Nematodes in Grape Production

distribution records show multiple infestations of two or more species of nematodes to be in most of California's vineyards

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Feeder roots of grapes may be almost completely lacking in heavy nematode infestations.

Laboratory study of soil and root samples is required for detection and identification of all parasitic nematodes other than the root-knot nematode.

The most common species of root-knot nematode in California is *Meloidogyne incognita acrita*—widespread on grapes in the sandy soils of the interior valleys from Lodi to Borrego Valley. The Javanese root-knot nematode—*M. javanica javanica*—and the Thames root-knot nematode—*M. arenaria thamesi*—are equally injurious where they occur, but they have been collected in relatively few samples and mostly from the San Joaquin, the Coachella, and the Borrego valleys.

The root-lesion nematodes of the genus *Pratylenchus* may be more destructive to the roots of vines than root-knot nematodes, but they are not so widely distributed. *P. vulnus* is the most prevalent species of this group found on grapes, and it often compounds the problem by occurring with root-knot infestations. Other species of this genus are found in vineyard soils, some very frequently, but their effects on vine growth have not yet been studied.

Citrus nematode—*Tylenchulus semipenetrans*—has been found since 1956 on grapes in Fresno and Tulare counties and as far north as Lodi. In greenhouse tests this nematode thrives on grape roots and builds into extremely dense populations. The effect of the species on vine growth under field conditions has not been determined, but there seems little doubt that some measure of decline is due to its parasitic habits.

Several species of ring nematodes belonging to the genus *Criconemoides* are known in California vineyards. However, most of them are rather limited in occurrence. *C. xenoplax* is extremely widespread, and evidence of its pathogenicity has been mounting every year. It multiplies rapidly under greenhouse conditions and, in one experiment, significantly reduced the growth of Thompson seedless rootings.

Members of the group called pin nematodes—*Paratylenchus* spp.—are frequently recovered from vineyard soils. The most common species found is *P. hamatus*. Although these ectoparasitic—surface feeding—species are small in size compared with other nematodes, they build up into great numbers on the roots of grape. Despite their rapid reproduction, there was no measurable effect on the growth of host plants by this nematode in a recent greenhouse experiment, and the pathogenicity of this species to grapes remains in doubt.

The dagger nematodes—*Xiphinema* spp.—include two forms found commonly in California: *X. index* and *X. americanum*.

X. americanum is found widely and frequently, but it does not reproduce in greenhouse soils and even its host range remains unknown.

X. index, on the other hand, reproduces readily on grapes, figs, and roses and has been proved highly pathogenic to grapevines. Some seedlings have been killed outright by high populations. In every instance these nematodes have caused gross malformation of rootlets, with swelling, distortion, discoloration, and killing the growing points of feeder roots. The species occurs commonly in the coastal areas and in the San Joaquin Valley, from Lodi as far south as Tulare County.

Xiphinema index has also figured in an important role as vector of the fanleaf disease of grapevines. This—the first record of plant virus transmission by a parasitic nematode—was established and reported last year. No other vector for this virus is known, although a number of nematode species have been tested. The discovery is fundamental to basic

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Typical spot in vineyard weakened by the root-knot nematode.

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studies of nematode-virus relationships, and could have practical value in virus control.

The conditions under which the virus reservoir persists over a period of years, maximum time of retention of the virus by the nematodes, complete host range of the nematode and virus, and the importance of crop rotation in reducing populations of the dagger nematode are all vital problems which are being pursued in current research.

Root-knot infestation is the most important problem in the light, sandy soils of the warm interior valleys. These soils lend themselves readily to fumigation as the most direct control for nematode problems—primarily by preplanting treatments for new or replant vineyards. Since the introduction of 1-2-dibromo-3-chloropropane—Nemagon or Fumazone—there have been extensive tests of soil fumigation by side dressing the growing vines.

The decision to fumigate before planting should be based on a demonstrated nematode situation in the particular vineyard involved. However, in the absence of available nematode analyses of farm lands, it should be a routine practice to fumigate the soil before planting any vines which are to be grown on their own roots or on other susceptible rootstocks. This is well justified in view of the general extent of nematode distribution and the long term nature of grape plantings. Established vineyards which later become infested with nematodes may remain productive for years before starting to decline, but young vines suffer severely from the outset and will produce irregular stands which never recover completely, though some improvement might be realized through very carefully managed fertilization, irrigation, and pruning practices to regulate crop.

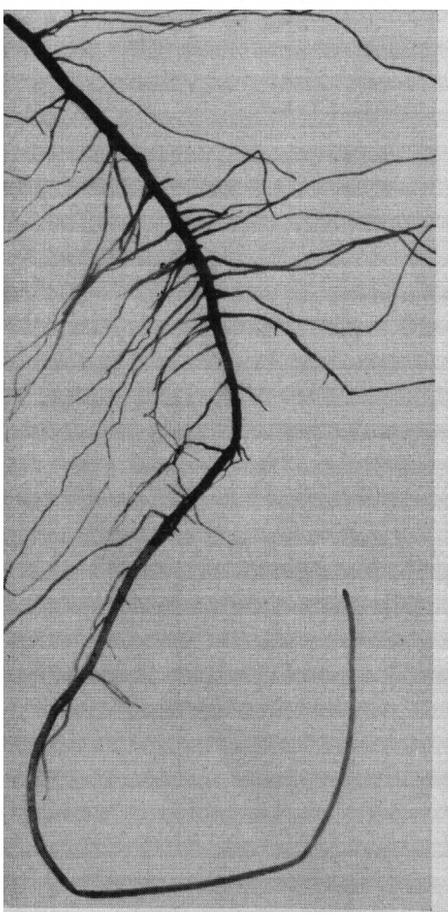
If a vineyard is to follow any perennial crop such as vines or fruit trees, an interval of two years or more should be allowed during which only annual crops are grown—preferably dry, winter grains such as barley or oats. The crowns of old plants should be cut off as deep as possible, to prevent suckering. If possible the soil should be summer fallowed, kept free of weeds, and worked to a depth of 12″–14″ several times during the warmest part of the year.

Before soil fumigation with dichloropropene mixtures—D-D or Telone—it is important to loosen the soil by subsoiling, irrigate, and work it into seedbed condition. Sealing with a roller cultipacker or harrow is essential immediately after treatment. The entire fumigation should be accomplished 3–6 months before planting.

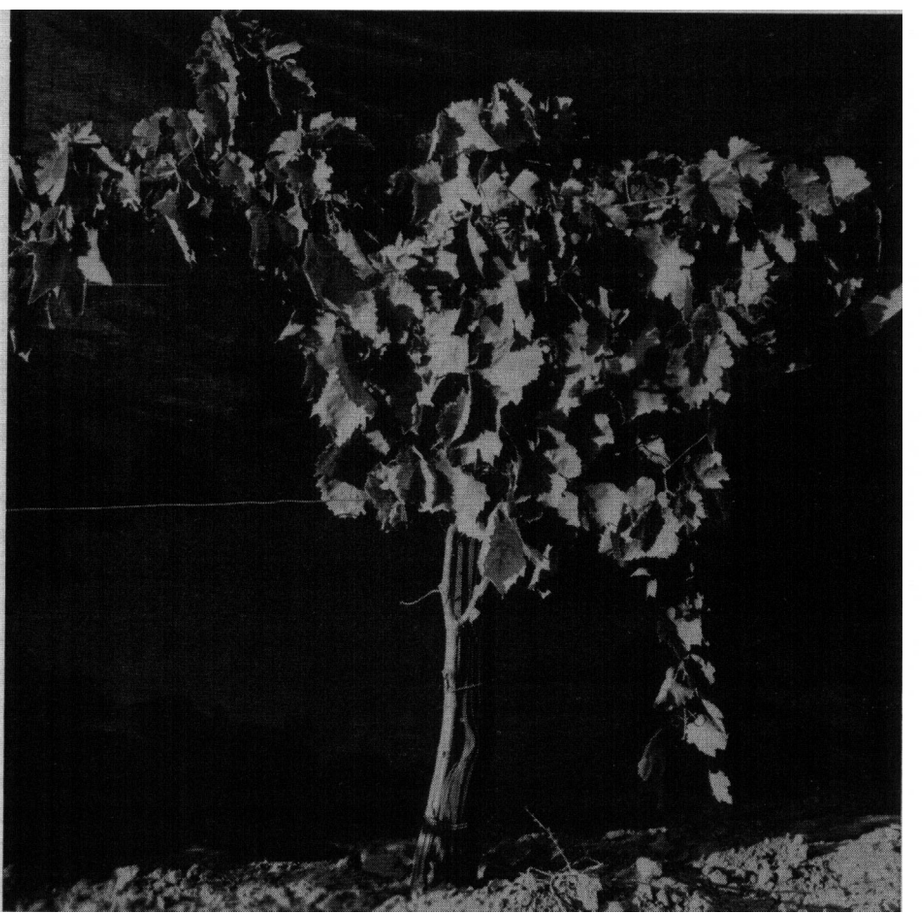
High doses of at least 60 gallons per acre of D-D or 45 gallons per acre of Telone—correspondingly more for soil types of greater moisture holding capacity—were suggested by recent work where high numbers of root-knot nematodes were found in sandy soils at depths of 12′ and more. Undecomposed roots in the soil afford nematode protection from the action of chemical fumigants.

Planting stock should be selected carefully to be sure that nematodes are not carried back into treated land on contaminated roots. Many of the nematode species in California have a relatively limited distribution and every effort should be made to exclude such parasites from noninfested lands. All nursery material should be propagated from cuttings rooted in beds in which soil fumigation is routinely practiced. If infested stock must be used, nematodes can be eradicated safely from rootings by immersion in hot water at a temperature of 118°F for 30 minutes, 120° for 10 minutes, or 125°F for five minutes; both tempera-

Clean roots of Thompson seedless grapevine, grown in sterilized soil.



Two-year-old Thompson seedless grapevine grown in fumigated soil in vineyard near Madera.



ture and time of exposure must be carefully controlled. Such treatment should be considered as an emergency measure only.

Preplanting soil fumigation has provided new plantings with favorable conditions for becoming established, whereas vines planted on untreated soils fail completely. However, no control measures to date have been successful in eradicating nematodes on a field scale. In every field experiment of the past seven years nematodes have built up again on the roots of the new vines within the first growing season. The inevitable recurrence of nematodes necessitates special care in cultivation to give vines the best possible opportunity for satisfactory growth. Also there is a need for an effective and economical treatment of growing vines to help maintain vigor and productivity.

Side-dressing established vineyards with soil fumigants has been under experimental testing in field plots for several years, most intensively since the introduction of dibromochloropropane, an extremely effective nematocide, which has been used safely around grapevines at doses up to 10 gallons per acre of active ingredient. However, response by improved vine growth and yield has been irregular. In some tests remarkable increases of cane growth and yields were obtained, but in most experiments no differences could be detected. Chemical treatment has been emphasized where vines are vigorous and have had a relatively nematode-free start. Dibromochloropropane, applied as the nematodes begin to build up, may be helpful in maintaining maximum vigor in the vines.

In locations where the nematode populations multiply rapidly to high numbers, the growth of own-rooted vines is not vigorous, regardless of the presence of nematodes. These light soil types are frequently low in fertility and have a low water-holding capacity; under these conditions the use of nematode-resistant grafting stocks has been advantageous. The variety Solonis x Othello—1613—resistant to root-knot nematodes and to phylloxera is widely used in California. Other resistant rootstocks are Saltcreek —*Vitis doaniana*—and Dogridge—*V. champini.*

Root-knot nematode is a relatively minor problem in the nonirrigated vineyards of the coastal areas, characterized by heavier, mineral soils of high water holding capacity. The nematodes found in these soils are mostly ectoparasitic types; possibly the most common is the dagger nematode.

The high incidence in the coastal areas of fanleaf virus and its nematode vector threatens future plantings.

The establishment of a Registration and Certification Program by the California State Department of Agriculture and the University of California has made vineyard planting and grafting stock—free of virus diseases of all kinds —available to growers through commercial nurseries. However, clean stock can not prevent infection of new vines planted in nematode infested fields with a history of fanleaf.

Control of the dagger nematode is essential because of the damage it causes in new plantings, even without the virus. However, soil fumigation is difficult in the heavier soils of most coastal areas.

The phylloxera resistant rootstock St. George, planted in the coastal valleys, is inadequate in resistance to the dagger and other nematodes.

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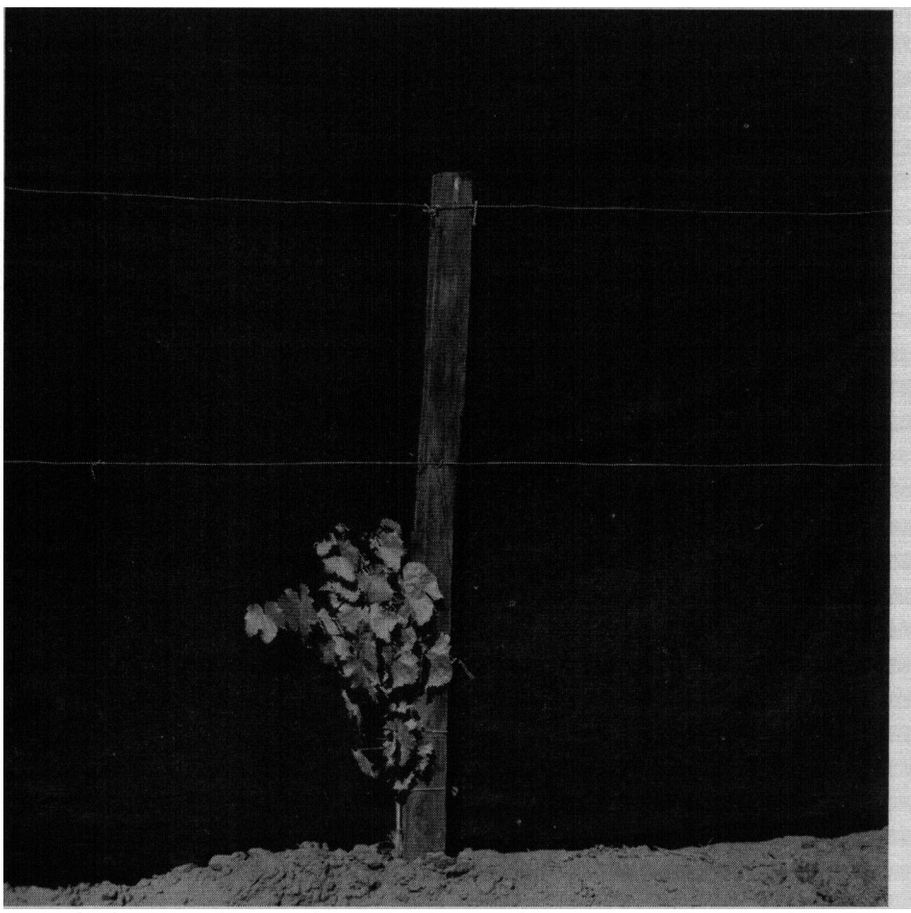
W. B. Hewitt, D. J. Raski, and A. C. Goheen reported, in 1958, the first record of plant virus transmission by a parasitic nematode.

Two-year-old Thompson seedless grape in soil infested by root-knot and root-lesion nematodes.



Roots of Thompson seedless grapevine grown in dagger nematode infested soil.