Vineyard management and nematode populations

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Corrective treatments must be directed to the location of the nematodes and must be considered in light of interacting factors.

Many factors in soil interact to reduce the effectiveness of grapevine roots, compounding the debilitating effects of nematodes on grapevines. Since optimum grape production requires a healthy, vigorous root system, these factors must be considered in vineyard management.

California grapevines are grown on various soil types and under a range of climatic conditions; consequently, generalizations may not apply in all cases. Further, some of the soil problems are compounded by trends toward increased mechanization and uniform management of large acreages.

Soil physical and chemical characteristics

Compacted layers from heavy equipment and cultural operations, clay lenses and hardpans laid down during sedimentary processes of soil formation, and old soil surfaces covered during leveling operations all restrict root growth. The magnitude of compaction problems can be assessed by backhoeing or soil coring and alleviated by preplant soil preparation, including deep ripping or slip plowing.

Variation in soil moisture characteristics due to soil textural differences in a vineyard may be compensated for by adjustment in vine spacing at time of planting, and by organic amendments, manipulation of sprinkler or dripper orifices, or use of check dams in irrigation furrows.

High salt concentrations in soils place a stress on the vines and may be corrected by leaching and careful water management. In most cases, extremes of pH and deficiencies or excesses of various nutrients can be corrected by fertilization and chemical amendments.

Soil biological characteristics

Many organisms inhabit vineyard soils. They may be harmful, beneficial, or have no obvious effect on grape production. Viticulturists and pest management specialists are concerned primarily with those organisms which detract from optimum crop yield.

However, they are aware that attempts to suppress or eradicate one organism can affect populations of other organisms and upset biological balances between organisms in the soil. Relatively little is known about the interactions and balances among populations of different soil organisms; control of one group of organisms without monitoring side effects on other groups may generate new problems.

Vertebrate pests such as gophers, insect pests including the root aphid phylloxera, soil fungi such as the oakroot fungus, and competition with weeds all render the root system less functional to the plant. Corrective measures for most of these problems are available. Weeds may be managed by tillage and herbicides—alternatively, a sod cover may be encouraged in vineyards, harboring predators of insect pests, reducing dust, and perhaps aiding water penetration.

The methods used to correct all these soil problems, and the level of management or control achieved, can affect the distribution of nematodes in the soil and the magnitude of their effect on the root system.

Nematode population studies

Several species of plant-parasitic nematodes commonly occur in vineyard soils. In our 1973-74 studies, a typical grapevine in an irrigated vineyard provided a suitable environment and food source for 8 million plant-parasitic nematodes, averaged over a year. There were another 11 million nematodes associated with the vine, which were feeding on bacteria, fungi, and other nematodes around the vine root system.

Usually there are several species of plant parasites in a single vineyard. We have studied the distribution of various nematodes in vineyard soils, in relation to cultural practices and nematode biology. In a vineyard of own-rooted Thompson

Seedless vines near Selma, California, weeds were controlled in the drive row by periodic disking, but the soil in the vine row had been undisturbed for 8 years, during which weeds were controlled by herbicides. The feeder roots of the vine were largely located in this upper region of soil in the vine row (fig 1A).

We found that root-knot nematodes (*Meloidogyne* spp.) occurred throughout the vine root system, but were in highest concentrations in the upper 2 feet of soil in the vine row (fig. 1B). The dagger nematode (*Xiphinema americanum*) was more distinctly limited to the upper region of soil in the vine row, the area where the feeder roots of the vine were concentrated (fig. 1C).

The following factors determined this distribution:

■The nematodes are present in large numbers because of the abundance of roots, which serve as their food.

■The dagger nematode appears in a restricted area because (a) it is intolerant of soil disturbances, (b) there are fewer roots in the disked areas, and (c) it has a rather high requirement for oxygen, and oxygen decreases with soil depth.

■The root-knot nematode has a lower oxygen requirement and is more widely distributed through the root system.

Findings

An important finding from these studies was that greatest concentrations of the nematodes were associated with the feeder roots. It is these roots that will require protection in order to promote high yields. Nematodes in other parts of the root system probably have relatively less effect on the growth of the vine and so may be less important.

From 1974 to 1976, we surveyed nematode distribution around the roots of vines in nine vineyards through the state of California. Where cultural practices were similar to those in the Selma location, distribution of nematodes was also similar. In a vineyard near Visalia, however, a restrictive soil layer prevented distribution of the roots below 2 feet, and nematodes were concentrated in the upper regions of soil.

In vineyards near Lodi and St. Helena, where a sod cover was maintained in the drive row, vine root distribution was not limited by soil compaction or root pruning and plant-parasitic nematodes were more common between vine rows.

Conclusions

In summary, it appeared that vine root distribution and nematode distribution patterns were fairly predictable in a given vineyard, based on cultural practices and soil profile.

As with other pests, nematodes must be located, and corrective treatment directed to that location. From these studies we can suggest several possibilities for improved nematode management.

In vineyards where the nematodes might be concentrated in the vine row, French plowing would disturb the soil making a less favorable environment for some nematodes. However, this practice would also destroy the feeder roots in the upper soil of the vine row—and the cost of damage to stakes and vines should also be considered.

Post-plant nematicide treatments should be more efficient if the chemical can be applied to the area of greatest nematode concentration. However, with the recent ban on the use of DBCP, there currently is no nematicide available for use in established vineyards. This emphasizes the need for further research in cultural and biological management of nematode populations.

Although plant-parasitic nematodes will reduce vine growth by themselves, their effect on the plant is compounded by interactions with stresses due to physical, chemical, and moisture problems of the soil and due to other pests. In some cases these interactions may have catastrophic effects on the plant as, for example, when grape fan leaf virus is vectored by *Xiphinema index*. The cause and treatment of nematode problems should be considered in conjunction with these interacting factors. Relief of other stresses on the plant should help to minimize the effects of plant-parasitic nematodes, especially on sandy soils and in marginal production situations.

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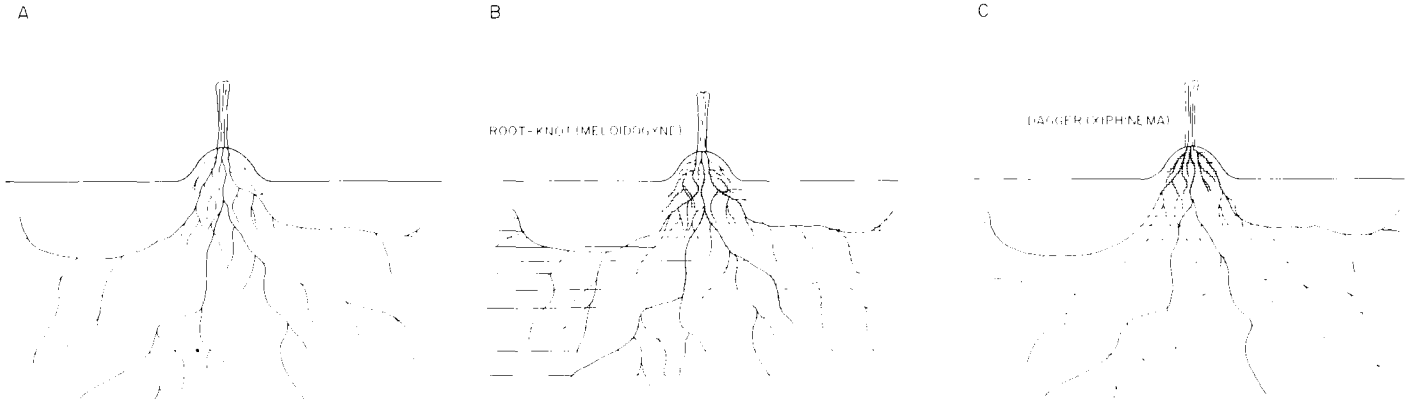

Fig. 1. Schematic distribution of roots and plant-parasitic nematodes in the upper 4 feet of soil in a vineyard near Selma, California. Section is perpendicular to the vine row. Increased density of horizontal lines indicates higher concentrations of nematodes. *A.* Distribution of vine roots. *B.* Distribution of root knot nematodes, *Meloidogyne* spp. *C.* Distribution of dagger nematodes, *Xiphinema americanum.*