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Plant Parasitic Nematodes

The true significance of plant parasitic nematodes in Minnesota and most of the Upper Midwest was largely undefined and overlooked until the early 1970's. About that time, as the result of carefully conducted tests, researchers began to show that these organisms were reducing corn and potato yields and were predisposing potatoes and other crops to the actions of other plant pathogenic microorganisms. Prior to the early 1970's, plant parasitic nematodes were known to be responsible for the failure of replanted fruit trees to grow normally in Michigan and for carrots and other root vegetables to fork or be otherwise distorted. Undoubtedly, as further research is completed and new types of plant parasitic nematodes unfortunately are introduced into this area, the recognized significance of these parasites and pathogens will continue to grow.

Characteristics of Plant Parasitic Nematodes

Plant parasitic nematodes are nearly microscopic, non-segmented roundworms usually only 300 to 1500 microns (0.01 to 0.06 inch) long. The body diameter of most forms present in Minnesota generally does not exceed 30 to 40 microns. Because of their small size they have been and are easy to overlook. Even today, much of what we know about the body structure of the plant parasitic forms was derived by inference from studies on the larger, more conspicuous animal parasitic forms such as the hookworm.

Plant parasitic nematodes are obligate parasites that derive all of their required nutrients from the living cells of higher plants. All plant parasitic nematodes have a protrusible stylet or mouth spear, only a few microns in diameter, that is used by the organism to puncture plant cell walls and in feeding. The average plant parasitic nematode can complete its life cycle in about 30 days; less than 30 during the warmest part of summer and more during spring or late fall. Certain kinds of plant parasitic nematodes, especially the dagger nematode (*Xiphinema americanum*) may require 1 or more years to complete its cycle. The mature female can lay between 30 to 500 or more eggs. These eggs are the most resistant form of some nematodes, although others appear to survive Minnesota winters most readily as adult females or second stage juveniles.

Habitat

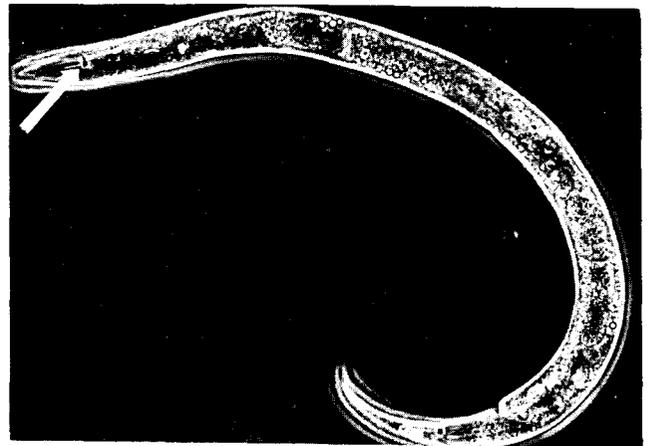
With the exception of organic soils present in recently drained former bogs or swamps, all Minnesota soils in which higher plants can grow contain at least a few plant parasitic nematodes. Although a certain kind of plant parasitic nematode can be found in the submerged roots of wild rice, the vast majority of plant nematodes will not survive a prolonged exposure in flooded soils. Lighter soils, sandy loams for example, because of their good drainage and aeration and their tendency to warm up rapidly in the spring, are particularly favorable for plant nematodes. Because of their wide distribution in Minnesota soils, all soils should be considered "suspect" and a garden soil, unless heat-treated or freed of plant parasitic nematodes in some other way, should not be used as a potting medium for house plants or other ornamentals.

Some nematodes, which may be present in the soil during only part of the year, must live within plant tissues to complete their development. Some of these remain wormlike, capable of moving between and through plant cells. Others find a specific feeding site, usually within the vascular tissue of the root, enlarge, and become immobile. Of these, the root-knot nematode tends to cause a gall or "knot" of plant tissue to develop. Because of this host overgrowth, the nematode, although enlarged, remains within the plant tissue. The other type of sedentary nematode present in Minnesota, the cyst nematode, does not stimulate such an overgrowth and, as a result, eventually ruptures the host tissue as its body becomes enlarged and saccate in shape.

In addition to those nematodes that live in the soil and those that live within plant roots, foliar nematodes occasionally are found in Minnesota. These nematodes, which move up plant stems during wet periods and enter the leaves of plants like begonia and chrysanthemums, are different from the majority of plant parasitic nematodes because they can survive in dry, dead leaves. Dessication is usually fatal to most other types of plant parasitic nematodes, except while they are in the egg stage.

How Are Plant Parasitic Nematodes Spread?

Plant parasitic nematodes cannot move very far very fast. For example, the size of an infestation of a very damaging nematode was shown in Florida to enlarge horizontally through light, sandy soil at the rate of only about 21 cm (8½ inches) per month. Although nematodes can be carried passively by wind and waters, these methods of spread do not appear to be nearly as important in Minnesota as the movement of nematodes by humans. Nematodes can be readily carried in soil and on and in plant parts. Infected seed is not an important means



The female *Paratylenchus homatus* is 0.35 to 0.40 mm (.014 to .016 inch) long. Nematodes belonging to this genus are probably the most common, although not the most damaging, of the 10 to 12 genera of plant parasitic nematodes present in Minnesota soils. The internal stylet or spear (see arrow) is used in feeding and can protrude to puncture plant roots.

by which nematodes are spread although seed lots may be contaminated, as in the case of the soybean cyst nematode, by small balls ("peds") of soil containing nematodes. Since only a few states have active programs for controlling the spread and introduction of plant parasitic nematodes, most nursery-grown plants are infested or infected with at least a few of these organisms. Since plant parasitic nematodes can survive for at least several months in soil without a plant host, used farm equipment should not be brought into Minnesota unless it previously has been thoroughly cleaned. Once a new nematode is introduced in this manner, there is a good possibility that, unless rather drastic measures are taken, the soil will remain infested with that organism indefinitely.

Why Are Plant Parasitic Nematodes Important?

Although plant parasitic nematodes are small, they do have one or more glands that produce substances which, we believe, when introduced into plant cells can cause a number of different effects ranging from a cessation of normal root growth, to abnormal cell enlargement and division, to the death of parasitized and adjacent cells. In addition, waste products excreted by the nematode may cause the same kinds of effects. The majority of nematodes found in Minnesota tend to feed rather superficially on the epidermal and cortical cells of feeder roots. The significance of these nematodes is, at present, often unknown. As mentioned before, several different types of nematodes will invariably enter plant roots. Nematodes of this type with common and descriptive names like "lesion," "root knot," and "cyst" are quite common in Minnesota where they can cause significant losses. These nematodes move through and between root cells causing mechanical and biochemical alteration and damage and often the death of those cells. In addition, the host tissues are altered in such a manner that other pathogens, the fungus that causes Verticillium wilt of potatoes for example, can attack the plant sooner or more severely than that pathogen could if the nematodes were not present.

When Are Plant Parasitic Nematodes Important?

Nematodes that deform plant tissues, the root-knot nematode on carrots for example, and nematodes that interact with other pathogens like fungi are likely to be a problem in a given soil every year a susceptible crop is grown. The effects of nematodes that restrict plant root systems will vary in severity from year to year depending upon the environment. During a year when plant growth is not restricted by lack of moisture or other environmental factors, the effects of these nematodes may be minimal. However, when high temperature and lack of moisture put crop plants under stress, the root rots caused by plant parasitic nematodes may reduce crop yields by 10 to 20 percent or more. Although nematologists have historically expected nematode-caused problems to be most severe on perennial plants growing in light soils, accumulating evidence suggests that nematodes are important on annual crops even in the heavier soils of southern and southwestern Minnesota.

How Can Nematodes Be Controlled?

As stated earlier, since nematodes are very difficult to eliminate it is far better to try to prevent their introduction than to try to cope with them later. In the majority of cases, however, the nematodes are already established. Control of such nematodes often can be achieved by crop rotation and use of chemicals.

Crop rotation is a valuable technique for controlling, or at least minimizing, diseases caused by a variety of soil-inhabiting pathogens like nematodes. Incorporating organic matter

and disturbing the soil while preparing the soil for a new and different crop both will tend to reduce nematode populations somewhat. Although many species of nematodes have very wide host ranges, some apparently cannot reproduce on soybeans, others don't reproduce to any extent on wheat, etc. Unfortunately, however, there seem to be some limitations in addition to the more obvious economic and crop preference restrictions that reduce the usefulness of this practice. Certain kinds of nematodes build up on the roots of one crop, overwinter to attack and destroy many of the roots of the next crop even though the nematodes may not be able to reproduce on that crop. Thus, although the rotation will reduce the size of the nematode population, the young plants of the "non-host" crop may be severely damaged.

The use of halogenated hydrocarbon-type fumigants to destroy 90 to 95 percent of the nematodes in a soil prior to planting the crop has not been as widely accepted in Minnesota as it has in other parts of this country. Time, soil temperature, and cost considerations seriously limit the usefulness of many of these chemicals in cooler areas with a relatively short growing season.

Granular and, to a lesser extent, liquid formulations of insecticides-nematicides are increasingly being registered for use in Minnesota. These materials are applied in the furrow or banded and lightly incorporated in the soil using equipment that is readily available on most Minnesota farms. Usually the application rates necessary to kill nematodes are two to three times those required to control insects. In some cases control has been as complete as that obtained with the use of halogenated hydrocarbons (90 to 95 percent reduction in population).

Since the effects attributable to plant parasitic nematodes are often not specific (a decline in vigor, reduction in yield, tendency to wilt) and the cost of applying even the granular nematicides to a large acreage is definitely appreciable, it is strongly recommended that soil samples be collected and processed for plant parasitic nematodes before any chemicals or other control practices are initiated. Consult Department of Plant Pathology form PL-16 for information about the collection of samples and submission of these samples for processing by the Plant Nematology Laboratory.

Other methods of control less applicable under Minnesota conditions but which may be useful in certain circumstances can be suggested by personnel of the Plant Nematology Laboratory or the Plant Disease Clinic, Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

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