Non-Chemical Control of Plant Diseases in the Home Garden

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Plants are considered diseased when they do not grow and develop normally. The cause of such a condition may result from infection by disease-causing organisms or from environmental factors. Organisms known to cause disease are bacteria, fungi, nematodes, viruses, phytoplasmas and parasitic seed plants. Examples of environmental disorders are air pollution, poor soil, excessive heat, low or excessive nutrition, and drought.

When organisms cause disease, it is usually due to a parasitic relationship with a host plant. The parasite, or causal organism, is called a pathogen. The interaction between host and pathogen results in disease. **This discussion is limited to diseases where a pathogen is involved.** Most plant problems arising from environmental conditions are covered under such topics as fertilization, water management and other cultural procedures.

Prevention is the best approach to plant disease control when using either chemical or non-chemical (organic) methods. Prevention may involve suppressing the disease agent or avoiding the disease. Utilizing as many disease-preventative practices as possible will ensure the best possible control. Many of the following practices aid in controlling many different disease problems that arise. Examples regarding ways they have been used are given where clarification is needed. "Root Knot Nematode Control" is covered below. Also, refer to sections on "**Cultural Practices for Disease Control** " and discussions on disease for specific plants.

Suppressing the Disease Agent

Rotation: Vegetables in the same family group are more likely to be susceptible to the same soil-borne diseases. Cantaloupes and watermelons, for example, have common diseases. If they follow each other in a rotation, a disease organism may be limited on the first crop but sustain enough carry-over in the soil to cause severe loss on the following crop. Vegetables from different family groups should be rotated because they are usually not susceptible to the same disease organisms. The groups listed below should be rotated so a selection from one group is not planted in the same location more than once every 2 to 3 years. Limited garden space may prevent an ideal rotation system.

Table 1: Crop Grouping for rotation to control soil-borne diseases

Group A	Group B	Group C	Group D	Group E	Group F

Cantaloupe, Cucumber, Honeydew Melon, Pumpkin, Squash, Watermelon.	Brussels Sprouts, Cabbage, Cauliflower, Collards, Lettuce, Mustard, Radish, Rutabaga, Spinach, Swiss Chard, Turnip.	Eggplant, Irish Potato, Okra, Pepper, Tomato.	Beet, Carrot, Garlic, Onion, Shallot, Sweet Potato.	Sweet Corn	Bean, Cowpea, Pea.

Organic Matter: Organic matter increases the number and kind of microorganisms in the soil. Many of these microorganisms compete with disease agents for nourishment. In most cases, the best organic matter is obtained by turning under a green cover crop, such as a small grain (wheat, oats, barley, cereal rye) or a legume.

Resistant Varieties: Agricultural scientists have made great strides in developing disease-resistant varieties. Resistance, however, is a relative term and does not indicate immunity. For example, a tomato plant resistant to Fusarium wilt may develop wilt if stressed but not become diseased to the degree that a susceptible variety might. Resistance could be expressed as slower disease development which allows resistant plants to produce an acceptable yield before or without losing vigor to disease attack.

Sanitation: Any crop residue destruction practice that reduces the disease agent's ability to reproduce or overseason could be included under sanitation. Examples are raking and burning diseased leaves and disposing of infected fruit. Root knot nematode-infested plants should be dug and as much of the root system as possible removed from the garden site. Root knot nematodes are harder to kill when protected by root tissue. Diseased leaves, fruits, and other plant parts should not be piled near the garden. Fungi, for instance, often produce thousands of spores in the reproductive process, and these spores can be wind-blown great distances. Diseased plant tissue should be buried, burned, or disposed of in some other way that prevents the dispersal of the disease agent. In most cases, it is best not to put diseased plant parts in a compost pile. This is especially true for nematode-infected plants. Although many disease organisms are destroyed by heat during composting, 100 percent kill is not normally obtained. Contaminated compost will only serve to spread disease organisms as the compost is being used. Compost for the garden could be made with grass clippings or shrubs and tree leaves, as the disease organisms on grass and leaves are not likely to affect garden plants.

Heat Treatment: Heating small amounts of soil is practical for potted plants and for growing seedling transplants. The soil should be moist but not saturated. Heat the soil at 180^{O}F for approximately 3 hours in a standard oven. An average-sized Irish potato placed in the middle of the soil can act as an indicator. When it is cooked, the soil should be sterile. Microwave ovens have also been used for sterilizing small quantities. Using high power, heat the soil for 3 minutes. Do not overheat using either system. Excessive heating will release certain elements in the soil to toxic levels. A new heating approach called solar pasteurization or solarization was developed in Israel. It simply consists of covering well tilled, moist soil with clear plastic, sealing the edges, and leaving it for several weeks. Black plastic should not be used because soil heating will not be as great as heating under clear plastic. The best results are with fungi, principally those causing root rots.

Certain weeds and nematodes are also controlled but not on a consistent basis. Solar pasteurization will work best during the hottest months. August should be ideal for home garden sites. For best results leave soil covered 30 days.

Fallowing: Leaving land idle and clean through the growing season will reduce disease agents in the soil. Fallowing is especially helpful if done in the summer months when soil temperatures are high. Frequent plowing will keep the soil dry and free of plant growth and expose soil-borne disease organisms, such as nematodes, to killing heat and excessive drying. Other benefits of fallowing are weed and insect control. This practice is most efficient if rainfall is low and temperatures are high.

Weed Control: Weeds harbor insects and serve as hosts for many virus diseases. For most viruses to survive they must remain in a living organism whether it be a host plant or insect. Destroying weeds in and around the garden may eliminate potential overwintering host plants.

Avoiding Disease

Change Planting Date: Some diseases can be controlled by changing the planting date. Spring-planted squash usually escapes mosaic virus, whereas fall-planted squash does not. Warm-season vegetables, like peas and okra, should be planted after soils warm sufficiently to avoid seedling disease.
Obtain Disease-Free Planting Stock: It is advisable to check transplants such as cabbage, tomatoes, peppers, and others for root knot nematode galls. Certified Irish seed potatoes are less likely to harbor a disease such as black leg. Some disease agents are seed transmitted; thus, only the best seed should be planted.
Cultural practices:

- **Select the best site:** Choose a site with deep, well drained soil.
- **Plant on raised beds:** Raised beds improve drainage. They also warm up faster than level soil which aids in faster emergence. Slow emergence increases chances of seedling disease.
- **Use proper plant spacing:** Crowded plants reduce air circulation which enhances leaf spot diseases. Septoria leaf spot on tomato is an example. However, in Far West Texas, with low humidity and few leaf spot diseases, crowding tomato plants may reduce losses to curly top virus by shading the plants and making them less attractive to the insect vector.
- **Overplant:** Overplanting where possible will ensure enough production if some plants or fruit are lost to disease.
- **Proper fertilization:** Plants receiving all needed nutrients may resist some of the less vigorous disease- causing organisms.
- **Do not overwater:** Excessively wet conditions increase soil-borne fungal diseases like root rots and wilts.
- **Avoid overhead irrigation:** Leaf spot diseases develop rapidly when leaves are moist.
- **Do not prune roots:** Roots cut while cultivating reduce plant vigor and leave openings for root rot and wilt fungi to enter.

Root Knot Nematode Control

No doubt many gardens have become infested by planting contaminated transplants or by bringing in topsoil harboring root knot nematodes. Taking steps to prevent this problem is just as important as implementing the steps to control this once it has become a problem. Where soils are already infested and a garden is first put into production, nematode levels are generally low. After several years of gardening and growing susceptible plants, the nematode population increases to the point that damage becomes unacceptable. Control practices that can be used are summer fallowing, rotation, adding organic matter, planting trap crops, removing diseased plants, and using resistant varieties. All these control measures are designed to reduce the nematode population in the soil. The benefits of summer fallowing have already been discussed. Removing all potential hosts and keeping the soil dry will reduce the nematode population, as the nematode requires a moist environment for survival. Additional years of fallowing will further reduce the nematode population.

Rotation with non-hosts or poor hosts of the root knot nematode is also another means of reducing the population. Sweet corn is a poor host and is good to use in a rotation, especially in an area where root knot has done severe damage. Onions, garlic, asparagus, and shallots are also poor hosts. Cool-season crops such as cabbage, Irish potatoes, greens (turnips), radishes, and broccoli are less likely to suffer yield loss from root knot nematodes. Even though these are susceptible plants, they grow best in the cooler time of the year which is not favorable for root knot nematode development.

High soil organic matter alone will not ensure root knot nematode control. The higher the organic matter, however, the better the chance that antagonistic organisms will develop. There are soil fungi that trap nematodes and utilize them as a food source. Some organic matter tends to work better than others. Turning under a green manure crop such as small grains or legumes several weeks before planting has shown to be the best. Additional nitrogen may be necessary for adequate crop production because decay organisms in the soil will utilize available nitrogen as they break down the green manure crop.

Sometimes people resort to using home remedies to control nematodes such as planting marigolds or mixing sugar or lye into the soil. Of these three, only French marigolds are effective in controlling nematode populations, and their effectiveness has limitations and is often questionable.

Some people think that marigolds secrete a toxic substance into the soil that kills nematodes and that planting a few marigolds around annual plants in infested soil will prevent infection. This is not true. Marigolds primarily act as a trap crop. Nematodes are able to enter their roots but are unable to complete their life cycle. The trapped nematodes die without reproducing.

The type of marigold is also important. French marigolds, Tagetes patula, are more effective in controlling root knot nematodes than the African marigold, Tagetes erecta, which is also referred to as the American, Big, or Aztec marigold. To be effective, marigolds must be planted as a solid crop and grown for 90 to 120 days to effectively reduce the nematode population sufficiently to grow annual plants without treatment. Marigolds should be planted in rows no further than seven inches between each plant, so that the roots penetrate the entire soil mass to trap as many nematodes as possible. If marigolds are planted close together, they form a dense canopy which helps retard the development of weeds and grasses. Many weeds and grasses serve as hosts for root knot nematodes. If the weeds are not controlled, the marigolds may be unable to suppress the nematode population.

Using marigolds in a manner other than that recommended can invite disaster. For example, planting a few marigolds here and there among tomatoes will encourage spider mites. The spider mite is one of the most difficult garden pests to control and can become nearly as serious a problem as the nematodes.

All nematode-infected plants should be removed from the garden as soon after production ceases as possible. Removing the root systems will eliminate many of the nematodes. To ensure that as much of the root system as possible is removed, use a shovel rather than just pulling the planting up by the stem.

Root knot resistant vegetable varieties are not plentiful. Fortunately, progress has been made in the development of root knot resistant tomatoes. The best resistance is found in the hybrid varieties that have been developed in recent years. Root knot resistant varieties are noted in seed catalogs by “N” following the variety name. Preceding the “N” are often “V” and “F.” “VFN” stands for verticillium wilt resistance, fusarium wilt resistance, and nematode resistance. Hybrid tomato seed is more expensive than open-pollinated seed, but the benefits in disease resistance alone are enough to make it worth buying.

Diseases caused by root knot nematodes and other organisms can be prevented with non-chemical methods that either avoid the disease or suppress the disease agent. However, maximum control can only be assured by utilizing as many of these disease preventive practices as possible.