Ministry of Agriculture and Food

Powdery Mildew of Greenhouse Peppers

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Powdery mildew, caused by *Leveillula taurica*, is one of the most damaging diseases of greenhouse bell peppers in British Columbia (B.C.). Research has shown a direct correlation between percentage mildew infection on pepper leaves and yield loss; that is, the higher the level of powdery mildew infection the higher the loss of production. Infection of pepper plants with mildew at the early stages of plant growth can cause about 30% loss of production compared to the infection at late growth stages.

Pepper powdery mildew is different from the powdery mildew of tomato (*Erysiphe, Oidium lycopersicum*) or cucumber (*Erysiphe cichoracearum, Sphaerotheca fuliginea*). Pepper powdery mildew grows unseen within the leaf tissue for a latency period of up to 21 days. Unlike tomato or cucumber powdery mildew, which is easily seen on the upper surface of the leaves, pepper powdery mildew grows on the under surface of the leaves (Figure 1). Disease monitoring and early detection of the symptoms of pepper powdery mildew is critical for timely disease management. By the time pepper powdery mildew is detected on a leaf many more leaves may have already been infected but do not show any symptoms. In addition, pepper plants infected with powdery mildew result in defoliation and subsequent death of the plants. Pepper powdery mildew does not infect the fruit or stems.

Distribution

Leveillula taurica was first detected in Florida, USA in 1971. Since the early 1990's it has been a recurring problem in California on chili and bell peppers, tomato, cotton, globe artichoke, onion and other weed species. By the late 1990's it had spread to Arizona, Idaho, New York, Oklahoma, Utah, Mexico and Ontario. It was first detected on greenhouse pepper in British Columbia (B.C.) in 2003 and has since spread throughout pepper greenhouses, but not on any other greenhouse vegetable crops in B.C. The pathogen can infect tomato and eggplant while cucumbers are not as readily infected. Over 1000 plant species in many plant families are susceptible to *L. taurica*.

Symptoms

Pepper plants become more susceptible to powdery mildew as they mature. Older plants and mature lower leaves are the first to show evidence of infection. Pepper powdery mildew needs living host plant tissue to grow and survive. The fungus only infects the leaves not the fruit or stems. Symptoms first appear as fluffy, white patches on the under surface of leaves (Figure 1). With time, these patches may turn brown. The upper surface of the infected leaves may appear

normal or have diffuse, yellow patches which correspond to the mildew colonies on the under surface (Figure 1). Early powdery mildew infections can be seen more easily by holding the leaf up to the light and looking for developing mildew colonies. Severely infected leaves wither and drop off, causing plants to die. Research has shown that the amount of leaf drop depends not only on the severity of powdery mildew, but also on the pepper variety.

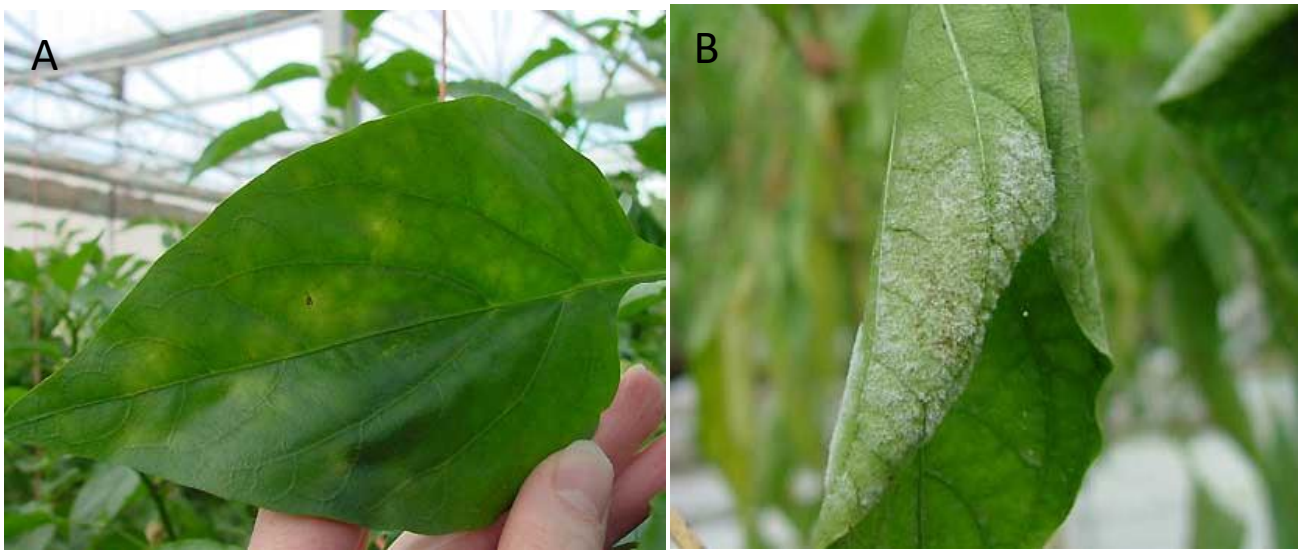

Figure 1. Symptoms of powdery mildew on a pepper leaf. Translucent light-yellow areas on the upper surface (A) corresponding to the fluffy, white powdery mildew colonies on the under surface (B) of an infected pepper leaf.

Disease Cycle

Disease cycle (life cycle) of *L. taurica* starts when spores (known as conidia) land on a pepper leaf. Infections can occur over a wide temperature range (19-33°C) at high or low humidity. Spores germinate, penetrate through the leaf surface, and produce mycelia that grow into the leaf tissue. The pathogen parasitizes the plant using it as a food source. It initially grows within the leaf for a latency period of 18-21 days. After the latency, the fungus grows thorough the leaf openings (stomata) and colonizes on the under surface of the leaf and where it produces numerous, fine strands or stalks called conidiophores. These conidiophores become visible as white fluffy patches, i.e. mildew colonies, and produce numerous conidiospores (spores) which are borne singly on each conidiophore. Air currents within the greenhouse carry the spores to other plants. Spores are dispersed further through the greenhouse vents. In addition to dispersal by air currents or wind, powdery mildew can spread from surrounding infected ornamental plants and weeds, and by workers on their clothing. Repeated generations (disease cycles) of powdery mildew can lead to severe outbreaks of the disease.

Disease Management Strategies

Cultural control

- Consult your seed supplier for the availability of powdery mildew resistant pepper varieties.
- Restrict visitor access to the greenhouse.
- Follow strict greenhouse biosecurity guidelines and hygiene throughout the growing season. For details, refer to the ministry's factsheets on "Disinfection and Sanitation Practices"
- Conduct a through year-end clean up and dispose of all crop debris off-site or by burning or burying in a landfill.
- Control weeds surrounding the greenhouse.
- Keep ornamentals and imported tropical plants out of the greenhouse and immediate area.
- Improve greenhouse climate to reduce relative humidity and increase air circulation.

Disease monitoring

- Train workers and integrated pest management (IPM) scouts to recognize early symptoms of powdery mildew. Early detection is important for a successful disease control. Follow season-long monitoring for powdery mildew starting as soon as new plants are placed in the greenhouse. Focus on areas in the greenhouse for closer inspection where powdery mildew first started the previous year. Hot spots for powdery mildew are areas where the greenhouse climate fluctuates, air circulation is poor, and relative humidity is high. Powdery mildew is likely to start on older, lower leaves. Remember to check the under surface of leaves for signs of powdery mildew. Also check leaves with oedema spots (water blisters) which indicate relative humidity fluctuations and possibly infection sites of powdery mildew.
- Powdery mildew infection can be easily detected by placing suspected leaves in a zip lock bag with a moist paper towel. After a day or two of incubation in a warm place, use a hand lens (15-30 x) or dissecting microscope (15-30 x magnification) to check the under surface of leaves for white mildew colonies.
- Submit any suspected plant samples to the Ministry of Agriculture and Food - Plant Health Laboratory or to a recognized plant diagnostic laboratory for disease confirmation.

Chemical control

The disease can be prevented by early application of fungicides (Table 1). Apply a protectant fungicide when powdery mildew is first detected, or in a greenhouse with a previous history of powdery mildew. Repeat the treatment by alternating with fungicides in different chemical groups. Continue treatments if the disease pressure warrants control.

Table 1. A summary of registered fungicides and label information. Please refer to Health Canada's Pest Management Regulatory Agency website for labels and information on application and safety measures.

Product name	Active ingredient	Chemical or biological Group	Mode of action	REI[1] hrs	PHI[2] days	Application guidelines
Bartlett	sulphur	M	protectant & suppression (non-systemic)	24	NA	Apply preventatively as required at 14-day interval. Do not exceed 10 applications per crop cycle
Microthiol Disperss	sulphur	M	protectant & suppression (non-systemic)	24	1	Apply preventatively at early crop development and, thereafter, as required at 10- to14-day interval. Do not exceed 8 applications per crop cycle
GROTEK	sulphur	M	protectant & suppression (non-systemic)	2	NA	Apply preventatively. Run the vaporizer for 1-8 h during night and repeat 2-7 times per week instructions.
MilStop	potassium bicarbonate	M	protectant (non-systemic)	4	0	Apply preventatively at 7-day interval.
Nova	myclobutanil	3	protectant & curative (locally systemic)	12	3	Apply preventatively at 10-to 14-day interval. Do not exceed 3 applications per crop cycle.
Pristine	boscalid & pyraclostrobin	7 & 11	protectant & curative (locally systemic)	12	1	Apply preventatively at 7- to 10-day interval in rotation with other fungicides. Do not exceed 1 application per crop cycle.
Palladium	cyprodinil & fludioxonil	9 + 12	protectant & curative (locally systemic)	1	1	Apply preventatively at 7- to 10-day interval. Do not exceed 3 applications per crop cycle.

Oxidate	hydrogen peroxide & acetic acid	disinfectant	protection & suppression	4	0	Apply preventatively at 7- to 10-day interval. Do not exceed 8 applications per year.
Actinovate	*Streptomyces lydicus*	biological	protection & suppression	1	0	Apply preventatively at 7- to 14-day interval. Use the product within 4 hrs of preparation.
Regalia	*Reynoutria sachalinensis* extract	biological	protectant	until dry	0	Apply preventatively at 7- to 10-day interval. Do not exceed 1500L/ha per crop cycle.
Timorex	tea tree extract	biological	protectant	4	4	Apply preventatively at 7- to 14-day interval.

[1]REI - re-entry interval

[2]PHI - pre-harvest interval

For Further Information

First report of powdery mildew of greenhouse pepper caused by *Leveillula taurica* in British Columbia, Canada. Cerkauskas, R.F. and A. Buonassisi. Plant Disease 87: 1151. 2003.

First report of powdery mildew of greenhouse pepper caused by *Leveillula taurica* in Canada. Cerkauskas, R.F. and J. Brown. Plant Disease 83:781. 1999.

Suppression of powdery mildew on greenhouse-grown cucumber by addition of silicon to hydroponic nutrient solution is inhibited at high temperature. Schuerger, Andrew and W. Hammer. Plant Disease 87:177-185. 2003.

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