BRITISH COLUMBIA | Ministry of Agriculture and Food

Pythium Diseases of Greenhouse Vegetables

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Pythium species are protists (Oomycetes), commonly referred to as water molds, which naturally exist in soil and water as saprophytes, feeding on organic matter. Some *Pythium* species can cause serious diseases on greenhouse vegetable crops resulting in significant crop losses. *Pythium* infection leads to damping-off in seedlings and crown and root rot of mature plants. In Canada, several *Pythium* species, including *P. aphanidermatum*, *P. irregulare* and *P. ultimum*, are known to cause damping-off and crown and root rot in greenhouse cucumber, pepper and tomato crops. There are no *Pythium* resistant varieties available although some varieties may have disease tolerance. Over watering, poor aeration and improper temperatures in the root zone, and root injury can weaken the crop and, thus, trigger *Pythium* outbreaks. Water saturated growing media that are either too cold or too warm can be conducive to *Pythium* build up and spread in water and recirculating nutrient solution. Plants grown under optimal environmental conditions are less susceptible to *Pythium* than plants grown under poor conditions.

Disease cycle

Pythium can be introduced into a greenhouse in plug transplants, soil, growing media, plant refuse and irrigation water. Greenhouse insects such as fungus gnats (*Bradysia impatiens*) and shore flies (*Scatella stagnalis*) can also spread *Pythium*. *Pythium* spreads by forming sporangia, sack-like structures, each releasing hundreds of swimming zoospores. Zoospores that reach the plant root surface encyst, germinate and colonize the root tissue by producing fine thread-like structures of hyphae, collectively called mycelium. These hyphae release hydrolytic enzymes to degrade the root tissues and absorb nutrients as a food source. *Pythium* forms oospores and chlamydospores on decaying plant roots which can survive prolonged adverse conditions in soil, greenhouse growing media and water, leading to subsequent infections.

Symptoms

'Pre-emergence' damping-off causes seeds and young seedlings to rot before they emerge from the growing medium, while 'post-emergence' damping off kills newly emerged seedlings. In 'post-emergence' damping-off, the pathogen causes a water-soaked, soft brown lesion at the stem base, near the soil line, that pinches off the stem causing the seedling to topple over and die. In young plants, *Pythium* causes crown and root rot, where plants suddenly wilt when weather turns warm and sunny and when plants have their first heavy fruit load. Often, upper leaves of infected plants wilt in the day and recover overnight but plants eventually die. In the root system, initial

symptoms appear as brown to dark-brown lesions on root tips and feeder roots and, as the disease progresses, symptoms of soft, brown stubby roots, lacking feeder roots, become visible (Figure 1). In larger roots, the outer root tissue or cortex peels away leaving the string-like vascular bundles underneath. Pythium rot also occurs in the crown tissue at the stem base. In cucumber, diseased crown turns orange-brown in colour, often with a soft rot at the base; brownish lesions extending 10 cm up the stem base may be seen.

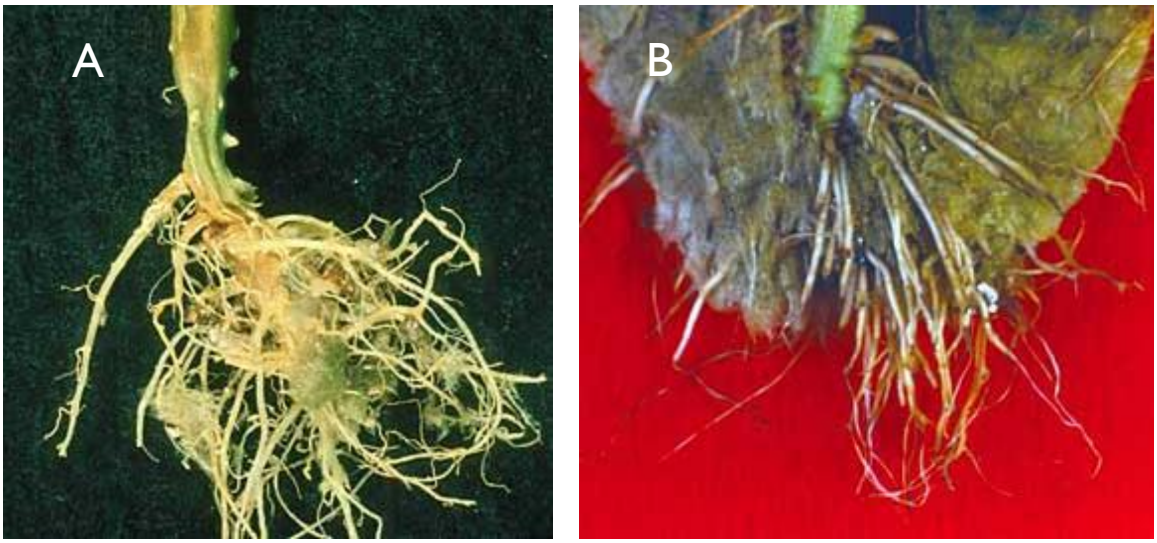

Figure 1. Pythium crown and root rot in greenhouse cucumber showing orange discolouration of the crown area (A) and rotted roots and root tips (B).

Monitoring & Identification

Routinely monitor the crop for slightly wilted plants and check wet areas in the greenhouse where *Pythium* is more likely to be present. *Pythium* occurs mostly in spring, at early fruit set and later in the season on mature plants. In cucumber, *Pythium* can also occur in the summer on young plants brought in for the fall crop. Monitor plants for wilting, and in cucumber, check the stem bases for discoloration. Always confirm *Pythium* diseases by sending representative plant samples with roots, crowns and foliage to a reliable plant diagnostic laboratory or the Ministry of Agriculture and Food - Plant Health Laboratory.

Disease Management

Cultural Controls

Sanitation: Filed soil, debris, irrigation water from pond or stream, and plant refuse and growing medium of previous crops can contain *Pythium*. Follow a strict greenhouse sanitation program throughout the year and a thorough year-end clean up. Clean and disinfest all interior greenhouse surfaces and equipment including tools, hoses, walkways, carts, totes, troughs, tanks and water supply lines. Use sterile propagating media. Remove diseased plants by placing them directly into plastic bags for disposal away from the greenhouse.

Irrigation water: Untreated water from rivers, or streams or ponds poses great risk for *Pythium* introduction while treated, municipal water is considered safe from *Pythium*. Water and nutrient storage tanks need to be disinfected periodically and covered to prevent contamination by *Pythium*.

Nutrient Solution: Generally, greenhouse vegetables are raised on rockwool in plastic sleeves or bags containing rooting medium (i.e. rockwool slabs, sawdust or coconut fibre) through which water and nutrient solution are circulated. Since *Pythium* and other pathogens can build up in nutrient solution, periodically disinfest recirculating nutrient solution using physical, biological or chemical methods (Marchuk, 2006).

> Physical - slow sand filtration, ultrafiltration (membrane filters), micro-pore filtration (high pressure, rapid flow membrane or sediment filters), heat pasteurization (95-97°C for 30 seconds or 85°C for 3 minutes), UV radiation, sonic energy, magnetism, aeration (i.e. oxygenation), ozonation, etc.
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> Biological - biofiltration (slow sand or lava rock), water retention ponds.
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> Chemical - chlorine, chlorine dioxide, copper, hydrogen peroxide, electrochemical, soaps (wetting agents), iodine, etc.

Resistant varieties: Although there are no resistant vegetable varieties, some vigorous varieties may have some tolerance to *Pythium*. Contact your local seed/transplant agent for further information on *Pythium* tolerant varieties.

Seedlings & Transplants: Carryout transplanting in the morning or late afternoon/evening to avoid stress from high day time temperatures. Allow for good air circulation around seedlings by proper plant spacing and good aeration of irrigation water and re-circulating nutrient solution. Use healthy transplants and handle them carefully to avoid wounding plants and roots and practice good sanitation when transplanting; do not let them dry when setting out. Water seedlings in the morning so that plants are not wet overnight.

Plant growing conditions: Ensure that transplants have the proper root zone temperature and adequate moisture when moved into the greenhouse. Plant growing media must be well drained as saturated bags with low oxygen levels can predispose transplants to *Pythium* diseases.

Use warm, aerated irrigation water (18-22°C). Avoid low light levels, low pH, high salts and warm growing conditions (above 28°C) which favour *Pythium*. For greenhouse cucumbers, nutrient solution should be delivered at pH 5.0 for approximately 5 weeks followed by adjusting the pH to a 5.8-6.2 regime for one week. (Tu, 2004).

Maintain rockwool block wetness at 70-75% between watering.

Use white/colourless drip lines instead of black or place drip lines on the shaded side of the grow bags.

Disease monitoring: Plants must be monitored for signs of *Pythium* diseases throughout the cropping cycle. Remove and destroy severely infected plants, including growing medium, and replant in new growing medium. Infected plant materials and growing medium must be safely disposed away from the greenhouse by deep-burying, incinerating or composting.

Control fungus gnats (*Bradysia impatiens*) and shore flies (*Scatella stagnalis*) which spread *Pythium*.

Biological and Chemical Control

Prevent *Pythium* diseases by practicing integrated disease management strategies based on cultural, biological and chemical controls. Use chemicals as a last resort at the onset of disease. Rotate the use of chemicals belonging to different chemical groups and strictly follow label directions to avoid resistance development in *Pythium*. Routinely monitor plants and stop chemical treatment if they fail to provide acceptable disease control; get professional advice.

Table 1. A summary of registered chemicals and biological agents and label information. Please refer to Health Canada's Pest Management Regulatory Agency website on product for labels and information.

Product name	Active ingredient	Chemical or biological group	Mode of Action	REI[1] hrs	PHI[2] days	Application guidelines
Greenhouse cucumber, pepper & tomato						
Previcur	propamocarb	28	protectant & curative (locally systemic)	12	2 for cucumber; 1 for tomato & pepper	Apply preventatively after transplanting, at 7 to 10 days interval. Only 2 applications per crop cycle.
Confine Extra	Phosphorous acid mono- & dipotassium salts	33	protectant (systemic)	4	1	Apply preventatively as foliar or drench treatment at 7 to 14 days intervals after transplanting. Do not exceed 5 to 6 applications per year.
Phostrol	Phosphorous acid mono- & di- sodium, potassium and ammonium salts	33	protectant (systemic)	4	0	Apply preventatively as foliar or drench treatment at 7 to 14 days intervals. Do not exceed 4 applications per crop

						cycle.
Rampart	Phosphorous acid mono- & dipotassium salts	33	protectant (systemic)	4	0	Apply preventatively as foliar or drench treatment at 2 to 4 weeks intervals after transplanting.
MycoStop	*Streptomyces* Strain K61	biological	suppression (non-systemic)	NA	0	Apply to growing medium after transplanting, thereafter, every 3 to 6 weeks intervals.
PreStop	*Gliocladium catenulatum*	biological	suppression	4	0	Apply to growing medium soon after transplanting, thereafter, every 3 to 6 weeks intervals.
RootShield HC & WP	*Trichoderma harzianum* Rifai, KRL-AG2	biological	suppression	4	0	Apply to plant growing medium soon after transplanting, repeat thereafter.
RootShield Plus	*Trichoderma harzianum* Rifai, KRL-AG2 & *T. virens* G-41	biological	suppression	4	0	Apply to plant growing medium soon after transplanting, repeat thereafter.
Greenhouse cucumber						
Ridomil Gold 480SL	metalaxyl-M	4	protectant & curative (systemic)	12	21	Apply as drench after transplanting. One application per crop cycle.
Greenhouse Lettuce						
Subdue Maxx	metalaxyl-M	4	protectant & curative (systemic)	12	21	Apply as drench to growing medium 1 day before transplanting. One application per crop cycle.
Torrent	cyazofamid	21	protectant (locally systemic)	12	40	For transplants, apply at seeding to prevent damping-off and root rot.
Confine Extra	Phosphorous acid	33	protectant (systemic)	4	1	Apply preventatively as foliar or drench

	mono- & dipotassium salts					treatment at 7 to 14 days intervals after transplanting. Maximum 6 applications per year.
Phostrol	Phosphorous acid mono- & di- sodium, potassium and ammonium salts	33	protectant (systemic)	4	0	Apply preventatively as foliar or drench treatment at 7 to 14 days intervals. Do not exceed 4 applications per crop cycle.
Rampart	Phosphorous acid mono- & dipotassium salts	33	protectant (systemic)	4	0	Apply preventatively as foliar or drench treatment at 2 to 4 weeks intervals after transplanting.
PreStop	*Gliocladium catenulatum*	biological	suppression	4	0	Apply to growing medium soon after transplanting, thereafter, every 3 to 6 weeks intervals.
RootShield Plus	*Trichoderma harzianum* Rifai, KRL-AG2 & *T. virens* G-41	biological	suppression	4	0	Apply to plant growing medium soon after transplanting, repeat thereafter.
Greenhouse Eggplant						
Previcur	propamocarb	28	protectant & curative (locally systemic)	?	?	Apply preventatively after transplanting, at 7 to10 days intervals. Maximum 2 applications per crop cycle.
Confine Extra	Phosphorous acid mono- & dipotassium salts	33	protectant (systemic)	4	1	Apply preventatively as foliar or drench treatment at 7 to 14 days intervals after transplanting. Maximum 5 applications per year.
Phostrol	Phosphorous acid mono- &	33	protectant (systemic)	4	0	Apply preventatively as foliar or drench

	di- sodium, potassium and ammonium salts					treatment at 7 to 14 days intervals. Do not exceed 4 applications per crop cycle.
Rampart	Phosphorous acid mono- & dipotassium salts	33	protectant (systemic)	4	0	Apply preventatively as foliar or drench treatment at 2 to 4 weeks intervals after transplanting.
PreStop	*Gliocladium catenulatum*	biological	suppression	4	0	Apply to growing medium soon after transplanting, thereafter, every 3 to 6 weeks intervals.
RootShield WP	*Trichoderma harzianum* Rifai, KRL-AG2	biological	suppression	4	0	Apply to plant growing medium soon after transplanting, repeat thereafter.
RootShield Plus	*Trichoderma harzianum* Rifai, KRL-AG2 & *T. virens* G-41	biological	suppression	4	0	Apply to plant growing medium soon after transplanting, repeat thereafter.
Pepper, Tomato						
Subdue Maxx	metalaxyl-M	4	protectant & curative (systemic)	24	2 - pepper 1 - tomato	Apply to growing medium as drench soon after transplanting or at first sign of symptoms. Maximum 1 application per crop cycle.
Torrent (Cyazofamid 400SC)	cyazofamid	21	protectant & curative (locally systemic)	12	0	Apply as drench at transplant. If needed, 6-8 weeks thereafter. Maximum 2 applications per crop cycle.

[1]REI - re-entry interval

[2]PHI - pre-harvest interval

NA –information is not available

For Further Information

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