Root-Knot and Root-Lesion

soil fumigation reduces infestations but can not be used ing

The characteristic galls or knots on the roots of trees and vines which are caused by root-knot nematodes make this pest easy to recognize in the field.

The galls on the roots develop as the result of the feeding activity of the nematode. The young nematodes enter small roots, usually near the growing tip. The head of the nematode comes to lie near or in the vascular system, and as the nematode begins feeding, plant cells in the vicinity of the head undergo changes that interfere with their normal function of translocation of nutrient materials and water. In this way, root-knot nematode may account for a marked reduction in the efficiency of a plant-root system.

Top symptoms become apparent when the efficiency of the available root system is reduced to the extent that it can no longer supply the materials needed for normal growth. Adult females of root-knot nematode are saclike or pearshaped in appearance and they resemble small white beads imbedded in the galls or knots. The time required for a nematode infestation to cause the appearance of top symptoms depends upon several factors. Lightly infested seedlings planted in nematode-free soil may grow normally for many years because the roots grow much more rapidly than the nematode population can increase. The same seedling planted in infested soil may be so heavily attacked that stunting and poor growth become an obvious effect within the first year or two.

Soil fertility and other environmental conditions conducive to good growth may enable a plant to make satisfactory growth despite a heavy root-knot nematode infestation. In any situation where all conditions are not favorable to satisfactory plant growth the presence of root-knot nematode may become an important limiting factor in the success or failure of the planting. Root-knot nematodes do their greatest damage in areas characterized by sandy soils and long-growing seasons. Trees and vines planted in the heavier soil types in coastal or mountain areas are less apt to be injured than those planted in warm interior valleys on light sandy soils.

Susceptible Crops

The fruit and nut crops most frequently injured by root-knot nematode are fig, grape, peach, and almond. A considerable amount of research has been directed toward the development of resistant rootstocks for peach and grape. This has resulted in the introduction of a number of rootstocks that are more or less resistant or tolerant of root-knot nematode infestations.

In many areas of California, for example, the Shalil peach rootstock has largely replaced the Lovell rootstock because of its ability to make better growth in root-knot nematode infested soil. However, it has become increasingly evident in recent years that Shalil is susceptible to injury by root-knot nematode. This difference in the susceptibility of Shalil and certain other plants to different root-knot nematode populations has led to splitting of the root-knot nematodes into five different species. Only one of these species is known to be capable of doing damage to the Shalil root.

Sparse foliage of the second tree fro

A flowering peach hybrid rootstock known as S-37 has been used with some success in areas where the Shalil rootstock has failed because of root-knot nematode. Most reports have indicated that S-37 is imune or only lightly attacked and will make satisfactory growth where Shalil has failed. However, recent observations made in one locality in California show S-37 to be heavily infested, and satisfactory tree growth is obtained only when the soil is treated with a soil fumigant prior to planting. This situation more or less parallels the history of Shalil rootstock and again indicates nematode resistance may be variable from one area to another.

Several grape rootstocks have been reported to possess some degree of resistance to root-knot nematode infestations. These include Dogridge, Salt Creek, and the hybrid rootstocks 1613 and 1616. As with Shalil, the performance of these rootstocks has varied in different localities or even in fields in the same locality.

***Left,* walnut tree on resistant paradox rootstock in orchard infested with root-lesion nematodes. *Right,* infested walnut tree on black rootstock.**

The healthy prune trees on the left were pla trees on the right wer

Nematodes

rowing orchards or vineyards

M. W. Allen

he right indicates nematode injury.

Seedling walnut on black walnut root, about two years afte planting, killed by root-lesion nematodes.

Continued cropping of infested land with susceptible crops usually results in building up of high nematode populations that are capable of doing considerable damage or even making trees and vines unproductive.

Root-Lesion Nematodes

Plants infested with root-lesion nematodes show evidence of poor growth and frequently exhibit symptoms of yellow foliage and die-back of twigs and small branches.

The root symptoms consist of the presence of necrotic areas or lesions of varying size on larger roots and the presence of dead feeder roots.

In contrast to root-knot nematodes, root-lesion nematodes retain their wormlike form during their entire life. Eggs are deposited within the root tissues and the feeding of the nematodes does not induce the formation of galls or swelling. It is difficult to diagnose root-lesion nematode damage in the field due to the fact that other conditions may be responsible for the appearance of root symtoms that can not be readily distinguished from those caused by the nematode. For this reason it is almost always necessary to examine portions of the diseased root material in the laboratory to ascertain whether or not root-lesion nematodes are present.

Walnut, cherry, grape, plum, fig, and olive are the fruit and nut crops most frequently found to be injured by root-lesion nematodes. Other hosts include apple, strawberry, and tuberous begonia, lily, bush berries, peach, and apricot.

Nematode Control

There is no satisfactory method of controlling nematode infestations on living trees and vines. The available soil fumigants used to control nematodes are highly phytotoxic and their use around living plants is restricted for this reason.

The large soil volume occupied by the plant root system is one of the factors limiting the possible success of such treatments. Soil samples taken from the root area of infested trees have shown that the nematode infestation has about the same distribution as the root system.

In addition to the difficulty of treating the large soil mass around the roots, the problem of treating living plants is complicated by the presence of nematodes within root tissues. Nematodes imbedded in root tissues are protected from the toxic effects of soil fumigants. There appears to be no satisfactory means of killing these nematodes without also killing the roots containing them.

Soil fumigation is an effective method of reducing the soil population of plant parasitic nematodes prior to planting susceptible trees or vines in infested soil. When replacing trees or vines injured by nematodes, it is advisable to treat the planting site even when the new plant is on a resistant rootstock. Satisfactory results can usually be obtained by applying D-D at the rate of 400 to 600 pounds per acre to an area four to eight feet in diameter at the planting site.

If several acres are involved the entire area can be treated with 400 to 600 pounds of the fumigant applied with a chisel-type machine applicator. This type of treatment is best suited for plantings such as grapes when the plants are placed close together. A period of two to four weeks should be allowed between treatment and replanting to avoid injury of the new plant by the fumigant.

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nted after cotton, while the nematode infested
e planted after alfalfa.

Left, healthy plum tree, uninfested by nematodes, in a Kern County orchard. *Right,* root-lesion nematode infested tree in the same plum orchard.

Enemies of Avocado Pests

parasites and predators if protected by sparing use of insecticides will keep avocado pests in check

Blair Bartlett and Paul DeBach

Southern California avocado growers enjoy a singularly fortunate position with respect to insect pests.

Localized outbreaks of some pests may present serious temporary problems to individual growers on occasions, but chronic pest problems such as beset the citrus industry have been largely avoided.

This favorable condition is mainly due to a remarkable array of natural enemies which prey upon the potential pests and destroy them. The latania scale, the long-tailed mealybug, soft-scales—4 spp.—, the omnivorous looper, the avocado brown mite, and the greenhouse thrips all have important natural enemies. Often the combat between natural enemies and avocado pests gets under way long before the pests become prominent and as a result the natural control may pass unsuspected unless something happens to upset the delicate equilibrium of the opposing forces in the early stages of their battle for domination.

Biological control work on avocados attempts first to favor the dominance of natural enemies over pests by introducing new parasites and predators left behind in foreign countries when the pests immigrated to California; and second to guard against catastrophes to the established array of natural enemies that are now present. This dual approach aims at swinging the pendulum even further in favor of biological control and away from the necessity of insecticidal treatment.

There is strong evidence that on avocados, insecticide treatment once initiated can upset the natural balance and develop into a condition of increased necessity for more chemical control applications. With very few exceptions the insecticides commonly used in experimental applications to avocados have shown greater toxicities to the natural enemies than to the pests themselves. This usually causes the pest to flare back unhindered by the retarding effect of natural enemies. Furthermore, some pests formerly of rare occurrence have increased to serious proportions due to the elimination of their natural enemies by insecticides.

These upsets resulting from the use of insecticides do not necessarily mean that insecticides should never be used on avocados. But a grower should weigh carefully the immediate emergency advantages of chemical control with the possible long-range danger involved in upsetting the balance between natural enemies and the potential pests.

If a fruit crop is seriously endangered and the decision must be made in favor of chemical control, the grower should choose judiciously from those materials which are recognized as less detrimental to natural enemies and make applications at dosages just high enough to save the crop. This may at times even mean choosing materials of only moderate insecticidal effectiveness or of using dosages which will merely partially reduce the infestations without attempting their complete elimination.

If the grower risks elimination of natural enemies for extensive periods of time, he may soon find himself with insecticide control measures calling for increasingly greater insecticide expenditures.

Some of the most commonly used materials on avocados are listed below in order of decreasing hazard to certain natural enemies as determined from standard laboratory tests. The relative hazards indicated are for the dosages specified and high dosages increase and lower dosages decrease the danger. The same principle applies to frequency of application of materials. In general, the list will permit the avocado grower to restrict usage of materials most likely to upset a favorable natural balance.

1. DDT, 50% wettable power	1½ lbs. per 100 gallons
2. DDD, 50% wettable powder	2 lbs. per 100 gallons
3. Dusting sulfur, 325 mesh	100 lbs. per acre
4. DN dust D-8	100 lbs. per acre
5. Cryolite	3 lbs. per 100 gallons
6. Nicotine sulphate solution 40%	¾ pt. per 100 gallons
7. Neotran, 40% wettable powder	1½ lbs. per 100 gallons
8. Ovotran, 50% wettable powder	1½ lbs. per 100 gallons
9. Aramite, 15% wettable powder	3 lbs. per 100 gallons
10. Zinc oxide	1 lb. per 100 gallons

In addition to the judicious use of insecticides the avocado grower should practice constant ant control. An abundance of ants can be as serious an upset to natural enemies as an insecticide. Ants may be attracted to only certain pests which secrete honeydew, but they are indiscriminate in their attacks on natural enemies. Hence latania scale may increase in the presence of ants even though it is of no direct interest to the ants.

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NEMATODES

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Growers should exercise every reasonable precaution against introducing plant parasitic nematodes into uninfested land. These should include measures to minimize the possibility of carrying infested soil into a clean area on equipment that might have previously been used on infested soil and the use of planting stock grown in nematode-free soil. The use of resistant rootstocks and soil fumigation is recommended if plantings are being made on land known to be infested with root-knot or root-lesion nematode.

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SCALE

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tis may destroy many scales that would have served as food and home for its progeny. But it can build up rapidly on a high population of scale hosts.

Physcus, on the contrary, is at a disadvantage on high host populations when its per cent of parasitization is low. Under such conditions, the unmated female has to search many purple scales to find a parasitic larva in which to lay its male eggs.

The economic value of *Aphytis* and *Physcus* should be apparent to the citrus grower in coastal areas within three or four years.

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