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TREE FRUIT

Cornell University

IPM Integrated Pest Management

Powdery Mildew of Apple

Podosphaera leucotricha (Ell. & Evherh.) Salm.

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Introduction

Powdery mildew occurs in all major apple-growing regions of the world, but is especially serious in semiarid regions and in nursery production. Losses from the disease vary depending upon the inherent susceptibility of the cultivar, environmental conditions, and management practices. In New York, the disease can cause extensive foliar infections in dry years, following mild winters, or on highly-susceptible cultivars. Young expanding plant tissues are the most susceptible to pathogen attack. The disease can be particularly severe during orchard establishment because non-bearing trees continue producing susceptible tissue until late in summer.

Symptoms and Signs

Powdery mildew infects young green tissues of the plant, as well as young blossoms. Symptoms of the disease are variable and dependent upon the variety, when infection occurred, degree of infection, and weather conditions. Definitive diagnosis can be made by using a hand lens or microscope to inspect the surface of foliar lesions for evidence of fungal mycelia and conidia.

Leaves: Leaves are most susceptible to infection in the first few days after they open. Initial infections on the underside of the leaf may cause chlorotic (yellow) patches or spots to occur on the upperside of the leaf. This symptom is not unique to powdery mildew, so inspection of the underside of the leaf is necessary to confirm the presence of the fungus. Lesions on the upper leaf surface appear powdery white but eventually turn a darker brown (fig. 1). Infected leaves have a tendency to crinkle, curl, or roll upwards along the edges giving them a narrow appearance (fig. 2). Severely infected leaves usually drop prematurely during the summer. Under favorable conditions, the disease will spread over the entire leaf and progress down the petiole onto young, green

PHOTO: TREE FRUIT AND BERRY PATHOLOGY

Fig. 1. Powdery mildew on upper surface of apple leaf (note darkening around the edges).

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Fig. 2. Advanced infection causing leaves to curl.

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Fig. 3. Shoot stunted by powdery mildew infection.

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Fig. 4. Powdery mildew infected blossom cluster.

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Fig. 5. Russet on apple fruit.

shoots. Small black fruiting bodies (cleistothecia) form late in the season and are visible to the naked eye.

Shoots: Shoot infections are the result of overwintering infections in dormant buds. When the terminal buds begin to grow in early spring, the fungus advances with the new succulent growth (fig. 3). Infected terminal shoots appear stunted and young shoots may be killed outright in the spring, or may survive the season and die in late fall or winter.

Flowers and Fruits: Blossoms, petals, sepals, receptacles, and peduncles may become infected and covered with the fungus (fig. 4). Blossom infections are less common but are important because infected blossoms will either fail to set fruit or produce small, stunted and/or russeted fruit (fig. 5). These fruit are unsuitable for fresh market sale.

Disease Cycle

Powdery mildew survives the winter as fungal strands (mycelium) in vegetative or fruit buds that were infected the previous season. Low winter temperatures (< -11° F or -24° C) can kill the mycelium in the buds or the infected buds themselves, thus reducing this source of infection. Infected buds usually break dormancy later than healthy ones. As infected buds break dormancy, the fungus resumes growth and colonizes developing shoots and young leaf tissue, causing primary infections. Primary mildew infections may occur on vegetative shoots and blossoms and thereby cause a reduction in yield.

Infected terminal shoots, or flag shoots, may have a silvery gray color, stunted growth, and a misshapen appearance. They are more susceptible to winter kill than healthy shoots. The powdery white appearance on infected shoots consists of many thousands of spores, called conidia, which are responsible for spreading the fungus and causing secondary infections. Secondary infections usually develop on leaves and buds before they harden off and may reduce the vigor of the tree. Secondary infections also result in the infected buds that carry the fungus through winter.

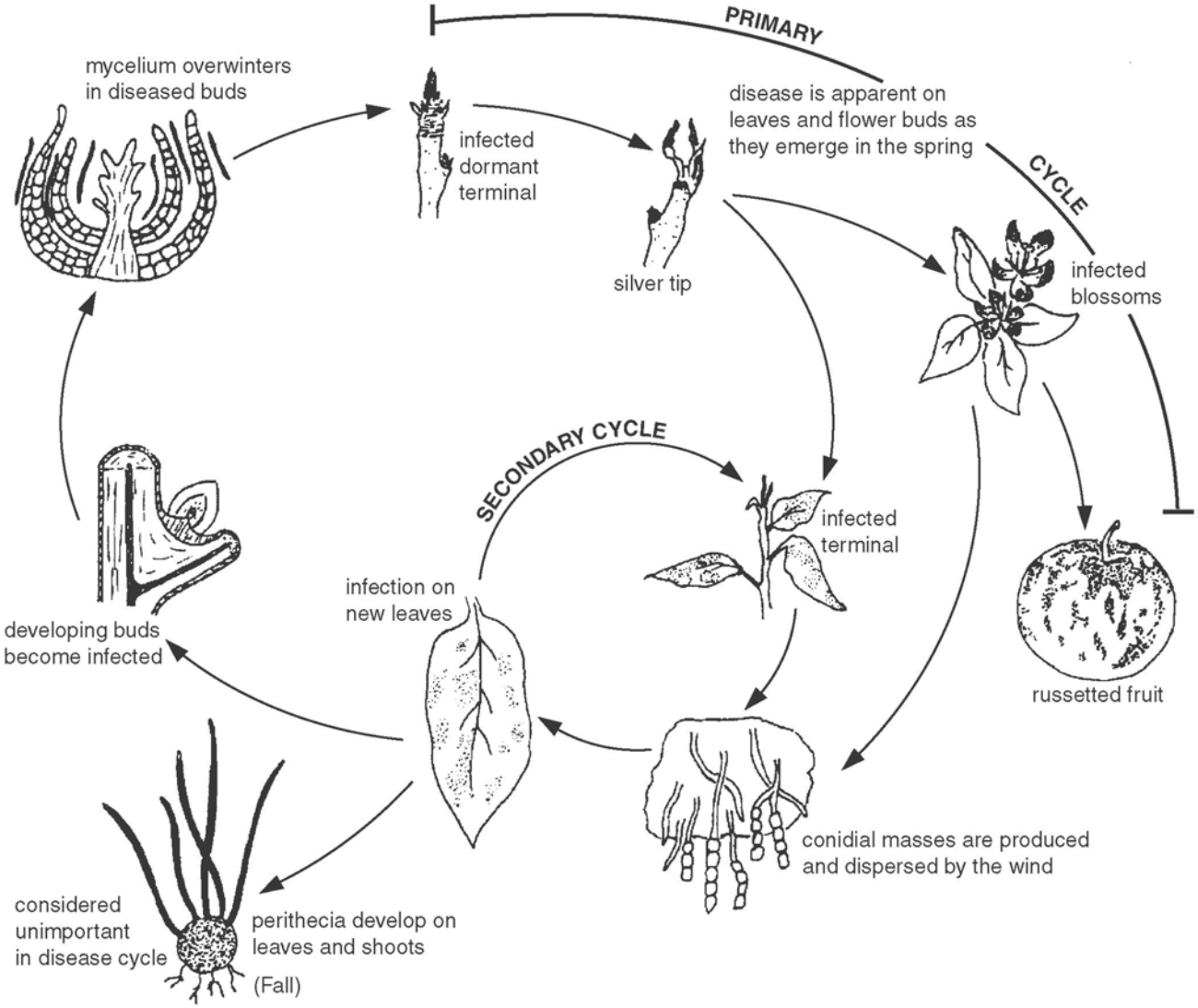

ILLUSTRATION BY ELAINE GOTHAM

In late summer and fall, the powdery mildew fungus produces masses of small black structures, called cleistothecia on infected leaves and terminals. These spore-producing structures are another form in which the fungus survives the winter; however, they appear to play a limited role in the infection process.

Conditions Favorable to Infection

Powdery mildew infections occur when the relative humidity (RH) is greater than 70%. Even on days when RH is low, infections may occur during night or early morning hours when RH usually rises. Infections can occur when the temperature lies between 50 to 77°F (10 to 25°C). The optimum temperature range for infection is between 66 to 72°F (19 to 22°C). Unlike other foliar diseases, leaf wetting is NOT a requirement for powdery mildew infection. Conidia will not germinate if immersed in water, although high RH is required for infection. Under optimum conditions, powdery mildew will be visible 48 hours after infections are initiated; new infections produce spores in about 5 days.

Disease Management

The use of resistant varieties is the most effective means for avoiding problems with powdery mildew. The cultivars Baldwin, Braeburn, Cortland, Crispin, Gala, Ginger Gold, Granny Smith, Idared, Jonagold, Jonathan, Monroe, Paulared, and Rome are particularly susceptible to powdery mildew. However, many other cultivars may become infected when inoculum is present and conditions are favorable for infection. Pruning out shoot infections during the dormant season has not proven effective for eradicating overwintering inoculum and is not done in commercial operations. In commercial orchards, fungicides are almost always necessary to control the disease when powdery mildew-susceptible varieties are grown. The major objectives of the spray program are to: 1) reduce the number of spores produced on newly infected tissues in the spring, 2) prevent secondary infections of new shoots, buds, and leaves during the growing season, and 3) prevent fruit infections. Spray programs should include a fungicide for powdery mildew beginning just before bloom and continuing at 7-10 day intervals until terminal buds have set and shoots are no longer producing new leaves that are susceptible to infection. Spray coverage is extremely important because infections can occur in the absence of rain and susceptible tissue not covered with the fungicide may become infected before fungicides can be redistributed by rainfall. Refer to the Cornell Pest Management Guidelines for Commercial Tree-Fruit Production for proper fungicides and spray timings.

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