

Control of Nematodes on Grapes

soil fumigation with crop rotation tested as way to protect grape replants against root parasites

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Nematodes—parasitic in and on the roots of grapevines—probably represent one of the most important factors in the premature decline of vineyards in California.

Premature decline of vineyards—accompanied by decreasing productivity and reduced vigor—is a major problem to the grape industry of the state because it is particularly common throughout the San Joaquin Valley and in southern California.

Premature decline has been observed in plantings of all ages varying from five-year-old to sixty-year-old grapevines. In some cases, the damage is confined to small, localized areas within a vineyard but in other cases, the damage may be extensive in large plantings where most of the vines show some degree of injury.

Attempts to replant such vineyards after removing the weakened vines often result in failures of the plant to establish and thrive. In many respects, this is a problem of greater importance than the weakening of old vineyards because some level of production can usually be maintained in the older plantings.

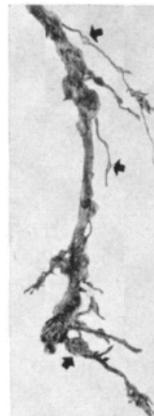
Soil fumigation tests directed toward the improvement of existing vines infected with nematodes have been unsuccessful largely because of the injury to the plants by the fumigants available. A series of experiments designed to compare the efficacy of various soil fumigants in helping to establish grape replants—in old vineyards infested with nematodes—were started in 1952 with five field plots on three different varieties of grapes. The soil in all plots was a sandy loam but Plot No. 5—near Delano—had considerable gravel.

The principal materials tested in all five plots were EDB—ethylene dibromide—and D-D—a mixture of 1,3-dichloropropene and 1,2-dichloropropane.

The formulation of EDB—66% by volume or 83% by weight—is commonly used for commercial fumigation and was used throughout the tests. In two of the experiments, OS-1897—a new experimental chemical—and CBP-55—1,3-chlorobromopropene—were included among the treatments.

The chemicals were injected by chisels at a depth of approximately 6"–8".

Grape roots heavily attacked by root-knot nematode. Note small beadlike swellings resulting from single nematode invasion and large galls from multiple infections. Absence of feeder roots is typical of nematode damage.



Wherever equipment was available, a harrow or roller—or both—were used to help seal the fumigants into the soil.

Most of the collections of root-knot nematode on grapes in California have been identified as *Meloidogyne incognita* var. *acrita*, a widely distributed species especially severe in the Fresno, Lodi, Delano and Arvin districts. The damage by root-knot nematode attacks tends to occur more frequently and is more intense on the light, sandy-type soils.

The root-lesion nematode—*Pratylenchus vulnus*—appears to be an equally serious parasite wherever it has been found infecting the roots of grapes, but it is not encountered nearly so frequently as the root-knot nematode.

In some of the experiments there has been encouraging improvement in the growth of vines planted in fumigated soil

over those planted in untreated soil. However, the success of these treatments cannot be judged from the results of one year's experience but must be based on the growth and productivity of these vines over a period of years.

Plot No. 1

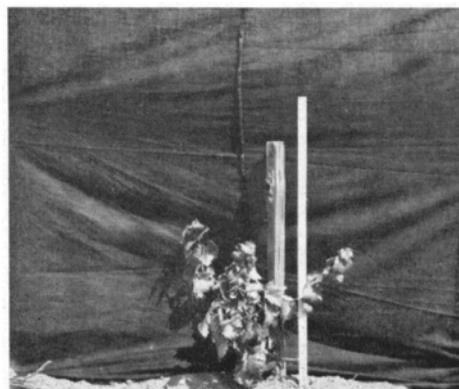
The most promising treatments were found in experimental Plot No. 1 near Lodi in a vineyard of Tokay grapes infected with root-knot nematode—*M. incognita* var. *acrita*. The vines had been removed during the winter of 1949–50, and for three succeeding years the field was planted to bean varieties susceptible to the nematode. This resulted in a very high population of root-knot nematodes at the end of the 1952 growing season.

The response of the vines to the fumigants was greater in this plot than in any of the others, and the nematode control was very effective, failing only in one treatment—EDB at six gallons per acre. This high count resulted from only two samples of the ten collected. The average count for the two samples was 124 root-knot galls per pint of soil; the average for the other eight samples was 2.8 galls. It is possible that an uneven application of the chemical could account for this apparently localized loss of control.

The alternate planting of beans may have resulted in a much greater nematode population than is ordinarily found

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Tokay grape replants in experimental Plot No. 1 near Lodi. Land had been planted to bean varieties susceptible to root-knot nematode for three years prior to soil fumigation treatment in the winter of 1952–3. Left: Vine planted March 25, 1953, in untreated soil. Right: Vine planted same date in fumigated soil. Photographed in October 1954.



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in vineyards and could account for this extreme degree of injury to the new plantings in untreated soil.

It is the belief of many growers that vines grown in nematode-free soil for two to three years can become sufficiently established to withstand subsequent nematode infections and still remain vigorous and productive. Even if this is true, it must still be determined whether the advantage of more effective control obtained in Plot No. 1 will be maintained or whether the nematodes will build up to high population levels in time to cause injury. Also, this advantage of rotation in obtaining superior vine growth as well as nematode control must be confirmed by additional experience in other areas and under varying conditions, including different soil types, grape varieties, nematode species.

Plot No. 2

The second test plot also involved Tokay grapes in a vineyard near Lodi. Vines infected with root-knot nematode—*M. incognita* var. *acrita*—had been pulled out during November 1952.

During 1953, the grower allowed a heavy weed growth to develop as a frost protection for the young vines.

The response obtained by fumigation was not so great as in Plot No. 1—possibly because of a lower population of nematodes at the time of treatment.

The lesser growth obtained after treatment with D-D at 60 gallons per acre may be due to injury to the plants resulting from the short interval between fumigation and planting.

Plot No. 3

A third plot was established near Livingston in a five-year-old Thompson seedless vineyard which was very heavily infected with root-knot nematode—*M. incognita* var. *acrita*—and had failed to develop to normal production. The old vines were removed during January 1953 about two weeks before the fumigants were applied.

The influence of fumigation on the growth of new vines in this plot was apparently not significant except at the higher dosages. Also, the vines showed a considerable infestation of nematodes.

The most effective nematode control was obtained by OS-1897 but did not result in improved vines. This was probably due to plant damage—observed in other experiments involving annual plants when the chemical was used at the same dosage.

Recent observations near the end of the second growing season revealed a

generally unsatisfactory growth and an extremely severe root-knot infection in all the treatments including the higher dosages.

Plot No. 4

The area selected for the fourth plot was in a vineyard of Thompson seedless grapes near Madera. The vines were approximately six years old and infected with both root-knot nematode—*M. incognita* var. *acrita*—and the root-lesion nematode—*Pratylenchus vulnus*. The old vines were removed in January 1953.

The effects of fumigation on the new vines in this plot have been outstanding—almost as great as the differences found in Plot No. 1. The coincident infestation of root-knot and root-lesion nematodes in this vineyard may account for the extreme injury found here. The D-D treatment at 60 gallons per acre seemed to show some degree of plant injury, but the vines appear to have overcome this depressed growth in the second growing season. The nematode control was probably the least effective of all the plots.

Plot No. 5

The last experiment was established in a vineyard of Black Malvoisie grapes located near Delano. These grapevines were found to be infected with the less frequently found species of root-knot nematode—*Meloidogyne javanica*. The root-lesion nematode—*Pratylenchus minyus*—occurred rather uniformly in the soil throughout the plot, but its role in this problem has not been clearly demonstrated as yet.

The old vines were approximately 12 years old and had not been producing satisfactorily for several years. Vines in the replant plot were removed in November 1952.

Three replications were included for each treatment except D-D at 20 gallons per acre, OS-1897 and CBP-55, each of which was replicated once.

The growth obtained in this plot has not been satisfactory. An uneven distribution of the root-knot infestation indicated that it was not the cause of decline in this vineyard. A more uniform distribution of the root-lesion nematode—*Pratylenchus minyus*—throughout the plot strongly suggested that it contributed to the injury, but more information is needed.

The nematode control obtained in Plots Nos. 2, 3, 4, and 5 was not consistent and should probably be considered as generally unsatisfactory. This failure of control is correlated with the removal of the old vines within three months or less, previous to the time of treatment. There is a good probability that survival of the nematodes occurs within the roots of the old vines—which may persist in the soil for months or even years—and this suggests that the chemicals at the dosages used are not able to penetrate the root-tissues to effect the desired kill.

The nematode counts in Plots Nos. 2–5 definitely show that in most cases nematode infections of the new vines occurred during the first year of growth. There is serious doubt, therefore, as to the eventual success of these fumigation treatments even though the vines in some of the treatments are very vigorous and

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Average Cane Growth and Nematode Counts in Grape Replant Fumigation Plots

Treatment	Tokay				Thompson Seedless				
	Plot 1		Plot 2		Plot 3		Plot 4		Av. root-lesion nematode count/pint of soil
	Av. cane wt. in gms./vine	Av. root-knot gall count/pint of soil	Av. cane wt. in gms./vine	Av. root-knot gall count/pint of soil	Av. cane wt. in gms./vine	Av. root-knot gall count/pint of soil	Av. cane wt. in gms./vine	Av. root-knot gall count/pint of soil	
Untreated	0.09	31.6	17.8	97.3	12.2	11.8	6.8	40.0	39
D-D									
20 gal./A	53.1	2.0	32.7*	39.0*	....	....	....	....	..
D-D									
40 gal./A	40.8	0.2	53.1	0.4	16.7	10.7	80.3	104.4	95
D-D									
60 gal./A	80.4	0.4	36.6	10.7	31.9	87.9	60.9	67.4	28
EDB**									
9 gal./A	45.7	27.0	59.4	50.3	16.7	20.9	47.5	283.7	0
EDB**									
15 gal./A	111.5	0.7	60.6	24.1	31.5	25.6	38.1	186.7	8
OS-1897									
10 gal./A	....	....	....	....	13.9	3.3	....	....	..

* The figures at this dosage were obtained from vines bordering the plot in which the soil was treated by a commercial applicator before planting.

** These data represent the equivalent of 6 and 9 gal. per acre respectively of active ingredient.

HUMBOLDT

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may remain unused in the form of residues left in the woods, and slabs, edgings, and sawdust resulting from manufacture.

In 1953 about 175 million cubic feet of such wood residues were produced in Humboldt County. About two fifths of the total was left in the woods—the bulk of it in the form of pieces too small or of too low a quality for use in sawmills or veneer plants. Much of this type of unused raw material is suitable for pulping. But unless an active local market for pulpwood is established, such logging residues cannot be considered part of the effective wood supply.

Substantial progress has recently been made in using coarse sawmill and plywood plant residues for pulp chips. Twelve plants in the county are now equipped with chippers, producing raw material for pulp mills located elsewhere in the State. Large volumes of unused mill residues remain, however.

These limitations on the volume, accessibility, and utilization of timber mean that Humboldt County is approaching the most difficult part of its transition from old-growth timber liquidation to permanent timber management. The county still has time to do many things that will help in mitigating future raw material shortages which would inevitably result if present trends continue. Permanent stability of timber industries can only be obtained if the forest land in the county is under effective management. Moreover, such management is needed now if the county is to avoid in the future the sort of crisis which has wrecked the economies of many other timber-dependent areas.

At present, net timber growth in the county is estimated at about 440 million board feet per year, or a little over 250 board feet per acre annually. Almost four times as much—960 board feet per acre—would be needed to balance the 1951 level of cutting.

Commercial timber growth in the redwood stands can be increased by cutting mature stands selectively. This means removing now only the bigger, overmature trees and leaving a fairly heavy reserve stand of thrifty younger trees. Such cutting increases annual growth substantially on redwood areas. Although selective cutting is now an established practice in Humboldt County, there is still much need to increase the area so treated and to leave heavier reserve stands.

Management of Douglasfir stands for increased timber growth would require cutting only those patches of timber in the stand which are now overmature, and leaving untouched those areas now occupied by thriftily growing trees. The cur-

rent practice of clearcutting Douglasfir stands over a large area of 100 or more acres has resulted in destroying much small timber which would have grown rapidly if left on the ground and has not led to satisfactory restocking of the land.

The cutting practices needed to build up timber growth will only be widely adopted if certain existing economic obstacles to forest management are removed. Among the most important of these obstacles are taxation policies which discourage timber growing, the difficulty of providing adequate technical forestry advice for the large number of landowners with small forest holdings, unfamiliarity of many owners with timber markets, and the need for better fire protection. Problems such as these cannot be solved by the timber owners and operators alone.

To use the timber resources fully and to realize their potential economic benefits will require efforts by all citizens: efforts to understand the forest situation; to recognize the potential benefits from improving it and the costs of failing to do so; and to put into effect practical measures of general county policy which seem likely to be essential for continued timber prosperity.

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POPULATION

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butter, and eggs are prominent examples—have shifted to the import category. As these deficits occurred, they were filled by inshipments from other states. Meanwhile, the production of export commodities—many of which California is the nation's principal or sole supplier—has continued without regard to the size of the state's market. Thus, the dominant influences governing the agricultural output of California have been those of demand outside of the state rather than within it.

Influence of Markets

Of the few commodities for which the state is on a self-sufficing basis, market milk is the most important and most likely to adjust to the needs of an expanding state population.

There would appear to be no compelling reasons for expecting a state market based on 20 or 25 million people to have much more influence on what California agriculture produces—other than such commodities as market milk—than a market based on 12 million. Hence, there appear to be no reasons for an expanding population, in and of itself, to induce

a trend toward a more self-sufficing agriculture.

Flexibility and adaptability have always been outstanding characteristics of California's agriculture. Future changes—even if the state continues its rapid growth—are likely to be influenced much more by national and world markets than by the size of the state's markets or by the need of an expanding occupational base to absorb its mounting population.

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COTTON

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measured, have always been the source of most reliable information. With the complexity of modern farming, diversity of soil conditions, variety of crops and management practices, field testing becomes a difficult and time-consuming task.

In experiments conducted to date, the most reliable and easily applied diagnostic guide in cotton fertilization is the sodium bicarbonate test for available phosphorus.

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The above progress report is based on Research Project No. 1437.

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have continued to make satisfactory progress during the second year of growth.

Most growers prefer to replace old vineyards immediately following their removal, but it is likely that a rotation program—followed by soil fumigation—will be essential to obtain productive vineyards for the length of time necessary to make them profitable. The minimum time for such rotations has not been determined, but in this case, three years seem to be sufficient.

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L. A. Lider, Assistant Professor of Viticulture, University of California, Davis, has cooperated in rating the vines and evaluating their growth.