Ministry of Agriculture and Food

Diseases of Wasabi (Greenhouse) in British Columbia

June 2024

There have been several new diseases reported on greenhouse-grown wasabi in British Columbia (B.C.). Information given below focuses on a few new diseases confirmed to be present on wasabi grown in greenhouses on the Lower Mainland and Vancouver Island of B.C. The purpose of this factsheet is to bring awareness to wasabi growers and to engage them in active surveillance and biosecurity measures to prevent the introduction, establishment and spread of wasabi diseases.

Powdery Mildew (*Erysiphe cruciferarum*)

Description and Distribution

Erysiphe cruciferarum is a pathogen responsible for powdery mildew on brassica species including oilseed rape, broccoli, and cabbage. It has a worldwide distribution. On wasabi, *E. cruciferarum* has been reported in Japan, Taiwan, South Korea and Canada. It was first reported in B.C. in 2013. *Erysiphe cruciferarum* produces conidia (spores), similar to the ones produced by other *Erysiphe* spp. causing powdery mildew on cruciferous crops. The pathogen produces appressoria (responsible for penetrating into host tissues) that are variable in shape, ranging from simple to lobed, and haustoria (responsible for absorbing nutrients from plant cells) that are multilobed. The sexual stage of *E. cruciferarum* has not been observed in the Pacific Northwest, and how this species overwinters has not yet been determined.

Symptoms

Powdery mildew pathogens are identified by white mycelia and abundance of conidia that they produce, which give them a 'powdery' appearance. Mycelial colonies on leaves may appear grey in colour and black speckling underneath the colony. Heavily diseased plants show symptoms of chlorosis, necrosis and early defoliation.

Figure 1: Developmental stages of powdery mildew on wasabi caused by *Erysiphe cruciferarum*. (A) Early stages with white mycelial colonies, (B) advanced stages with white-grey mycelia, and (C, D) severe powdery mildew causing chlorosis and necrosis.

Spread

Erysiphe cruciferarum is spread aerially from plant to plant. The initial inoculum source is believed to be from nearby cruciferous crops or weeds. *Erysiphe cruciferarum* prefers greenhouses without overhead misting system, as leaves/foliage at reduced leaf wetness are more susceptible to infection.

Verticillium Wilt (*Verticillium isaacii*)

Description and Distribution

Verticillium isaacii was first described in 2011. It was previously considered as part of *Verticillium tricorpus* but was found to be genetically distinct. It has been isolated from spinach, artichoke, and lettuce, but it is sometimes considered to be endophytic rather than pathogenic. *Verticillium isaacii* produces sclerotia, as over wintering structures, that have been observed in soils throughout Canada and the United States. In wasabi, *V. isaacii* was first reported in 2020. Both the cultivars 'Green Thumb' and 'Daruma' were found to be susceptible to verticillium wilt, but it is yet unknown if other cultivars are susceptible.

Symptoms

The disease cycle of *Verticillium* sp. starts with microsclerotia which germinate in the presence of root exudates, and the resulting mycelia colonizes the cortical cells of the plant root system, initiating the biotrophic stage of the infection. Often the biotrophic phase is asymptomatic, and asymptomatic plants can remain without symptoms for several months. In a successful infection, the mycelia enter and colonize the xylem (vascular transportation system), conidia are formed and travel via the xylem to infect the plant systemically. As a result, the plant shows symptoms of chlorosis and necrosis of leaves, blackening of the vascular tissues and wilting. The fungus produces microsclerotia on the colonized tissues that can survive in the soil or growth substrate for many years.

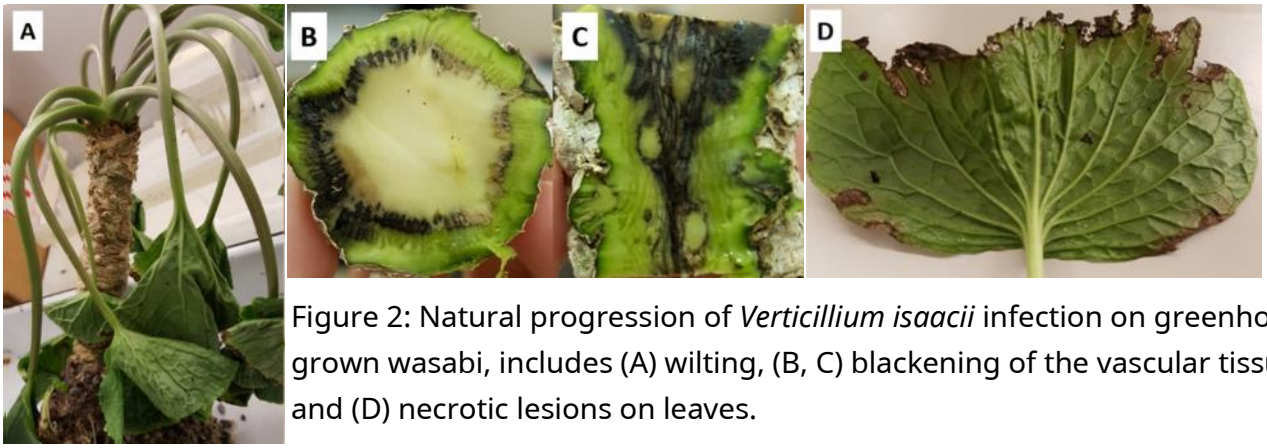

Figure 2: Natural progression of *Verticillium isaacii* infection on greenhouse-grown wasabi, includes (A) wilting, (B, C) blackening of the vascular tissue, and (D) necrotic lesions on leaves.

Spread

The initial source of *V. isaacii* inoculum is unknown, but it could come from nearby infected *Brassica* spp. or as microsclerotia in growing substrates. It is believed to be spread through contaminated growing substrates and irrigation water. Infected asymptomatic cuttings from diseased plants may also transmit the pathogen.

Phoma Leaf Spot (*Leptosphaeria biglobosa*)

Description and Distribution

Perhaps the most damaging disease of wasabi is blackleg caused by *Phoma wasabiae* (sexual stages are *Leptosphaeria maculans* or *Leptosphaeria biglobosa*). It has been found on wasabi in Japan, Taiwan, China, New Zealand, the United States and Canada. In greenhouse-grown wasabi in B.C., only *L. biglobosa* has been identified. All cultivars grown in B.C. are susceptible to this pathogen.

Symptoms

This fungus causes internal and external blackening of the wasabi rhizome, resulting in an unmarketable crop and necrotic leaf spots which reduce photosynthetic capacity of plants (Fig. 3). The disease can be distinguished from other leaf spot causing pathogens by the presence of small spore producing structures called pycnidia in the necrotic regions.

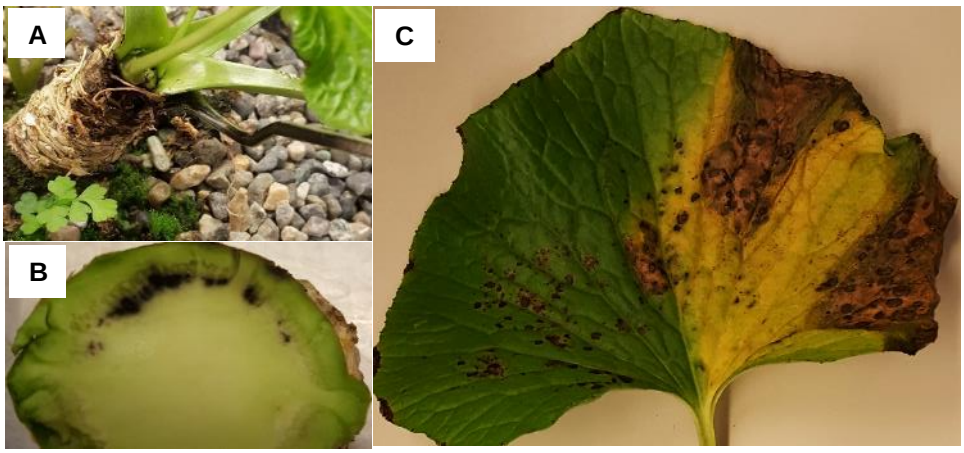

Figure 3: Wasabi plant infected with *Leptosphaeria biglobosa* (*Phoma wasabiae*) displaying (A) petiole blight, (B) blackening of vascular tissues in the rhizome, and (C) necrotic leaf spots.

Spread

Leptosphaeria biglobosa and *L. maculans* are part of the *Leptosphaeria* species complex. Both are ubiquitous pathogens of brassica species, most notably of oilseed crops including canola, causing blackleg or phoma stem canker. They likely spread to wasabi from nearby brassica crops or weeds. In B.C., this may include crops such as broccoli and cauliflower. In greenhouses, *L. biglobosa* can

spread through contaminated water, growing substrates, or pruning implements. Care should be taken while pruning to prevent the spread between plants. Pruning implements should be sanitized between plants to minimize spread.

Grey Mould (*Botrytis cinerea*)

Description and Distribution

Botrytis cinerea is known to infect many fruit and vegetable crops including grapes, strawberries, tomatoes, broccoli and lettuce. It was first reported on wasabi in 2013. It has been reported in the Fraser Valley and on Vancouver Island, B.C., and in Washington State. It can cause major economic losses in wasabi if the rhizome is infected.

Symptoms

Botrytis cinerea is a necrotrophic pathogen and usually causes leaf blight in wasabi. The leaves first become chlorotic and then develop necrotic lesions. *Botrytis cinerea* infects wounded areas of the rhizome, then quickly grows and spreads throughout the rhizome, causing rot and making it completely unmarketable. Both rhizome rot and leaf blight can be characterized by the fuzzy grey mould growing on the infected tissues.

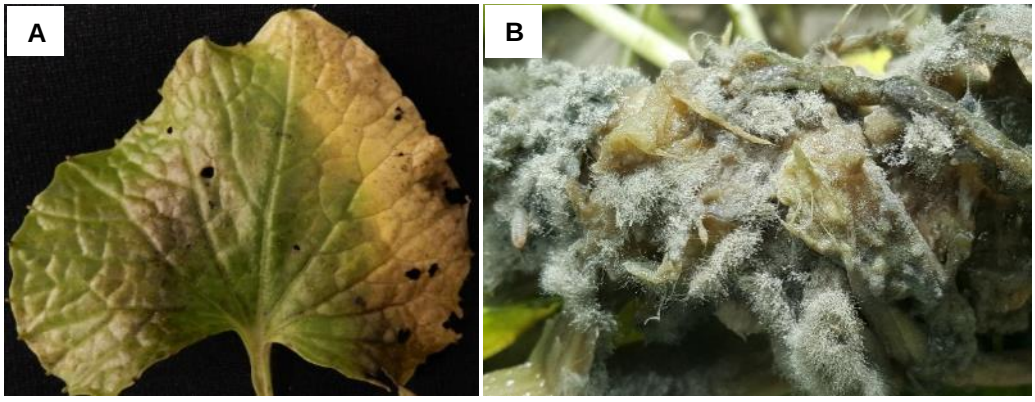

Figure 4: Symptoms of (A) botrytis leaf blight (Photo credit: J. MacDonald, AAFC, Summerland, B.C.), and (B) rhizome rot of a wasabi plant infected with *Botrytis cinerea*.

White Blister Rust (*Albugo candida*)

Description and Distribution

Albugo candida is a pathogen of cruciferous species causing white blister rust. *Albugo candida* is prevalent worldwide and reported on over 240 species, including cultivated oilseed and other brassica species. It was first reported on wasabi in B.C. in 2010. It has also been reported in South Korea. Additionally, a related *Albugo* sp. has been reported on wasabi in Japan, Taiwan and New Zealand.

Spread

Botrytis cinerea is favoured by wet warm conditions, and it is often found in wasabi production facilities that use an overhead misting system. It primarily attacks tissues that are already damaged (i.e. by frost, pruning, etc.). Care should be taken while pruning to prevent the spread of the pathogen between plants. Pruning implements should be sanitized between plants to minimize the spread. Other sources of contamination can be water or growing substrate. Sclerotia produced by the pathogen present in growing substrates become extremely difficult to eradicate.

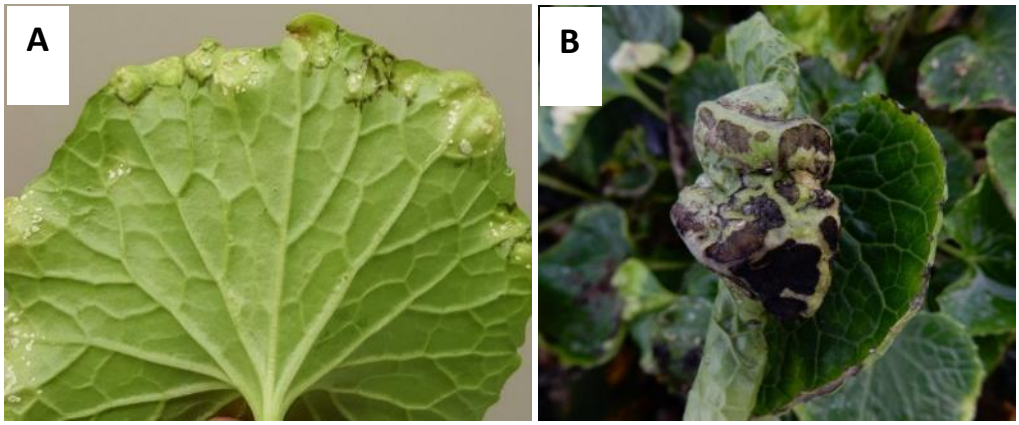

Figure 5: Symptoms of (A) white blister rust and (B) black galls on wasabi leaf infected with *Albugo candida*. (Photo credit: J. MacDonald, AAFC, Summerland, B.C.)

Symptoms

Symptoms appear as white pustules containing masses of spores, often on the underside of the leaves. Severe infections can produce gall-like symptoms on the underside of leaves which eventually turn black.

Spread

Albugo candida spores are spread by air, water and insects. In order to germinate, spores need high humidity and cool temperatures. *Albugo candida* is an obligate pathogen, therefore it requires living tissues to survive. Care should be taken to ensure that transplants coming into production sites are pathogen-free. Additionally, weeds of *Brassica* spp. such as shepherd's purse may also serve as an inoculum source. Therefore, it is important to manage these weeds to help reduce disease incidence in wasabi.

Wasabi Mottle Virus

Description and Distribution

Wasabi mottle virus (WMoV) belongs to the family Virgaviridae and the genus *Tobamovirus*. It has previously been reported in Japan and Taiwan, causing symptoms of rugose and yellow mosaic.

This virus was previously known as the wasabi strain of *Tobacco mosaic virus* or the wasabi strain of crucifer Tobamovirus. In 2017, symptoms of vein-clearing and ringspots were found on wasabi plants grown in a B.C. greenhouse and were found to be associated with WMoV.

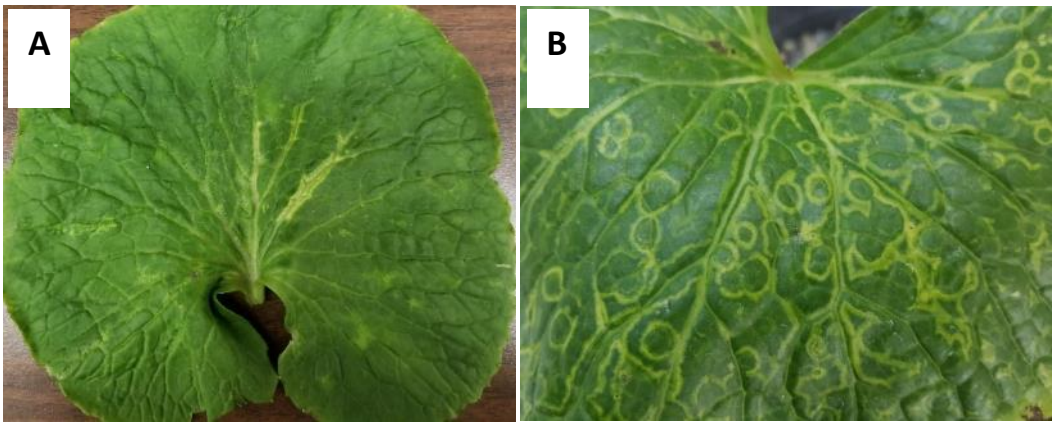

Figure 6: Symptoms of (A) vein-clearing and (B) ringspots on wasabi leaves infected with *Wasabi mottle yellow virus*.

Symptoms

In Japan and Taiwan, symptoms include stunting, rugose and yellow mosaic. Symptoms observed in B.C. include vein clearing, leaf spots and leaf mottling. It is believed that the virus could have been introduced into B.C. via asymptomatic tissue culture plants from wasabi propagation nurseries. The symptoms develop quickly when plants grown in greenhouses are heat stressed.

Spread

The WMoV strain found in B.C. is genetically similar to the strain reported in Taiwan. Taiwan is suspected to be the primary source of entry of the virus since the cultivar 'Green Thumb' introduced from Taiwan is used in the tissue-culture production of wasabi transplants in Canadian nurseries. WMoV is spread between plants by mechanical means, therefore extreme care should be taken to avoid transmitting the virus via pruning or propagating from cuttings taken from virus-infected plants. Pruning tools should be regularly sanitized.

General Control Measures for wasabi diseases

Due to lack of approved pesticides on wasabi, disease control is mostly managed through cultural practices. As such, monitoring for early disease symptoms becomes especially important. Leaf diseases are controlled via pruning and removal of infected leaves or removing the entire plant if severe root or rhizome diseases are present. These practices are cost effective for small production systems, but not feasible for large greenhouse facilities or when disease pressure is high and becomes unmanageable. Periodic monitoring for early disease symptoms, strict

greenhouse biosecurity and sanitation measures, and greenhouse clean-up at the end of a crop cycle are essential for preventing the introduction, spread and establishment of wasabi diseases.

Some growers have attempted using drip irrigation to reduce moisture levels in greenhouses, as opposed to the more traditional overhead sprinkler system. Those greenhouses with drip irrigation to reduce leaf wetness tend to develop less diseases, such as from *B. cinerea*, but, conversely, can encounter more powdery mildew development due to reduced leaf wetness.

Tissue culture plants are also used by some growers to obtain pathogen-free plants. There is a tissue culture facility in the Lower Mainland that specializes in wasabi micropropagation. Tissue culture plants are more expensive than vegetative cuttings, and there is also the concern that tissue culture plants may harbour viruses if mother plants are not tested for 'virus-free' status. Wasabi diseases can be difficult to control once they are established within a crop. It is highly recommended that a collective management approach, i.e. a combination of cultural practices, biosecurity measures, disease monitoring, greenhouse sanitation and disinfection practices, should be adopted to reduce the impact of wasabi diseases.

Some important steps to consider,

- Use virus-free tissue culture plants from approved nurseries
- Monitor wasabi plants for early disease symptoms; remove and properly dispose of symptomatic plant tissues and plants as recommended
- Monitor for nearby cruciferous weeds that may harbour diseases. Consider pulling up and disposing of weeds
- Submit plants showing disease symptoms to the Ministry of Agriculture's Plant Health Laboratory or to a recognized plant pest diagnostic laboratory for proper diagnosis and confirmation.

For Further Information

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