meloidogyne hapla,* which is a known pathogen of grapes (Ramsdell et al., 1996), was limited to a small number of vineyards, mainly in southern Oregon.

Observations of vine vigor and growers' yield records suggest that even high population densities of these species were rarely damaging. Several factors may account for observed tolerance of grapevines in Oregon to nematode parasitism. *Vitis vinifera* has a vigorous growth habit and is able to thrive under unfavorable conditions. In a study in California vineyards, Ferris and McKenry (1975) observed relatively few clear relationships between population densities of plant-parasitic nematodes and vine growth. They concluded that vigorously growing vines could tolerate nematode-induced stress, and that pathogenic effects of nematodes became apparent only when vine vigor was reduced by other factors, such as water stress in coarse-textured soils. Vineyards in Oregon are only rarely subjected to stressful abiotic conditions. Most Oregon vineyards are located on fine-textured soils in areas of relatively high annual precipitation, favorable seasonal precipitation patterns, and mild temperatures. In fact, many Oregon vineyards are managed to reduce excessive vigor. This vigor may mask the effects of nematode parasitism on most sites. In addition, Oregon vineyards are managed for 50% the crop-load of vineyards in other western states (U.S. Department of Agriculture, 1999). The low crop-load reduces the stress on vines. However, other factors, such as a shallow soil profile, extended periods of drought, or the added stresses of other diseases and pests, may interact with nematode parasitism and account for the reduced vine vigor observed in a few Oregon vineyards.

The age distribution of the vineyard blocks surveyed is representative of the young Oregon winegrape industry, which expanded from 200 to 3,000 ha between 1975 and 1996. These data suggest that population densities of *M. xenoplax* and other plant-parasitic nematodes increase over the life of the vineyard. The impact of these nematode species on vine health were observable when population densities exceeded 1,000/250 g soil, a level recorded in several low-vigor vineyards during this survey. Thus, damage may be observed more frequently in the future as vineyards age and nematode population densities increase.

When vines are planted in soil infested with high population densities of plant-parasitic nematodes, their establishment and growth most likely will be reduced (McKenry, 1992). An increasing number of Oregon vineyards, many on nematode-infested sites, will be replanted in the future. Since the discovery and spread of grape phylloxera in Oregon during the past 10 years, some old vineyards have been removed and replanted with vines grafted to phylloxera-resistant rootstocks. Other vineyards are being replanted with new cultivars and selections to respond to changes in consumers' tastes and market demands. Since Oregon grape growers do not fumigate the soil before establishing vineyards, populations of *M. xenoplax* and *X. americanum* may be sufficiently high on old vineyard sites to adversely affect the re-establishment of vineyards, particularly on suboptimal sites. Growers should consider rootstocks with tolerance and resistance to *M. xenoplax* (Pinkerton et al., 1998; Ramsdell et al., 1996) or applications of nematicides when replanting vineyards on such sites.

There is limited information on the relationships between physical and viticultural characteristic of vineyards and the distribution of species of plant-parasitic nematodes. Güntzel et al. (1987) reported that the abundance of each of the 20 nematode species in Swiss vineyards was independent of geographic location and the occurrence of other nematode species, but was correlated to soil type and moisture. The distribution of plant-parasitic nematodes also was correlated to soil type in California vineyards (Ferris and McKenry, 1975). Graham et al. (1988) reported that *X. bricolensis* was found in a wide range of soil types and in association with every grape cultivar surveyed in the Okanagan Valley in British Columbia. A study of 50 vineyards in Michigan described the spatial and temporal dynamics of plant-parasitic nematode communities but did not relate nematode abundance to vineyard characteristics (Bird and Ramsdell, 1985). These studies did not consider the effects of other past and present crop management.

In the current study, the limited number of blocks previously planted in grass and grain crops, row and small fruit crops, or woodland make it difficult to draw definitive conclusions about the relationships of nematode population densities and vegetation history. In addition, the correlation between the factors most highly associated with nematode distributions, vineyard age, geographic region, and vegetation history made it difficult to identify specific sets of conditions that related to the abundance of any nematode species. For example, *M. xenoplax* was collected more frequently and at higher population densities in the northern and middle Willamette Valley regions. However, these regions were the first planted to vineyards, and, within the region, the first sites planted were on the southern slopes of low hills, many of which were cleared of cherry or prune orchards. Therefore, relationships between these site characteristics and nematode distribution, if any, cannot be determined.

We observed a number of trends in the distribution of *M. xenoplax, X. americanum,* and *M. hapla*. *Mesocriconema xenoplax* occurred more frequently and at greater population densities in the northern and mid-Willamette Valley on old *Prunus* orchard sites. Because stone fruits are excellent hosts for *M. xenoplax,* we hypothesize that populations may have been well-established prior to planting grapevines and may account for abundance of this species on these sites. In addition, population densities of *M. xenoplax* and *X. americanum* were greatest on sites with stable plant communities prior to planting grape, i.e. orchard and pasture, and lowest on sites previously in grass and small grains. This observation is in agreement with the maturity index for the soil ecosystem based on nematode fauna proposed by Bongers (1990). In his system, Criconematidae and Longidoridae are persisters associated with stable conditions. These two species also were less abundant in plantings of Pinot Gris than in vineyards planted with other cultivars. Since most Pinot Gris has been planted since 1990, these data and vineyard age data suggest that population densities require a number of years to increase to high levels. The distribution of *M. hapla* in southern Oregon may be explained by the coarser soils characteristic of the region, warmer temperatures, and cropping history. Most vineyards in this region were planted in old pastures and hay fields that contained alfalfa and clovers, which are good hosts for *M. hapla.*

Although plant-parasitic nematodes were collected in all Oregon vineyards, the full impact of these species on winegrape production remains unknown. The nematode species found in this survey are known to cause economic loss in other grape production areas of the world. The unique edaphic and climatic conditions of western Oregon may ameliorate the effects of that nematode parasitism. However, damage to vines may be observed in future vines that are replanted on sites infested with high nematode population densities or planted with highly susceptible rootstocks (McKenry, 1992). Our observations suggest that nematode damage will be expressed when vines are subjected to other stresses, such as drought stress, poor soil characteristics, or when vines are over-cropped. When these relationships are understood, strategies can be developed to manage nematode-induced damage.

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