

Downy Mildew in Greenhouse Cucumber

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Introduction

Downy mildew is a disease caused by the fungus-like water mold, *Pseudoperonospora cubensis*, which attacks only cucumbers and related crop species (gourds, pumpkin, squash, melons). This disease primarily affects the foliage and can cause severe yield losses in a short period of time.

Symptoms

Symptoms are usually seen first on the lower, older leaves. Initial symptoms of downy mildew typically consist of angular, yellow spots on the upper leaf surfaces (Figure 1). On the undersides of such spots, a purplish grey fungal (Figure 2) growth may be visible when there is high relative humidity or moist conditions. As the disease progresses, the yellow spots enlarge, become necrotic or brownish in the centre, with the browning spreading to the margins of the spots (Figure 3). Such spots may merge to form large brown areas on the leaves (Figure 4). This kills leaves if the disease is allowed to develop unchecked. Lack of photosynthetic tissue results in stunting of plants, reduced fruit size, and poor fruit set.



Figure 1: Yellow angular spots defined on upper surface of cucumber leaf



Figure 2: Fungal growth of *Pseudoperonospora cubensis* on lower surface of cucumber leaf



Figure 3: Typical papery brown spots of downy mildew



Figure 4: Coalescing of many infected spots in downy mildew infection

Disease Cycle

Pseudoperonospora cubensis is an obligate parasite requiring living host tissue to survive and does not live in debris in the soil. The pathogen does not survive over winter in Canada. However, occasionally under optimum environmental conditions, the pathogen may develop thick-walled spores (called oospores) that are resistant to low temperatures and dry conditions, but this is rare and not considered an important source of inoculum. Infections in greenhouses likely originate from another type of spore (called sporangia), that enter the facilities from the outside. Local field infections are usually established by spores that are carried by moist air currents blowing northwards from southern regions during the summer.

Moisture on the leaf surfaces is necessary for infections to occur. When spores land on a wet leaf surface, they can either germinate and infect through the breathing pores (stomates) on leaves, or release many smaller spores (called zoospores) that swim in the film of water on leaves during humid or wet conditions, and infect leaves through stomates. Optimum temperatures for infection range between 16° to 22°C. Infection occurs more rapidly at the warmer temperatures. The period of wetness needed for infection on cucumber leaves are about 12 hours at 10 to 15°C, 6 hours at 15 to 19°C, and 2 hours at 20°C. About 4 to 5 days after infection, new spores are produced and released into the air primarily during the morning period. Spores can quickly spread within the greenhouse via moist air currents, contaminated tools, equipment, fingers, and clothing. Fortunately, the spores become less infective under conditions of high temperatures and low humidity in the greenhouse.

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Management Strategies

Cultural Practices

1. **Management of the greenhouse environment** - Avoid dew formation by providing adequate heating and ventilation. This is critical to reducing incidence of downy mildew. Special attention must be paid to purging moist air out of the greenhouses during the evenings, and keeping the plant foliage dry, particularly during the night. At normal greenhouse temperatures, relative humidity should generally not be allowed to exceed 70-75%.
2. **Sanitation** - All sources of infection should be removed and discarded away from the greenhouse so that spores are not blown back into the greenhouse. This could include burial of plant debris. Infected leaves or plants should be carefully removed and placed in a garbage bag before disposal to ensure that spores do not escape and infect nearby commercial cucurbit fields (pumpkin, zucchini, cucumber, squash). All cucurbit plants should be removed from the immediate surroundings of the greenhouse because they may serve as reservoirs for the downy mildew fungus. Surfaces in infested greenhouses should be thoroughly disinfected.
3. **Adequate canopy aeration** - Ensure that plants are sufficiently spaced and that the canopy is well pruned and thinned to provide for adequate air-circulation.
4. **Avoid over watering** - Over-watering not only leads to overly soft, more vulnerable plants, but

also to guttation or production of droplets of moisture at the margins of leaves early in the morning. This moisture at the leaf margins provides perfect infection sites for the downy mildew pathogen.

5. **Avoid overhead watering or humidification** - Any cultural practice (e.g. misting) that increases leaf moisture will increase disease development when spores are present in the air.

Chemical Controls

Apply chemical controls in a timely manner - If only a few spots are evident on a few leaves of one plant, then the disease is in the early stages of development. Appropriate chemical control procedures should be implemented immediately because the spores are readily dispersed by air currents. Further disease development may be very rapid under favourable environmental conditions as previously described.

Rotate products - Where possible, it is best to rotate fungicides to reduce chances of development of resistance in the fungus to the material applied. Generally, systemic fungicides should be used in combination with protectant fungicides to reduce the chances of development of resistance in the fungus. As for all crop protection chemicals, growers must always read and follow label recommendations.

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