

Management Strategies for *Pythium* Diseases of Greenhouse Vegetable Crops in British Columbia

1. Introduction

Pythium species are fungal-like organisms (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 in older 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 root aeration, root injury and improper root zone temperatures can weaken the crop and, thus, trigger *Pythium* outbreaks. 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.

2. Disease cycle

Pythium can be introduced into a greenhouse in plug transplants, soil, debris, pond and stream water, growing media and roots or plant refuse of previous crops. Greenhouse insects such as fungus gnats (*Bradysia impatiens*) and shore flies (*Scatella stagnalis*) can also carry *Pythium*. *Pythium* spreads by forming sporangia, sack-like structures, each releasing hundreds of swimming zoospores (Figure 1). Zoospores that reach the plant root surface encyst, germinate and colonize the root tissue by producing fine thread-like structures of hyphae, forming masses of mycelium. These hyphae release hydrolytic enzymes to destroy the root tissue 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.

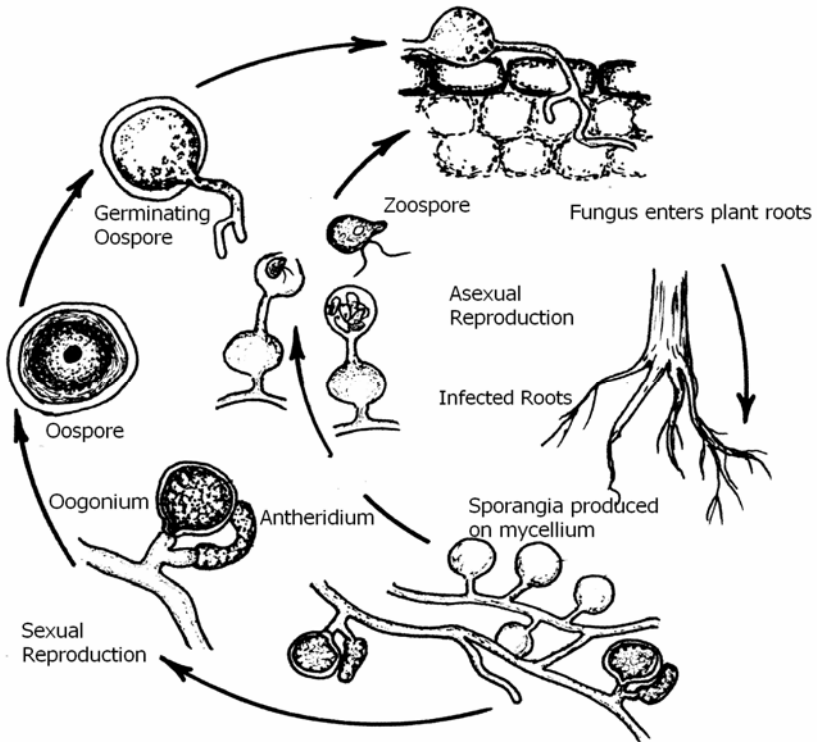


Figure 1. The disease cycle of *Pythium* damping-off and crown and root rot of greenhouse vegetable crops.

3. 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 older plants, *Pythium* causes crown and root rot, where mature 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 2). 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 color, often with a soft rot at the base; brownish lesions extending 10 cm up the stem base may be seen.

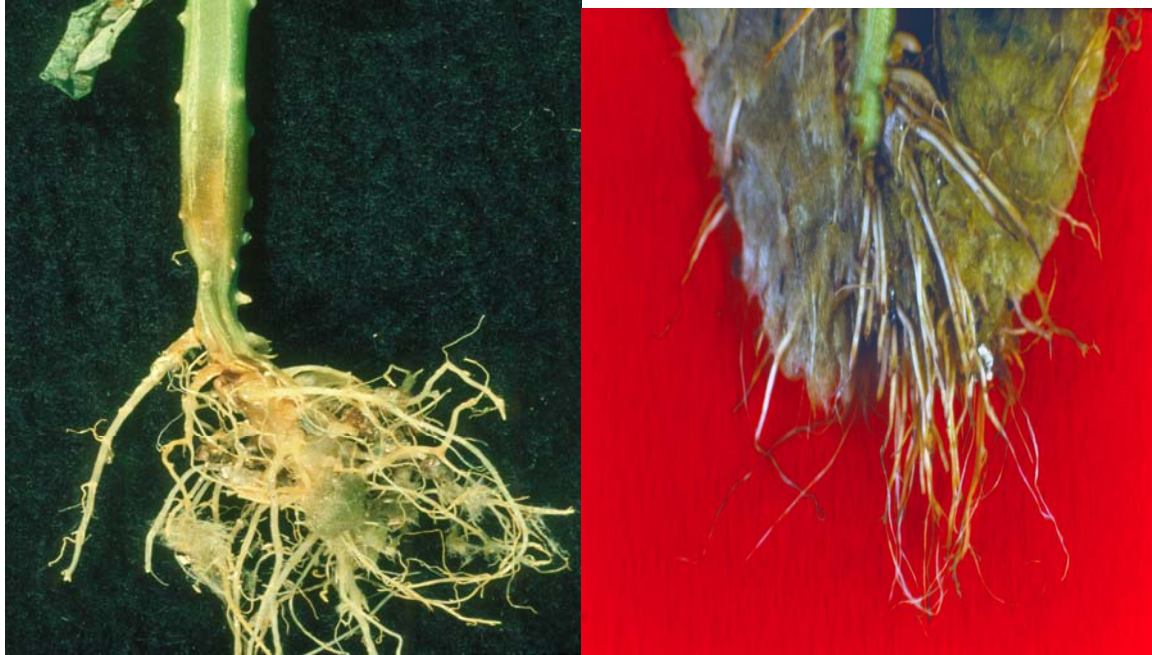


Figure 2. *Pythium* crown and root rot in greenhouse cucumber showing orange discoloration of the crown area and rotted roots and root tips.

4. Monitoring & Identification

Routinely monitor your 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 promptly sending a representative plant sample with root, crown and foliage to the Ministry of Agriculture and Land's Plant Diagnostic Lab.

<http://www.al.gov.bc.ca/cropprot/lab.htm>

5. Integrated Disease Management

Integrated disease management provides a combination of cultural, biological and chemical tools to control and/or manage crop diseases effectively. Cultural controls keep *Pythium* from reaching the roots while biological and chemical controls inhibit or suppress *Pythium* in the root zone.

5.1 Cultural Controls

5.1.1 Sanitation

Field soil and debris, pond and stream water, sand, sediments and roots 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 dying plants by placing them directly into plastic bags for disposal away from the greenhouse.

5.1.2 Irrigation water

Untreated water from rivers or streams poses a threat while treated, municipal water is considered safe from *Pythium*. Water storage and nutrient tanks need to be covered to prevent *Pythium* contamination and may require disinfesting.

5.1.3 Disinfesting nutrient solutions

Generally, greenhouse vegetables are raised on rockwool cubes and 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** treatments (Marchuk, 2006).

Physical treatments:

Filtration - slow sand filtration, ultrafiltration (membrane filters), micropore filtration (high pressure, rapid flow membrane or sediment filters).

Energy - heat pasteurization (95-97°C for 30 seconds or 85°C for 3 minutes), UV radiation (80-100 mj cm⁻²; e.g. Priva Vialux[®]), sonic energy, magnetism, aeration (i.e. oxygenation; bubbling air into water).

Biological treatments: biofiltration (slow sand or lava rock), water retention ponds

Chemical treatments: ozonation, chlorine, chlorine dioxide, copper (e.g. Aqua-Hort[®] from Aqua-Perl, Denmark), hydrogen peroxide, electrochemical (e.g. ECA[®]), soaps (wetting agents), iodine.

5.1.4 Resistant varieties

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

5.1.5 Greenhouse Environment: Seedlings & Transplants

- Allow for good air circulation around seedlings by proper plant spacing and good aeration of irrigation water and recirculating nutrient solution. Water seedlings in the morning so that plants are not wet overnight.
- 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. Transplant in the morning or later in the evening to avoid stress from high day time temperatures.
- Growers suggest that recirculation of the nutrient solution be suspended for the first few weeks after transplanting as a precautionary measure.
- Ensure that transplants have the proper root zone temperature and adequate moisture when moved into the greenhouse. The 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*. In greenhouse cucumbers, the

nutrient solution should be delivered at a pH 5.0 regime for approximately 5 weeks followed by adjusting the pH to a 5.8-6.2 regime for one week. (Tu, 2004)

- Target rockwool block wetness at 70-75% between watering.
- Use white/color-less drip lines instead of black or place driplines on the shaded side of the grow bags.
- Control fungus gnats (*Bradysia impatiens*) and shore flies (*Scatella stagnalis*) which spread *Pythium*.
- Avoid injuring roots with excess use of insecticide or fungicide drenches and follow an integrated pest management program, including cultural and biological controls.
- The temperature of growing media should not be less than 20-23°C. Minimum root temperature should be maintained at 20°C in the root zone.
- Remove and destroy severely infected plants and replant in new growing bags. Infected plant materials, including grow bags, must be safely disposed away from the greenhouse by deep-burying, incinerating or composting.

5.2 Biological Controls

Biological control strategies are gaining importance in Canada with the registrations of Mycostop (*Streptomyces griseoviridis*) and RootShield (*Trichoderma harzianum*), which directly protect seeds and young plants by suppressing *Pythium* in the root zone. Apply the biological control agents to the planting mix several days before seeding or transplanting (Table 1).

5.3 Chemical Control & Resistance

Previcur (propamocarb) and Ridomil (metalaxyl), the two fungicides registered in Canada for *Pythium*, have a high risk of *Pythium* developing resistance (Table 1).

- Prevent *Pythium* diseases by practicing integrated disease management strategies based on cultural and biological controls. Use fungicides as a last resort at the onset of disease.
- Rotate registered fungicides with different chemical groups and strictly follow label directions to avoid resistance development in *Pythium*.
- Routinely monitor plants and evaluate the level of disease control if fungicides are used. Stop fungicide treatment and get professional advice if fungicides fail.

6. Further information

Alberta Agriculture, Food and Rural Development. Watch for early seedling diseases.
[http://www1.agric.gov.ab.ca/\\$Department/deptdocs.nsf/all/opp4593](http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/opp4593)

Cherif, M. et.al. 1994. Defense responses induced by soluble silicon in cucumber roots infected by *Pythium* spp. *Phytopathology* 84: 236-242.

Compendium of pepper diseases. 2003. K. Pernezny, et. al. editors. The American Phytopathological Society. <http://www.shopapspress.org/comofpepdis.html>

Diseases and pests of vegetable crops in Canada. 1994. R. Howard et. al. editors. The Canadian Phytopathological Society and the Entomological Society of Canada. <http://www.esc-sec.org/disease.htm>

Growing greenhouse peppers in British Columbia. A production guide for commercial growers. 2005. BC Greenhouse Growers' Association and BC Ministry of Agriculture and Lands.
www.bcgreenhouse.ca/publications.htm

Growing greenhouse vegetables. 2005. Ontario Ministry of Agriculture, Food and Rural Affairs. Publication order #371, Agdex #290. <http://www.omafra.gov.on.ca/english/products/newpubs.html> or products@omaf.gov.on.ca

Jarvis, W.R. 1992. Managing diseases in greenhouse crops. American Phytopathological Society. <http://www.shopapspress.org/41221.html>

Marchuk, R. 2006. Treatments for greenhouse recirculation water. Proceedings, 48th Annual Horticulture Growers Short Course, 2006. Lower Mainland Horticultural Improvement Association, Pages 3-8.

Pesticide label information for Canada: http://pr-rp.pmra-arla.gc.ca/portal/page?_pageid=34,17551&_dad=portal&_schema=PORTAL

Tu, J. C. 2004. An integrated control measure for *Pythium* root rot of hydroponically grown greenhouse cucumbers. *Acta Horticulturae* 644: 571-574.

Zamir, P.K. and R. Yip. 2003. Biological control of damping off and root rot caused by *Pythium aphanidermatum* on greenhouse cucumbers. *Can. J. Plant Pathol.* 25: 411-417.

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Table 1. Registered biocontrol products and fungicides for *Pythium* diseases of greenhouse cucumber, tomato and pepper crops in Canada.

Greenhouse cucumber, pepper & tomato				
PRODUCT	ACTIVE INGREDIENT	RATE	Days to Harvest	COMMENTS
Mycostop Wettable powder (biofungicide) PCP 26265 Guarantee: 10 ⁸ cfu/g www.plantprod.com	<i>Streptomyces griseoviridis</i> Strain K61 Naturally occurring soil bacterium.	As seed treatment for cucumber & tomato, use 5-8 g/kg of seed. Immediately after transplanting, use 5-10 mg/plant or 10-20 ml/plant of 0.05% suspension	0	Do not treat lettuce, gerbera or sweet pepper seed. Repeat treatment every 3-6 weeks depending on disease pressure. Re-entry 4 hours. Store Mycostop as unopened packets in a cool, < 8°C, dry place.
Greenhouse cucumber & tomato				
RootShield Granules (biofungicide) PCP 27116 Guarantee: 10 ⁷ cfu/g www.bioworksinc.com	<i>Trichoderma harzianum</i> Rifai strain KRL-AG2	600 g/m ³ of planting mix or soil and thoroughly incorporate.	0	Apply to seedling media. Effective when root zone temperature is > 10°C and pH is neutral or acidic not alkaline. Re-entry 4 hours. Store RootShield in a secure, dry place at 2-5°C.
RootShield Drench (biofungicide) PCP 27115 Guarantee: 10 ⁷ cfu/g www.bioworksinc.com	<i>Trichoderma harzianum</i> Rifai strain KRL-AG2	60-90 g/100 L of water as a drench for potting mix or soil. Treat several days before seeding or transplanting.	0	Apply to seedling media. Effective when root zone temperature is > 10°C and pH is neutral or acidic not alkaline. Re-entry 4 hours. Store RootShield in a secure, dry place at 2-5°C.
Greenhouse cucumber				
Previcur PCP 26288 group U Guarantee: 722g/L www.bayercropscience.ca	propamocarb hydrochloride	10ml/10 L of water and apply this solution at rate of 100-200 ml/plant drench onto growing medium. Use higher volume for 2 nd and 3 rd applications	14	Maximum 3 applications per season: once during propagation stage, early post-transplanting and again if warranted. Re entry is 12 hours.
Ridomil Gold 480 EC PCP 25384 group 4 Guarantee: 480g/L www.syngenta.ca	metalaxyl-M, S isomers (mefenoxam)	Immediately after transplanting, apply 250 ml of mixture (0.75-1.25ml product/10 L water) as a drench to growing medium at base of each plant.	21	One application per planting cycle. Do not apply to foliage. Not for greenhouse cucumbers grown in soil. Do not use in the propagation house. Re-entry is 12 hours
Ridomil Gold 480 SL PCP 28474 group 4 Guarantee: 480g/L www.syngenta.ca	metalaxyl-M, S isomers (mefenoxam)	Immediately after transplanting, apply 250 ml of mixture (0.75-1.25ml product/10 L water) as a drench to growing media at base of each plant.	21	One application per planting cycle. Do not apply to foliage. Not for greenhouse cucumbers grown in soil. Do not use in the propagation house. Re-entry is 12 hours