Phytophthora Blight of Cucurbits and Peppers

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Phytophthora blight, caused by a fungal-like pathogen *Phytophthora capsici*, is a serious threat to vegetable crops worldwide, particularly legumes, cucurbits and solanaceous plants. It is a fast spreading, aggressive disease, capable of causing complete crop failures. Many vegetable growers are familiar with a close relative of this disease - late blight of potato and tomato, caused by *Phytophthora infestans*. In British Columbia, it was first detected on pepper, pumpkin, squash, gourds and eggplants in market gardens in Kelowna area in 2004; however, the disease has not been observed thereafter. In the USA, *P. capsici* is known to affect many crops, particularly in the eastern states.

Hosts

Phytophthora capsici can infect a wide range of field crops, including all cucurbits (e.g. melon, cucumber, pumpkin, squash), solanaceae (e.g. peppers, tomato, eggplant), legumes (e.g. snap bean, lima bean), many weeds and, under laboratory conditions, crops such as root crops (e.g. beet, carrot, radish, turnip, onion), greens (e.g. spinach, swiss-chard), legumes (e.g. alfalfa, soybean, snow pea) and okra.

Infected pumpkin fruit covered with white cottony growth and sporangia of Phytophthora capsici.

Infected pumpkin fruit turned completely white by growth of Phytophthora capsici

Symptoms

Phytophthora capsici may affect all parts of the plant, causing a wide variety of symptoms. It may cause pre- and post-emergence damping-off, stem and vine blight, wilting or fruit rot. Symptoms can appear as fast as 3 to 4 days after initial infection when temperatures are warm.

Damping-off may occur both before and after emergence of seedlings in susceptible crops in the spring. Symptoms include a watery rot near the soil line, wilting, and subsequent plant death. White fungal growth may appear on infected areas of blighted seedlings under moist conditions. Damping-off is more likely to occur when soil conditions are wet and warm (20 to 30°C), and when the disease is well established in the soil. Many other fungi and fungus-like organisms can also cause damping-off, including *Pythium, Rhizoctonia* and *Fusarium* species.

Cucurbits

Foliar symptoms on leaves and petioles appear as rapidly expanding, irregular, water-soaked lesions, resulting in a rapid collapse and death of leaves. Leaf spots are chlorotic (yellow) at first and then turn brown with yellow or light green borders.

Vine blight appears as water-soaked lesions on the vines. Lesions turn brown and necrotic within a few days, resulting in stem girdling, wilting and death of foliage above the lesions. Dieback of shoot tips, wilting, shoot rot, and plant death quickly follow initial infection. *P. capsici* can devastate entire squash plantings in a matter of days when conditions are warm and moist.

Yellow scallop squash fruit covered with white cottony growth and sporangia of Phytophthora capsici

Gourd fruit infected with Phytophthora capsici

Fruit rot was the predominant symptom seen on pumpkin, squash and gourds during the Kelowna outbreak in 2004. Fruit rot often starts on the underside of the fruit where it sits on the soil. It can also develop on the upper side of the fruit following rain or overhead irrigation. Early symptoms include large, water-soaked or slightly sunken, circular lesions, which expand to cover the fruit with white mold. The mold consists of millions of sporangia (spores), which can spread with wind and rain to cause further infections. The white fungal growth of *P. capsici* on the fruit should not be confused with the white growth of powdery mildew, which is a common problem on cucurbit leaves. Fruit rot progresses rapidly, resulting in complete collapse of the fruit and invasion of secondary rots. Fruit rot can also develop after harvest.

Pepper

On pepper, infection of the stem near the soil line is common. Stem lesions start as dark, water-soaked areas which become brown to black and result in girdling, wilting and plant death. *P. capsici* may also cause root rot and foliar blight on pepper. On leaves, small, water soaked lesions expand and turn a light tan colour. White moldy growth may be seen on leaves during wet periods. Rapid blighting of leaves and shoots may occur. Pepper fruit can also be infected through the fruit stalk. Fruit rot appears as dark green, water-soaked areas that become covered with a white to gray mold. Infected fruit dries, becomes shrunken and wrinkled, and remains attached to the stem.

Pepper plants killed by Phytophthora blight

Eggplant

Fruit rot is the most common symptom of phytophthora blight in eggplant. Symptoms appear as a round, dark brown area on the fruit, which is surrounded by a rapidly expanding lighter tan zone. Fruit lesions and eventually whole fruit may be covered with white to gray moldy growth during wet periods.

Eggplant fruit showing symptoms of Phytophthora blight infection in the field.

Infected eggplant fruit showing discolouration and light sporulation of Phytophthora capsici.

Tomato

Phytophthora blight can cause crown rot, leaf spot, foliar blight and fruit rot in tomatoes. Fruit rot begins as dark, water-soaked spots, often where fruit is touching the soil. The infected spot rapidly expands during warm weather to cover most of the fruit surface with a brown, watery discoloration that may appear as concentric rings. Under humid conditions, infected fruit may be covered with white moldy growth and rot entirely following invasion by secondary microorganisms. Similar symptoms can also be caused by the late blight pathogen, *Phytophthora infestans*.

Life Cycle

P. capsici is a soil-borne pathogen which overwinters as oospores (thick-walled resting spores) in the soil or in plant debris. Oospores are resistant to desiccation and cold temperatures, and can survive in the soil for many years.

In the spring, oospores germinate to produce sporangia and zoospores (asexual spores) when soil moisture is at field capacity. Sporangia are spread by wind and water through the air and are carried with water movement in soil. Sporangia germinate to directly infect host tissue, or if conditions are wet, they can also germinate to release zoospores. Zoospores are motile and swim to invade host tissue. *P. capsici* can also be spread in infected transplants, seed, and through contaminated soil and equipment.

Abundant sporangia are produced on infected tissues, particularly on infected fruit. Sporangia are spread in water, by rain-splash, or in air currents. Wind-borne sporangia can be carried long distances. If the environmental conditions are favourable, the disease develops very rapidly.

Phytophthora blight is favoured by high soil moisture, frequent rains or irrigation, and warm temperatures (optimum 24-33 ◦C). The disease is usually associated with heavy rainfall, excessive-irrigation, or poorly drained soil. *P. capsici* does not survive cold temperatures very well unless oospores are present.

Pathogen Variation and Strains

P. capsici shows considerable genetic variation. Different pathogenic strains may have the ability to infect different crops, and there are also differences in virulence, or the ability to cause disease in host plants. Some strains may be more aggressive than others on certain hosts.

Limited pathogenicity tests were conducted at the Pacific Agri-Food Research Centre using *P. capsici* isolates collected from pumpkin and squash in Kelowna in 2004. The B.C. isolates were able to cause infection of sweet pepper, winter squash and golden zucchini, but did not infect musk melon.

P. capsici has 2 mating types, A1 and A2. When both mating types are present in the same field, the pathogen is able to reproduce sexually and produce oospores - a type of spore that can survive for many years in the soil. To date, only one mating type has been detected in B.C. from the 2004 outbreak.

Prevention

Seed Source: The disease may have been introduced to the Kelowna area on infected seed. Use a reliable source for disease-free seed and transplants. Do not collect seed from an infected field.

Scouting: Early detection may help to avert serious losses. Scout your field regularly for disease symptoms. Pay particular attention to low areas of the field where the soil remains wet for longer periods of time.

Identification: Submit suspected *P. capsici* infected plants to the Plant Diagnostic Laboratory or contact a Ministry of Agriculture Plant Pathologist for disease diagnosis. Proper identification of pests and diseases is an important component of integrated pest management.

Biosecurity: Take precautions to prevent spreading diseases between fields, and to prevent possible introductions of diseases from fields of other growers. Be aware that *Phytophthora* may be carried on clothing, foot-ware and farm equipment. Refer to the publication: *Biosecurity Guidelines* for more information.

Disease Management

Phytophthora blight is a difficult disease to control, particularly once established in the soil as oospores. Management strategies should combine cultural and chemical controls, along with other disease prevention measures.

- Crop rotation is an excellent disease management strategy for most vegetable diseases. Rotate to non-susceptible or non-host crops for at least 2 years. Be sure there is no crop residue left from previous infected crops before replanting. Note, crop rotation is not effective in areas where oospores are present in the soil. When soil is infested, it may be best to move production of susceptible crops to a field with no history of the disease. Currently it is not known whether the disease has successfully overwintered in Okanagan soils.
- Control volunteer crop plants and susceptible weeds such as nightshade during crop rotations. Control weeds during the growing season.
- Plant resistant varieties, if available. Some pepper varieties have tolerance to Phytophthora blight. Check seed suppliers for resistance ratings. There are no cucurbit cultivars with measurable resistance currently available.
- Select well-drained fields, and avoid planting into low-lying areas. Raised beds are recommended for non-vining cucurbits.
- Do not over-irrigate. Discontinue overhead irrigation if the disease is present.

- When symptoms are localized in a small area of the field, disk the area. This will help to prevent movement of spores from infected plants to healthy plants during subsequent rainfalls.
- Clean equipment before moving it from infested to clean areas.
- Do not work in wet fields.
- Do not keep cull piles. Bury or remove infected plant material from the vicinity of fields and vegetable stands/display areas.
- Remove healthy fruit from the infested area as soon as possible and check them periodically for symptoms. Cull all fruit with symptoms, and do not leave culls on the field.

- Several fungicides belonging to different chemical groups, Cyazofamid or Torrent (Group 21 – cyazofamid), Allegro (Group 29 – fluazinam), Confine (Group 33 - phosphorous acid), Revus or Acrobat (Group 40 – mandipropamid), Zampro (Group 40 & 45 – ametoctradin & dimethomorph), Presido or Fluopicolide (Group 43 – fluopicolide), and Orondis Ultra (Group U15 – oxathiapiprolin) have been registered in Canada to manage *P. capsici* on various crops. Please refer to fungicide label instruction when choosing products for a specific crop (for label assess: http://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php). Preventive sprays are more effective than spray programs started after the disease symptoms are already present. For best results, the use of fungicides should always be combined with other disease management practices. Consult the Vegetable Production Guide for current fungicide recommendations.

Links for Further Information

- Phytophthora Blight: A Serious Threat to Cucurbit Industries, by Mohammad Babadoost, University of Illinois - APSnet
- Scary Diseases Haunt Pumpkins and Other Cucurbits - APSnet
- Phytophthora Blight of Cucurbits, Pepper, Tomato, and Eggplant - Thomas A. Zitter, Department of Plant Pathology, Cornell University
- Vegetable Diseases Caused by Phytophthora capsici in Florida, by P.D. Roberts, R.J. McGovern, T.A. Kucharek, and D.J. Mitchell - University of Florida

Prepared by:
Dr. Siva Sabaratnam
Plant Pathologist
Abbotsford Agriculture Centre,
British Columbia Ministry of Agriculture
Abbotsford, B.C.