**Effect of nematode Meloidogyne incognita on soil borne diseases**

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In understanding the effect of nematode Meloidogyne incognita on soil borne disease, we have to understand the meaning of some terminologies. They include:

Nematodes

They are any unsegmented worm of the phylum Nematode, having an elongated, cylindrical body; a roundworm. They are common soil pests that affect plants. The aboveground symptoms of disease caused by nematodes can be difficult to detect, and may be often confused with symptoms of nutrient deficiency. Typically, plants do not thrive, are paler than normal, and may wilt in the heat of the day. Affected plants are often dwarfed, with small leaves. Sometimes, when infected plants are growing in moist, fertile soil, or during cool weather, the aboveground parts can still appear healthy They include pest nematodes like the root knot nematode which invades the roots and causes them to form gall-like lesions that restrict water and nutrient uptake which causes wilting. Nematodes are also susceptible to death from harsh environmental changes, like temperature and water availability. Some, not all, types of nematodes can enter into a state of metabolic inactivity (sort of a suspended animation) during these times of environmental stress. If they can do this, they can often survive for years waiting for more favorable conditions to trigger their revival. Some nematodes move similar to snakes. However, most can move no farther than a meter or so within their lifetimes. The spread of nematodes from field to field usually involves farm equipment, contaminated plants or seeds, soil or mud transferred on the feet of people or animals, or surface water movement. Various nematodes feed on all plant parts: roots, stems, leaves, flowers and seeds. They specialize in the use of their stylet, depending on their style of feeding. Most plant parasitic nematodes are root feeders and live in the soil

Types of nematodes

There are numerous soil-inhabiting nematode species, but not all are harmful to plants. Within this group, some nematodes spend their life within the plant roots. These are endoparasitic. Others are ectoparasitic, and only their stylets (hollow spears used to puncture roots) enter the plant to extract nutrients from the roots or root cells. Plant-parasitic nematodes have many hosts and are seldom plant-specific.

* Root knot nematodes

Root knot nematodes (Meloidogyne) are the most damaging species in the home garden. These nematodes have a very wide host range, affecting more than 2000 plant species worldwide. Root knot nematodes enter the roots as larvae, causing the plant roots to form galls or knots, and there may be excessive root branching. Underground organs such as potato tubers or carrot taproots may be damaged and become unmarketable. The nematode larvae mature in the roots, where they mate. The female adults enlarge, remain in the roots, and lay eggs into an egg sac that exudes into the soil. The eggs hatch and the young larvae go on to infect more roots.

Plants are damaged because the galls or root knots block the transport of water and nutrients through the plant. Nematode feeding sites in the roots can also provide entrance for other disease-causing organisms, like fungi or bacteria, leading to increased plant damage. Nematodes are a greater problem where conditions favour them, such as a long growing season, sandy soil and if plants are under water or nutrient stresses.

* Root lesion nematodes

Although they are present in home gardens, where they can affect fruit trees, roses and turf, root lesion nematodes (Pratylenchus) are more damaging to broad-acre crops like cereals. Root lesion nematodes use the stylet to puncture roots and enter the cells. They move through the root, piercing cells, extracting cell contents, and leaving behind a trail of both cell-killing metabolites and eggs. Root cell death results in browning and lesioning of the roots. These lesions can rapidly coalesce, resulting in browning of whole roots. Individual lesions may fully encircle a root. These nematodes also damage feeder roots and root hairs, further reducing a plant’s effective extraction of water and nutrients from the soil. The overall effect is a weak, shallow root system with many dead or dying areas. When the soil dries out, root lesion nematodes become inactive and survive in a dry form in the soil or in root tissue of old crops. As the soil moistens, the nematodes become active again and reinfect the fresh roots of the new crop.

Soil borne diseases

Of all the problems plants are susceptible to; soil-borne diseases can be the most frustrating. The gardener can think they are doing everything right and yet their plants become sickly, stunted and near death. Soil-borne diseases are caused by microorganisms that survive and move about in the soil. Most cannot be seen by the eye and go undetected until the plant becomes ill. In the case of soil-borne diseases, the pathogens can remain in the soil for long periods, waiting for the host - our plants - to come along. The environmental conditions can vary widely. Some pathogens favor damp conditions, some like certain soil pH levels and others target tender, succulent growth. While some pathogens are short term visitors, appearing when the host and conditions are just right, others are naturally found in the soil and persist for years. When their favorite plant is not available, they may turn to an alternative. Many plant diseases have similar symptoms, like yellowing leaves or dark spots. It is important to try and finds signs of the actual pathogen, but these are not usually visible without magnification. If you are having a longstanding problem, it would be worth your time to take a sample into your local Cooperative Extension.

Types of soil borne diseases

Here are the common types of soil-borne pathogens:

* **Fungi** - the most common soil-borne pathogens. However, not every fungus causes plant problems and while the vast majority does not, over 8,000 fungi species do. And most plants are susceptible to some type of fungus.
* **Bacteria** - less common pathogens (and most don't stick around long). Some examples: Erwinia (soft rot), Rhizomonas (corky root of lettuce) Streptomyces (potato scab, soft rot)
* **Viruses** - rare, thankfully, and most require living plant tissue to survive, but they can also hitch a ride on fungi or nematodes and flow in on water. When a virus enters a plant cell, it can cause the cell to produce more virus cells. Lettuce necrotic stunt virus affects Romaine lettuce plants, causing stunting and yellowing and sometimes spotting of lower leaves, while newer leaves remain green and thick.
* **Nematodes** - sometimes called roundworms, nematodes are unsegmented worms with round bodies and points at both ends. Some are parasitic, like the nematodes sold to feed on beetle larvae in the lawn. And some will feed on or in roots. This is especially problematic for root crops, like carrots. Root rot nematodes are probably the most familiar. They cause distortion and swelling of roots and can affect the plant's vigor. Needle nematodes feed on the tips of roots, causing branching and swelling. And stubby root nematodes caused - yes - short, stubby roots.

Nematode Meloidogyne incognita

Meloidogyne incognita (root-knot nematode), also known as the "southern root-nematode" or "cotton root-knot nematode" is a plant-parasitic roundworm in the family Heteroderidae . This nematode is one of the four commonest species worldwide and has numerous hosts. It typically incites large, usually irregular galls on roots as a result of parasitism. Meloidogyne incognita is probably the most economically important plant-parasitic nematode species among the tropical and subtropical regions. This nematode is extremely polyphagous, attacking both monocotyledons and dicotyledons. It is estimated that more than 3,000 plant species can be affected.

Now that the important terminologies have been explained, let’s see the effect of nematode Meloidogyne incognita on soil borne diseases.

Most plant parasitic nematodes are soilborne root pathogens, but a few species feed primarily upon shoot tissues. The root-knot nematode (Meloidogyne spp.) comprises over 100 species, with Meloidogyne javanica, Meloidogyne arenaria, Meloidogyne hapla, and Meloidogyne incognita representing the most devastating threat to agricultural crop production. The Meloidogyne spp. are globally distributed, have enormous host range and develop dynamic disease complexes with fungal species and bacteria which may exacerbate disease incidences in cultivated plants.

Nematodes Meloidogyne incognita feed on all parts of the plant, including roots, stems, leaves, flowers and seeds. Nematodes feed from plants in a variety of ways, but all use a specialized spear called a stylet. The size and shape of the stylet is used to classify nematodes and also can be used to infer their mode of feeding. Often nematodes withdraw the contents of plant cells, killing them. When this type of feeding occurs, large lesions are formed in the plant tissue. Some nematodes do not kill the plant cells they feed upon but “trick” the plant cells to enlarge and grow, thus producing one or more nutrient-rich feeding cells for the nematode. These feeding cells enable long term feeding associations, and form by repeated nuclear division in the absence of cell division (giant cells) or by the incorporation of adjacent cells into a syncytium formed by the breakdown of neighboring cell walls. Collectively, nematodes can feed on almost any plant cell type, and form a variety of feeding cell types. Many plant-parasitic nematodes feed on the roots of plants. The feeding process damages the plant's root system and reduces the plant's ability to absorb water and nutrients. Typical nematode damage symptoms are a reduction of root mass, a distortion of root structure and/or enlargement of the roots. Nematode damage of the plant's root system also provides an opportunity for other plant pathogens to invade the root and thus further weakens the plant. Direct damage to plant tissues by shoot-feeding nematodes includes reduced vigor, distortion of plant parts, and death of infected tissues depending upon the nematode species.

The aboveground symptoms of nematode damage to roots are relatively nondescript, including nutrient deficiency, incipient wilt, stunting, poor yield and sometimes plant death. Few diagnostic signs and symptoms of plant damage by nematodes exist except root galls, cysts, "nematode wool," and seed galls. Thus, damage to crops by root-infesting nematodes often goes unnoticed by growers. Field patterns of nematode damage to roots begin in a small area and spreads radially from the initial infection site, often assisted by farm equipment.

Effects of the different life stages of nematode Meloidogyne incognita on soil borne diseases.

The lifecycle of Meloidogyne spp. involves four developmental stages including larval stage 1 (within the egg), larval stage 2 (migratory), larval stage juvenile 3 (sedentary), larval stage 4 (sedentary) and adult stage (sedentary). Under favorable environmental conditions, first stage moulting to J1 larval stage within the egg occurs resulting in hatching, with or without the presence of a chemical stimulus. Infective second-stage juveniles (J2s) are often attracted to root exudates and migrate to root tips where they infiltrate behind the root cap at the elongation zone. Root knot nematodes attenuate plant cells by stylet thrusting and secrete cell wall degrading enzymes to separate the middle lamella during intercellular migration through root cortex cells as they target the undifferentiated procambium cells of the vascular cylinder. During later stages in primary infection, dorsal gland activity increases to promote shuttling of secretory granules to the stylet where proteinaceous secretions are released in the development of the primary feeding site—the giant cell. The multi-nucleated giant cell is a result of nematode-induced end reduplication within the host cell in the absence of cytokinesis. Cellular ingrowths arise to sequester solutes from the xylem further enhancing nutrient availability. J2 larvae moult into larval stage 3 (J3) during the initial intake of plant nutrients from giant cells. Additional moulting occurs resulting into the J4 and final adult stage. Further reproductive development in females results in the characteristic “apple” shape associated with the Greek nomenclature Meloidogyne. The lifecycle completes when eggs are released into the soil from the gelatinous egg matrix formed on epidermal root tissue. Root-knot nematode infection is typically characterized by stunted growth, wilting, root galling and abnormalities in root formation.

Control of Root knot nematodes (Meloidogyne)

There are four main tactics used to control root knot nematodes (Meloidogyne): biological, cultural, chemical and genetic.

Biological control includes use of natural predators or pathogens or introducing those organisms. Biological control of nematodes is generally much more effective in the laboratory than the field.

Cultural control consists mostly of crop rotation with non-host plants. This is a very effective method to limit nematode population growth and can reduce nematode levels below damage threshold in the years when non-host crops are grown. However, some nematodes, such as root-lesion, are difficult to manage using crop rotation due to their wide host ranges.

Chemical control consists of economically viable products that kill nematodes in soil. Fumigants and liquid or solid non-fumigants are available. Most fumigants have been banned by EPA because of environmental hazards, but a few are still available. The non-fumigant nematicides work similarly to insecticides. These products can reduce nematode populations, but are not as effective as fumigants. Because of the expense of nematicide use, they are practical only on high-value crops.

Genetic control typically consists of using resistant varieties.

Conclusion

Root knot nematodes (Meloidogyne) are the most damaging species in the home garden. These nematodes have a very wide host range, affecting more than 2000 plant species worldwide. Root knot nematodes enter the roots as larvae, causing the plant roots to form galls or knots, and there may be excessive root branching. The root-knot nematode (Meloidogyne spp.) comprises over 100 species, with Meloidogyne javanica, Meloidogyne arenaria, Meloidogyne hapla, and Meloidogyne incognita representing the most devastating threat to agricultural crop production. The lifecycle of Meloidogyne spp. involves four developmental stages including larval stage 1 (within the egg), larval stage 2 (migratory), larval stage juvenile 3 (sedentary), larval stage 4 (sedentary) and adult stage (sedentary). Nematodes Meloidogyne incognita feed on all parts of the plant, including roots, stems, leaves, flowers and seeds. Nematodes feed from plants in a variety of ways, but all use a specialized spear called a stylet. The size and shape of the stylet is used to classify nematodes and also can be used to infer their mode of feeding. Often nematodes withdraw the contents of plant cells, killing them.

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