Nematodes - The Unseen Enemy in Orchards

Nematodes undoubtedly are the most numerous multicellular animals in the world. You can pick up a handful of soil almost anywhere and extract nematodes from it.

ARTICLES | UPDATED: OCTOBER 25, 2017

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Nematodes: The Unseen Enemy

Most kinds of nematodes escape notice, however,

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because they are so small that they cannot be seen without the aid of a microscope. Most soil-dwelling nematodes are of no concern to the gardener and are, in fact, a normal component of fertile soil. These innocuous nematodes feed on bacteria, fungi, algae, and even other nematodes. Some nematodes are parasitic on insects and higher animals. Others, however, are parasitic on higher plants and can present a serious problem in the home fruit garden. Because nematodes are out of sight and gradually multiply to damaging population levels, they have been referred to as the unseen enemy in agriculture.

Nematodes are threadlike roundworms that move about in the thin film of moisture surrounding soil particles and root surfaces. Although each species of nematode is unique and can be identified under the microscope on the basis of size, shape, and certain morphological characteristics, all plant-parasitic nematodes share one distinguishing feature: a stylet. The stylet is essentially a hollow spear, like a hypodermic needle, that the nematode uses to puncture cells and feed.

The symptoms of nematode infection are commonly those of root impairment, such as growth reduction, increased wilting, mineral deficiency symptoms, decreased winter hardiness, and dieback in perennials. Since many of these symptoms are not necessarily diagnostic of nematode disease, they might be confused for other biotic or abiotic problems. In some cases, additional fertilizer and/or water may temporarily mask the problem. In small plantings, nematode problems initially might escape notice unless a similar healthy plant is nearby for comparison. Nematodes contribute to a number of other disease problems as well.

Problems Caused by Plant-Parasitic Nematodes

Plant-parasitic nematodes vary in their feeding habits; each species causes a slightly different type of damage to the root. These differences are important because they affect the physiology and growth of the plant in different ways.

Loss of Vigor and Yield

One basic feature of nematode attack, however, is that nutrients and metabolic activities are diverted from normal, healthy growth and fruit production into sustaining the nematode population and repairing the wounds they cause. This is a chronic problem that continues throughout the growing season. All plants tolerate minor attacks by pathogens without a significant impact on vigor, but nematodes become a problem when the population level surpasses the damage threshold; at this point damage is measurable. Because of different feeding habits, reproductive potential, and other factors, the damage threshold is different for different species of nematode. The threshold for damage also will vary according to other variables such as plant age, size, nutritional status, moisture stress, and other disease problems.

Nematodes as Predisposing Agents

Research to determine the precise role of nematodes in plant decline has shown that feeding may have diverse effects on plant physiology. For example, it is clear that some nematodes may predispose fruit trees to other disease problems. Although very little is understood about how nematodes do this, some examples are well documented. Feeding by the ring nematode on peaches, for example, has been linked to increased susceptibility to bacterial canker, reduced winter hardiness, and the development of peach tree short life disease. Other research has shown that nematodes can make plants more susceptible to certain fungal pathogens such as verticillium wilt. The basis for predisposition presumably lies in the disruption of the normal hormonal balance of the root. More research is needed to understand the nature of this interaction.

Nematode-Related Replant Problems

Replanted fruit trees frequently have problems with reestablishment. The cause of these replant problems has been extremely difficult to pinpoint because of the abundance of microorganisms that have been isolated from replant sites. The available evidence indicates that replant disease results from an interaction between nematodes and various microflora. The nematode most frequently associated with this problem is the lesion nematode. The lesion nematode is very destructive; it burrows through the root as it feeds, leaving a trail of dead cells that appear as dark lesions. These wounds allow bacteria and fungi to enter the root. In older, well-established trees, a balance exists between new root growth and the activities of nematodes and microorganisms. When old trees are replaced with seedling trees, however, the balance is upset and the young trees cannot compete with the high populations of pathogens present.

Nematodes as Virus Vectors

Perhaps the most serious nematode-related problem with fruit production in the Cumberland-

Shenandoah region is the transmission of plant viruses. The tomato ringspot virus (TmRSV) and tobacco ringspot virus (TbRSV) are both vectored by common species of dagger nematodes (*Xiphinema* sp.). The nematode acquires the virus when it feeds on an infected plant, then transmits the virus when it feeds on a healthy plant. Figure 2.1 illustrates this exchange. Feeding by dagger nematodes is the only natural means of infection for these viruses. In the absence of dagger nematodes, the virus does not spread naturally from plant to plant. Because dagger nematodes transmit TmRSV, their damage threshold is much lower than that of a parasite that causes damage only by feeding. TmRSV causes serious disease problems in a number of different fruit crops, including peach, apple, plum, cherry, grape, raspberry, and blueberry. TmRSV infects many different plants, including most of the common broadleaf weeds. Good broadleaf weed control may be the most effective way of avoiding these virus problems. TmRSV can be spread in the seed of some weeds such as wind-blown dandelion seed.

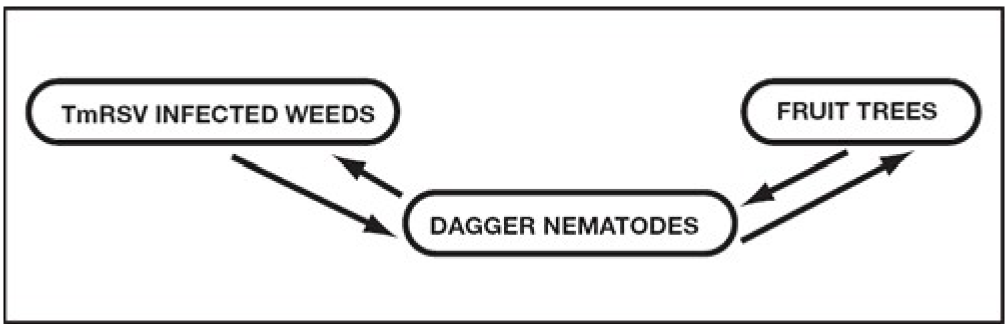

Figure 2.1 Tomato Ringspot Virus (TmRSV) transmission

Considerations Basic to Nematode Control

The first step in diagnosing a crop-production problem in which nematodes may be a factor is to collect and identify the nematodes that are present in the involved soil or plant material.

Accurate species identification is essential because of differences in nematode life habits, host ranges, and pathogenic effects on various host plants. Distribution data are also important for determining whether the nematodes are associated or coincident with the disease problem. Since nematode control is difficult in an established planting (this is especially true for perennial crops), the best approach is to assay for potential nematode problems before planting. If a potential problem exists, control measures will be easier to execute. The biology of the nematode, its ecological relationships, its methods of spread, the value of the host crop, and the cultural practices used in the particular area are important factors that must be considered in developing control measures.

Prevention of Spread

Plant-parasitic nematodes move only relatively short distances under their own power; therefore, the most usual means of nematode spread is the transportation of infested soil and infected plant parts by humans.

Sanitation and good cultural practices are the best preventive measures against nematodes. Obtain plants from reputable nurseries and wash soil from tools and machinery before using them at a new location. Nematodes also might be carried by wind, water, and animals. These methods of spread can be important under certain situations such as when water runs from an infested site.

Establishment in a new area occurs only when sufficient numbers of viable nematodes are transported to a location where susceptible hosts are subsequently planted and where the environment is suitable for reproduction of the nematode species.

Control of Nematode Populations

Although several chemicals that effectively control plant-parasitic nematodes are available, the chemical approach is generally not satisfactory for the home fruit grower. Chemical nematicides and fumigants are relatively expensive and require specialized equipment for application. In most cases, the cost and labor of application cannot be justified for a non-commercial planting. Instead, growers may use some of the control strategies given below.

Fallow

Fallow may be used as a preplant nematode control when nematode assay reports indicate a potential problem in the intended planting site. Fallow is the practice of keeping land free of all vegetation for varying periods of time by frequent disking, plowing, or harrowing of the soil, or by applying herbicides to prevent plant growth. At least two principles of nematode control are represented by fallow. The first principle, and perhaps the most important, is starvation of the nematode. Plant-parasitic nematodes are obligate parasites, which depend on living hosts for the food necessary to develop, mature, and reproduce. Therefore, in the absence of a host plant, the nematode will die after the stored food in its body has been depleted. Most plant-parasitic nematodes probably do not survive for more than 12 to 18 months, and many do not survive the first 6 months.

The second principle involved in fallow is death through desiccation and heat. With some exceptions, most species of nematodes will die if exposed to the drying action of the sun and wind. Sometimes, the term "fallow" is used to mean letting the plot go without a crop, but allowing a weed cover to develop to minimize soil erosion. This practice is not suitable for reducing nematode populations since the weeds may serve as hosts for the nematodes.

Cover Crops

Although no single crop will act as a "magic bullet" against all nematodes, specific problems may be controlled successfully in preplant situations by planting certain cover crops. Cover crops work for different reasons, depending upon the specific nematode-crop combination. In some cases, the cover crop may be a nonhost for the nematode. Since nematodes do not feed on plants outside of their host range, such plants will starve out the population with the same effect as fallow cultivation. Other plants are known to be susceptible to nematode invasion but prevent the development of larvae into adults. Such plants are referred to as "trap crops."

Crotalaria, for example, has been used successfully in this way to reduce populations of root-knot nematodes. Still other "antagonistic" plant species have been found to naturally exude chemicals toxic to nematodes. French marigolds and asparagus are examples of such crops. While antagonistic and trap crops have been used successfully to control nematodes, little is understood about the principles involved. Clearly, this is an area in which more research is needed.

Crop Rotation

The use of crop rotation to reduce nematode populations is a very effective and widely used land-management practice. This practice was used by growers long before its significance as a means of nematode control was recognized. To be an effective control practice, crops that are unfavorable, or nonhosts, for nematodes must be included in the rotation sequence. Although many people think of crop rotation as a short-term strategy against nematodes, some long-term crop rotations can be very effective for fruit production. For example, rotations of asparagus, raspberries, and Christmas trees might be an option.

Organic Manuring and Soil Amendments

In some instances, adding large amounts of organic materials to soil results in reduced populations of plant-parasitic nematodes and higher crop yields. The reduction in nematodes is thought to be caused, at least in part, by an increase in natural enemies of nematodes. In addition, the presence of decomposing organic materials in the soil apparently provides host plants with some tolerance to nematode attack. Decomposition products of organic matter and plant residues may also be detrimental, directly or indirectly, to plant-parasitic nematodes, as demonstrated by the butyric acid released by the decomposition of cover crops such as rye and timothy.

Other examples of green manure crops and soil amendments reportedly effective for reducing plant-parasitic nematodes include ground sesame stalks and crabmeal. Some research suggests that ammonia released by decomposition of these soil amendments might be the active killing agent. This theory has been supported by reduced nematode populations after incorporation of agricultural-grade urea in the soil.

Nutrition and General Care of the Host

The deleterious effects of nematode damage to certain crops can be offset to some degree by proper nutrition, moisture, and protection from adverse conditions such as cold that place plants under stress. Practices that tend to offset the damage caused by nematode attack include irrigation, conservation of moisture by mulching, fertilization, protection of plants on cold nights, and control of root and foliar diseases caused by other pathogens. It should be pointed out, however, that these are only delaying tactics, and if susceptible crops are grown continuously, the nematode population will reach proportions that will cause serious damage. The rapidity of disease development and the magnitude of the damage will depend on the host and nematode species involved, the resistance or tolerance of the host, and various factors in the environment that favor or deter development of the disease.

Some research has shown that soil population levels of several nematode species may be changed by host nutrition and, similarly, that disease development and severity are more pronounced in infected plants that are deficient in one or more essential nutrients. Nematode infection also has been found to cause an increase or decrease in the concentration of one or more minerals in leaf or root tissue. The interactions among host, parasite, and nutrition are complex, and the application of such information to fertilization programs designed to minimize crop plant nematode damage is just beginning.

Sanitation and Nematode-Free Planting Stock

The land-management and cultural practices discussed above reduce nematode populations in plots to varying degrees. Most of these measures have limitations; the degree of control is erratic; and sometimes those factors actually responsible for the reduction in nematode populations are not fully understood. Sanitation and the use of nematode free planting stock, however, are sure and effective means of nematode control.

The cost of these practices is small, yet many growers continue to use nematode-infected transplants. Although pathogenic nematodes are already widespread, indiscriminate use of nematode-infected plants and plant parts introduces new species into many fields and consequently complicates control measures. Furthermore, nematodes introduced in this manner are in a favorable position for survival since they are already in or close to host plant tissues.