

Powdery Mildew of Greenhouse Peppers

March, 2016

Powdery mildew, caused by *Leveillula taurica*, is one of the most damaging diseases that affect greenhouse bell peppers in British Columbia. Research has shown a direct correlation between percentage mildew infection of the leaves and yield loss. One percent mildew infection on the leaves would result in a one percent yield loss. Studies show that the higher the level of powdery mildew infection, the higher the loss of production. An early, heavy infection with mildew had about 30% loss of production compared to a later, lighter infection. Powdery mildew generally has caused 10-15% yield loss in North American greenhouse pepper crops. Greenhouse pepper growers need to follow an intensive disease prevention plan because it is very important that powdery mildew never gets out of hand. Once pepper leaves are infected with powdery mildew it is difficult to control; if left unchecked the crop can be entirely destroyed. Monitor the crop right from the start. Apply preventive fungicide sprays once the disease is detected. Carry out strict hygiene throughout the year and practice a thorough year-end clean up. There are no powdery mildew resistant pepper varieties currently available.



*Figure 1. Unlike other powdery mildew diseases, greenhouse pepper powdery mildew, *Leveillula taurica*, forms on the underside of leaves not on the upper leaf surface.*

Pepper powdery mildew is different in several ways from the mildews that infect 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 and cucumber powdery mildew which is easily seen on the top side of the leaves, pepper powdery mildew grows on the undersurface of leaves (Figure 1). Disease monitoring, early detection and prevention of pepper powdery mildew is critical. By the time pepper powdery mildew is detected in a greenhouse many more leaves are already infected but do not show any disease symptoms. In addition, pepper plants can become defoliated and do not recover as quickly as other greenhouse crops when infected with powdery mildew. Pepper powdery mildew does not infect the fruit or stems but can quickly destroy unprotected leaves and eventually the entire pepper crop.

Distribution

Leveillula taurica is a fungus which first appeared in North America in Florida 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 can also infect weed species. By the late 1990's it had spread to Arizona, Idaho, New York, Oklahoma, Utah, Mexico and Ontario. It was first detected in British Columbia in February, 2003 on greenhouse pepper crops and has since spread throughout the greenhouse pepper industry.

Susceptible Greenhouse Crops and Environment

Over 1000 plant species in numerous plant families are susceptible to the pepper powdery mildew fungus. *Leveillula taurica* has been reported on greenhouse bell peppers but not on any other greenhouse vegetable crop in British Columbia. The disease can also infect tomato and eggplant while cucumbers are not as readily infected.

Pepper powdery mildew infection can occur over a wide temperature range (19-33°C) with high or low humidity.

Symptoms

In general, pepper crops become more susceptible to powdery mildew as they mature. Older plants and lower leaves are the first to show evidence of powdery mildew infection. Pepper powdery mildew needs living host plant tissue to grow and survive. The fungus only infects the leaves not the fruit or stems of pepper plants. Check for pepper powdery mildew by closely inspecting the underside of older leaves for the first signs of the disease. Look for fluffy, white patches of powdery mildew on the underside of leaves (Figure 1). With time, these patches may turn brown rather than remaining white. The upper surface of the leaf may appear normal or have diffuse, yellow patches which correspond to the mildew colonies on the lower surface (Figure 2). 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. Outbreaks of pepper powdery mildew can devastate a pepper crop. Send samples of pepper powdery mildew for laboratory confirmation to a plant diagnostic laboratory or to the B.C. Ministry of Agriculture's Plant Health Laboratory.



Figure 2. Light yellow spots may form on the upper side of the leaf corresponding to the powdery mildew colonies on the undersurface of infected pepper leaves.

The Disease Cycle

The powdery mildew disease cycle (life cycle) starts when spores (known as conidia) land on a pepper leaf. Spores germinate much like a seed and begin to grow into the leaf. Pepper powdery mildew parasitizes the plant using it as a food source. The fungus initially grows unseen within the leaf for a latency period of 18-21 days. Then the fungus grows out of the leaf openings (stomata) on the undersurface of the leaf, producing conidiospores which are borne singly on numerous, fine strands or stalks called conidiophores. These fungal strands become visible as white patches, i.e. mildew colonies, on the undersurface of the leaf. Air currents within the greenhouse carry these microscopic, infectious 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 on ornamental plants and weeds, and by workers on their clothing. Repeated generations of powdery mildew can lead to severe outbreaks of the disease that economically damage the crop.

Disease Management Strategies

Cultural control :

- Take the following steps to prevent introducing pepper powdery mildew into your greenhouse:
- Restrict visitor access to the greenhouse
- Follow strict greenhouse hygiene throughout the growing season
- Conduct a thorough year-end clean up and dispose of all crop debris off-site or by burning or burying in a landfill. For more information consult the fact sheet 'Greenhouse Vegetable Crop Clean-Up'.
- Control outdoor 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 and signs of powdery mildew. Early disease detection is important for successful powdery mildew control. Follow season-long monitoring for powdery mildew starting as soon as new plants are placed in the greenhouse. Target areas in the greenhouse for closer inspection where powdery mildew first started the previous year. Hot spots for powdery mildew are areas where the 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 undersurface of leaves for signs of pepper powdery mildew. Also check leaves with oedema spots (water blisters) which indicate relative humidity fluctuations and possibly powdery mildew sites. Use a hand lens or dissecting microscope (15-30 x magnification) to examine the under surface of suspect leaves and compare them to healthy leaves.
- Timely disease detection: Enhance early disease detection by placing suspected leaves in a zip lock bag with some moist paper towelling. After a day or two of incubation in a warm place, use a hand lens (15-30 x) to check the under surface of leaves for white mildew colonies. Be sure to have the disease confirmed by sending a sample to the plant diagnostic lab.
- Resistant varieties: Consult your seed supplier for the latest information concerning new developments in resistant pepper varieties.

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 your greenhouse has had powdery mildew the previous season or if disease pressure warrants control. If practical, remove and dispose of the first infected leaves or entire plants to help stop the disease build up. Strict hygiene is necessary as powdery mildew can survive in plant debris. Inactive powdery mildew colonies should be flattened, discoloured and not actively expanding once fungicide treatment has been applied.

The following fungicides (Table 1) are registered in Canada for pepper powdery mildew control. For more information refer to Health Canada's [Pest Management Regulatory Agency](#) website for fungicide label information.

Table 1. A summary of registered fungicides and label information (Please adhere to product label instructions when using each chemical). For more information refer to Health Canada's [Pest Management Regulatory Agency](#) website for fungicide label information

Product	Chemical/Biological Ingredient	Chemical Group	Mode of Action	REI	PHI2	Application
Actinovate SP	Streptomyces lydicus	biological	preventative/ suppressive	1 hr	0 day	use preventatively; apply at 7-14 days interval; use the product within 4 hrs of preparation
Bartlett	sulphur	M	preventative/ suppressive	1 day	NA	use preventatively; apply as required at 14 days interval; do not exceed 10 applications per crop cycle
GROTEK ASCEND	sulphur	M	preventative/ suppressive	2 hrs	NA	use preventatively; Run the vaporizer for 1-8 h during night and repeat 2-7 times per week as per label instructions.
MilStop	potassium bicarbonate	NC	preventative, non-systemic	4 hrs	0 days	use preventatively; apply at 7 days intervals; treated produce cannot be exported to the USA
Nova 40W	myclobutanil	3	preventative/ some curative action, locally systemic	12 hrs	3 days	use preventatively; do not exceed 3 applications per crop cycle; apply at 10-14 days interval
Pristine	boscalid & pyraclostrobin	7 & 11	preventative/ some curative action, locally systemic	12 hrs	1 day	use preventatively; do not exceed 1 application per crop cycle, hence, use in rotation, after 7 days, with other fungicides
Palladium or Switch	cyprodinil & fludioxonil	9 + 12	preventative/ some curative action, locally systemic	1 day	1 day	use preventatively; do not exceed 3 application per crop cycle, hence, use in rotation, after 7 to 10 days, with other fungicides
Regalia	Reynoutria sachalinensis extract	Natural product	preventative	until dry	0 day	use preventatively; apply at 7-10 days interval; do not exceed 1500L/ha per crop cycle
Timorex	tea tree extract	natural product	preventative	4 hrs	4 days	use preventatively; apply at 7-14 days 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.
- Cornell University Vegetable MD
- Pest Management Fact Sheet: Powdery mildew (*Leveillula taurica*) on greenhouse pepper. Isaacson, Peter, 2001. Available upon request from the BC Greenhouse Growers Association
- PMRA label search, for fungicide label information

Updated by:

Siva Sabaratnam,
Plant Pathologist,
Abbotsford Agriculture Centre,
British Columbia Ministry of Agriculture
Abbotsford, B.C.