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# IDENTIFICATION AND MANAGEMENT OF SOILBORNE DISEASES OF TOMATO

HYG-3314 Agriculture and Natural Resources Date: 12/04/2017

#### Anna L. Testen and Sally A. Miller

Growers who have grown tomatoes in a single location for several years may notice stunting, yellowing and reduced yields. These symptoms may indicate soilborne diseases. Soilborne disease complexes, composed of two or more soilborne pathogens, may reduce yield and quality of tomato crops, particularly in long-term protected culture production. Soilborne disease complexes consisting of Verticillium wilt, Fusarium wilt, corky root rot, black dot root rot, and root knot nematodes are present in tomato production operations in Ohio. Other soilborne diseases that may be present are Rhizoctonia root rot, Pythium root rot and Sclerotinia white mold.

#### Symptoms

**Verticillium wilt:** Distinctive V-shaped lesions form on the edges of leaves, with V-shaped dead tissue surrounded by a yellow halo (Figure 1). Plants wilt and have yellowing and dieback. Plants may wilt during the day and recover overnight. The inside of the stem has brown discoloration (Figure 2).



Figure 1. V-shaped necrosis and yellowing of leaves characteristic of Verticillium wilt.







Figure 2. Vascular discoloration of tomato plants consistent with Fusarium wilt or Verticillium wilt.

Figure 3. Tomato plant with Fusarium wilt. Note the yellow discoloration on one half of the plant.

**Fusarium wilt:** Plants have yellowing, dieback and wilting. Sometimes only half a leaf or leaves on only one half of the plant turn yellow and die (Figure 3). The inside of the stem has brown discoloration near the soil line and discoloration may continue up the stem (Figure 2). Roots may look brown and rotten. Fusarium wilt can be distinguished from Fusarium crown rot (*F. oxysporum* f. sp. *radicis-lycopersici*), in that discoloration in crown rot remains limited to the lower portion of the stem.

**Corky root rot:** Plants may appear slightly yellow and have weakened growth. Roots appear to be dry, brown and cracked, and have a similar appearance to tree bark. Cracked areas usually occur in distinctive bands and may be swollen (Figures 4 and 5). Dark brown cracking may occur on the crown and taproot of the plant.



Figure 4. Roots with severe case of corky root rot. Note the cracked, corky, bark-like roots.



Figure 5. Characteristic banding pattern of corky root rot.

**Black dot root rot:** Roots are discolored, usually a honey-brown to grayish-brown, and are speckled with black dots (Figure 6).



Figure 6. Roots with sclerotia of Colletotrichum coccodes, the causal agent of black dot root rot. The honeybrown discoloration is also characteristic of this disease.

**Root knot nematodes:** Roots are misshapen with small to large galls (Figure 7). Galls may range in size from pin-head sized to finger-sized. Golden-brown dots (egg masses) may appear on the outside of galls. Plants may appear stunted and weak.



Figure 7. Tomato roots with severe root knot nematode galling.

**Rhizoctonia and Pythium root rots:** Roots display a generalized rotting, including discoloration and deterioration of the roots and "rat-tail" symptoms.

### **Causal Organisms**

Verticillium wilt is caused by the fungus *Verticillium dahliae*, which has an extremely broad host range. There are two races of *V. dahliae* that infect tomatoes.

Fusarium wilt is caused by the fungus *Fusarium oxysporum* f. sp. *lycopersici* and there are three races that infect tomatoes. The pathogen is an excellent soil survivor.

Corky root rot is caused by the fungus *Pyrenochaeta lycopersici* and survives in soil via microsclerotia that form on roots.

Black dot root rot is caused by the fungus *Colletotrichum coccodes*, which also causes anthracnose on tomato fruits. The pathogen is capable of surviving in soil by microsclerotia that form on infected fruit and roots (the black dots).

Root knot nematodes belong to the genus *Meloidogyne*. Both the northern root knot nematode (*Meloidogyne hapla*) and southern root knot nematode (*Meloidogyne incognita*) have been found in Ohio tomato production. In general, *M. hapla* forms smaller, distinct galls on tomato roots, while *M. incognita* tends to form larger, fused and malformed galls. Both species of nematodes have extremely broad host ranges.

## Soilborne Disease Management in Tomato Production

When managing soilborne diseases, practices that prevent existing soilborne pathogen populations from increasing should be combined with others that actively reduce pathogen populations in the soil.

- 1. Prevention: Always use clean planting materials. Ensure that transplants are healthy before transplanting. Maintain proper fertility and watering to ensure healthy seedling development, and maintain adequate nutrient and water levels throughout crop development.
- 2. Sanitation: Remove diseased plants and diseased plant parts. Clean soil from boots and equipment between fields and high tunnels. Do not move from soilborne disease-affected fields to non-affected fields.
- 3. Rotation: Rotate out of the same plant family when possible. For pathogens with extremely wide host ranges, such as *Verticillium* sp. and *Meloidogyne* spp., it is difficult to rotate to a suitable non-host crop.

Since most soilborne pathogens are excellent soil survivors, rotations of three to five years are usually necessary to reduce pathogen populations adequately.

- 4. Host resistance and grafting: Resistant varieties should be selected whenever possible and resistance to Verticillium wilt and Fusarium wilt is incorporated into most modern tomato varieties. Grafting a diseasesusceptible scion onto a disease-resistant rootstock can reduce damage due to soilborne diseases. Many commonly used rootstocks have resistance to Verticillium wilt, Fusarium wilt, corky root rot, and some resistance to root knot nematode.
- 5. Soil disinfestation: Several soil disinfestation options are available that vary in cost, efficacy and environmental impact. Chemical fumigation and steam sterilization are two options that have been commonly used historically, but are often not feasible for use on vegetable farms. Anaerobic soil disinfestation is a newer method of soil disinfestation that involves amending, saturating and tarping soil. Soil solarization uses solar-generated heat trapped under plastic sheeting to kill soilborne pathogens, but this technique is not often effective under Midwestern production conditions. Soils can be flooded or left fallow to kill pathogens over a period of time, but these methods are often ineffective due to the survival structures of most soilborne pathogens.
- 6. Chemical or biological control: Few options are available and many biological control options are still experimental.

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Roger Rennekamp, Associate Dean and Director, Ohio State University Extension

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