A CLINIC CLOSE-UP

Management of Black Leg in *Brassica* Vegetable Crops

Oregon State University Extension Service *September 2016*

Phoma lingam (sexual stage: *Leptosphaeria maculans*, syn. *Plenodomus lingam*) is a fungus that can infect a range of cruciferous crops including *Brassica* species (broccoli, Brussels sprouts, cabbage, collards, canola, forage rape, kale, mizuna, mustard greens, oilseed rape, oilseed turnip rape, rutabaga, turnip, etc.), *Eruca sativa* (arugula), *Raphanus sativus* (radish, daikon, and oilseed radish), and *Sinapis alba* (white and yellow mustard). Ornamental cruciferous flower-types can also be hosts, including Siberian wallflower (*Cherianthus allioni*) and Candytuft (*Iberis umbellate*). Aggressive strains of *L. biglobosa* have been found in western Oregon. *Leptosphaeria maculans* and *L. biglobosa* can both infect cruciferous weeds, and since 2014 have been found in western Oregon on birdsrape mustard (*Brassica napus*), black mustard (*B. nigra*), wallcress (*Arabidopsis thaliana*), American wintercress (*Barbarea orthoceras*), western yellowcress (*Rorippa curvisiliqua*), and wild radish (*Raphanus raphanistrum*).

The fungi that cause black leg in crucifers, *Leptosphaeria maculans* and *L. biglobosa*, survive on infected plant residues and will produce small, black, sexual reproductive structures known as pseudothecia (see photo 1) when infected plant residues are left on the soil surface. Pseudothecia develop sacs of ascospores (see photos 2A & B). Once ascospores are mature, they are forcibly ejected from the sacs following wet or humid conditions as the relative humidity drops and mean temperatures are between 46°F and 59°F, appearing outside of the pseudothecia through a small opening formed at the top of the dark, volcano-shaped structures. Dry periods of at least a few hours will allow the release of ascospores. Ascospores can be picked up by wind currents and potentially move several miles before alighting on crucifers' cotyledons or leaves where they can infect; however, most ascospores will be moved shorter distances. OSU monitoring of infected crop residues in western Oregon indicates that ascospore release during 2014 and 2015 began by mid-October and continued through February of 2015 and May of 2016 (see Figure 1). Freezing temperatures or prolonged dry conditions will pause ascospore development and release, but production will resume once cool and rainy conditions return.

Infection by ascospores is promoted by conditions of high humidity or leaf wetness, leading to the development of primary leaf spots. Wounding, insect or herbicide injury can also facilitate infections. Initially, leaf spots are small, indistinct, light-green areas (see photo 3) that turn into small brown spots (see photo 4). Spots enlarge as the fungus colonizes more leaf tissue, typically appear roundish, and leaf spots turn ashy gray with small, black dots (see photo 5). These small, black dots are pycnidia (see photo 6), structures that produce asexual spores known as pycnidiospores or conidia (see photo 7). Pycnidia can be produced on living tissues, including leaves, petioles, stems, or upper roots. Pycnidia can also be produced on infected seeds or dead plants. Pycnidiospores are dispersed by splashing rain or irrigation water, so their spread is limited to a few feet but their production can enable disease buildup within a planting, causing new leaf spots or infections on stems and petioles. Workers or equipment moving through an infected planting, especially during wet conditions, can spread disease within the field.

The fungus can infect and form cankers anywhere along plant stems as well as on the base of plants. Cankers are enlarged stem infections, brownish to gray in color with a dark brown to purplish-black margin (see photos 8 and 9); pycnidia can be found in small, ashy-gray areas within stem cankers. Stem cankers result in a grayish-black decay that can reach the center of main stems and girdle stems, resulting in premature plant death. Sometimes cankers are found only at the base of a plant, at or below the soil line (see photo 10). The upper root system can also be decayed as lower stem cankers develop along the plant length. Both pycnidia and pseudothecia can form on dead stem and root pieces, producing spores that lead to further disease spread (see disease-pathogen lifecycle in Figure 2).

Phoma lingam and *L. biglobosa* can survive for years on infected seeds. Planting only seed certified to be free of the black leg pathogen is a crucial management tool to aid in the prevention of black leg outbreaks; it is imperative that untested seed not be planted in Oregon. Current seed rules (OAR 603-052-0862, filed August 18, 2016) administered by the Oregon Department of Agriculture require that all crucifer seed stock (cabbage, broccoli, kale, radish, turnip, forage crucifers, etc.) intended for planting for commercial or home use in Oregon must be accompanied by an official test stating that the

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untreated seed is free from the black leg pathogen (*P. lingam=L. maculans*; *L. biglobosa*). When infected seed are planted, transmission to the seedling can result in small indistinct brown spots on cotyledons (see photo 11) or brown decay of the lower stem and upper taproot (see photo 12). Seedlings with infected stems often collapse, appearing as a damping-off problem, while the small brown patches on cotyledons are often mistaken for insect damage or mechanical injuries prior to cotyledons drying up and falling off of infected plants. Infected plants that survive past the seedling stage grow more slowly, eventually stunting is noticeable (see photo 13). Typically, there are stem cankers on the lower stem (see photo 14) which may resemble wirestem. However, close examination of affected lower stems will reveals the presence of pycnidia when black leg is present. Stunted plants should be lifted from the soil for examination the base of the plants because black leg due to infected seed is sometimes visible only on tissues growing below the soil line.

Plantings of cruciferous vegetable crops in western Oregon should be scouted for black leg during the months of October through May for disease symptoms and black leg buildup. Coordination among neighboring producers for black leg suppression will aid in minimizing localized disease pressure. Best management practices for control of black leg in *Brassica* vegetable crops include:

- Do not plant fall or winter crucifer crops in or adjacent to a site where a black leg outbreak has occurred within the past three years. Plants growing within a quarter mile of infected residues are at high risk for developing severe black leg during the fall, winter, or spring months.
- Do not grow *Brassica*, *Raphanus*, or *Sinapis* varieties or hybrids as cover crops or forages on or around cruciferous vegetable farms; utilize cereals, vetches, clovers, and/or other non-cruciferous species instead.
- If possible, delay spring plantings and practice summer cropping to avoid periods of windblown spore release from infected residues. Avoid overwintering of crops on farms that have recently experienced outbreaks until infected plant residues have decomposed and are no longer infectious (1 to 3 years).
- Treat seed with a hot water seed treatment (25 to 30 minutes in 122°F (50°C) water) or a conventional fungicide seed treatment. Either method will aid in controlling any infected seed that may occur in seed lots with infections levels below the threshold of seed testing detection limits.
- Provide ample space among plants to allow for faster drying of leaves. This can decrease the period of time conducive for infections.
- Scout crop plants regularly for presence of black leg, weekly is recommended in organic cropping systems. Removal of infected leaves and seedlings, or entire plants if cankered, may delay the onset of more severe disease if done early and regularly during disease outbreaks.
- Control susceptible weeds including birdsrape mustard, hedge mustard, penny-cress, western yellowcress, wild turnip, wild radish, and tansymustard as well as any volunteer cruciferous plants. Black leg can be difficult to see on weeds without magnification or not looking at the proper growth stage for symptom development. Control weedy and volunteer cruciferous plants across the farm, even where rotating out of crucifers. Don't forget to examine roadsides and farm lanes for weedy cruciferous plants. Destroy weedy plants prior to flowering in order to halt the production of infected weed seed that can perpetuate disease outbreaks during subsequent years.
- Harvest the crop and get it to market quickly because leaf spots and stem cankers will continue to enlarge after harvest even while in refrigeration. OSU has noted the development of severe leaf lesions on fresh market turnip plants after just 5 days in refrigeration under moist conditions (see photo 15).
- Do not leave vegetable crop plants standing in the field after harvest. Prior to the severe black leg outbreaks, plants could be left to flower, providing insect forage, but this practice with crucifer crops should no longer be occurring in western Oregon. Other flowering plants should be planted instead, and encouraged to bloom for beneficial insects.
- If possible, bury crucifer crop residues as quickly after harvest as feasible, or otherwise remove or destroy plant debris. Breaking up of the plant residues into smaller pieces by mechanical means will accelerate plant decomposition if left in the field. The lower stem region and the upper taproot often take much longer to decompose compared to the rest of the plant. Undecomposed plant pieces that remain on the soil surface in organic fields should be collected or buried before the fall rains begin.

For confirmation of black leg disease, contact a plant diagnostic clinic:

OSU Corvallis Plant Clinic
1089 Cordley Hall
Corvallis, OR 97331-2903
Tel: (541) 737-3472
http://plant-clinic.bpp.oregonstate.edu/

OSU HAREC Plant Pathology
PO Box 105/2121 S. 1st Street
Hermiston, OR 97838
Tel: (541) 567-8321
http://oregonstate.edu/dept/hermiston/plant-pathology-plant-lab-testing

For additional information:

On **hot water treatment**: Miller, S.A. and Lewis Ivey, M.L. Hot water treatment of vegetable seeds to eradicate bacterial plant pathogens in organic production systems. Ohio State University Extension Factsheet HYG-3086-05. Available on-line at http://onioline.osu.edu/hygfact/3000/pdf/3086.pdf

For **regulatory** items on the Oregon crucifer black leg seed rules, contact Oregon Department of Agriculture at (503) 986-4666 or see http://www.oregon.gov/ODA/programs/PlantHealth/Pages/PHMeetings.aspx. For Washington, see WSDA Crucifer Quarantine Chapter 16-301 WAC: General Seed regulations: http://apps.leg.wa.gov/wac/default.aspx?cite=16-301&full=true (Section 409).

For more **information on the disease**, see black leg in the PNW Plant Disease Management Handbook or on its website at https://pnwhandbooks.org/plantdisease.

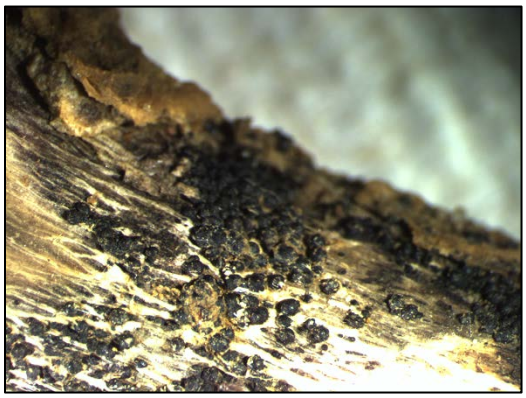
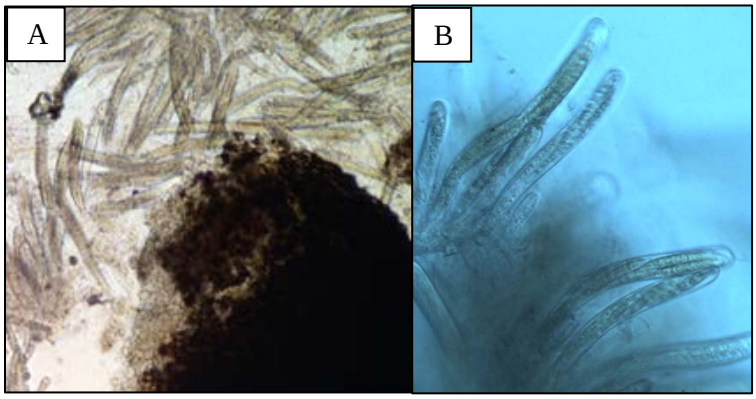


Photo 1. Portion of plant residues with black leg sexual reproductive structures known as pseudothecia (image: Ocamb).



Photos 2A & B. Sacs containing ascospores are produced in pseudothecia of the black leg pathogen, *Leptosphaeria* (image A: Claassen; image B: Ocamb).

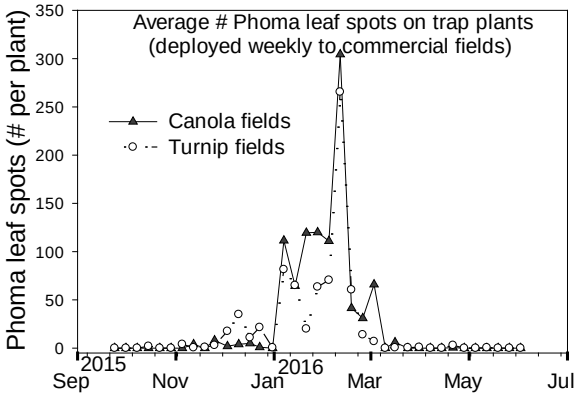


Figure 1. Development of black leg on trap deployed outside fields of infectious crop residues on commercial farms (figure by Claassen et al.).

Photo 3. Early stage of Phoma leaf spot shows an indistinct, light-green area (image: Ocamb).

Photo 4. Phoma leaf spot turns from light green to brownish while still in the early stages (image: Ocamb).

Photo 5. Phoma leaf spot on turnip has an ashy gray center with a yellow border and small, black dots which are spore-bearing structures known as pycnidia (image: Ocamb).

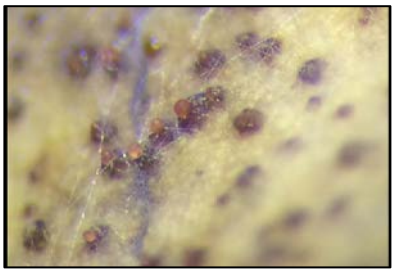


Photo 6. Close-up of pycnidia oozing asexual spores known as pycnidiospores(image: Claassen).

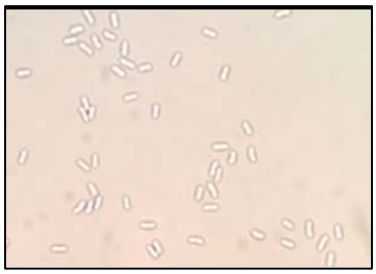


Photo 7. Close-up of asexual spores known as pycnidiospores (image: Claassen).

Photo 8. Stem canker on a broccoli plant (image: Ocamb).

Photo 9. Stem lesion on cabbage var. Michihili (image: Claassen).

Photo 10. A kale plant with black leg cankers on the base of the main stem and upper taproot (image: Ocamb).

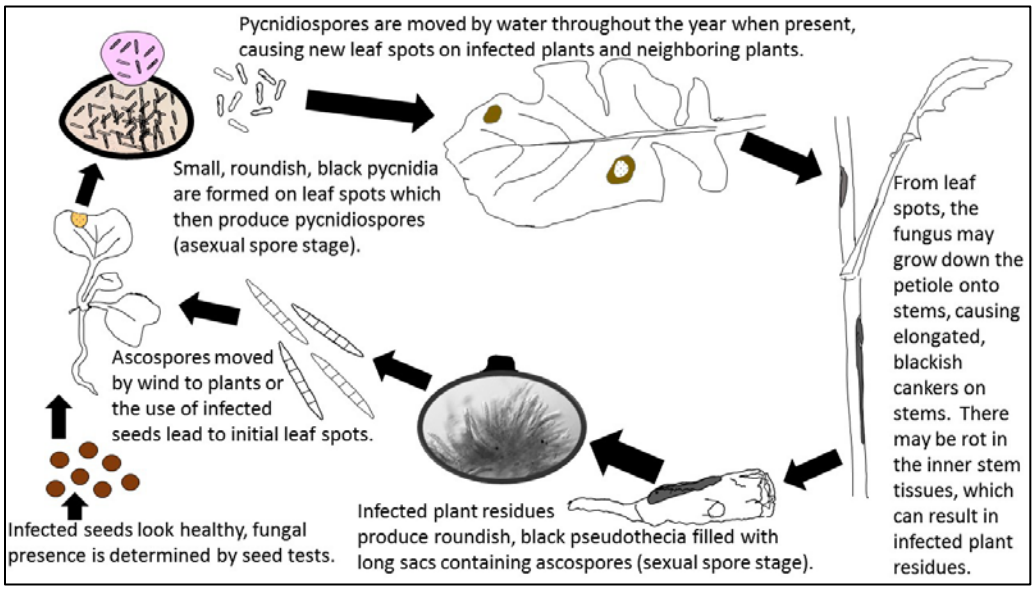


Figure 2. Lifecycle of the fungus, *Phoma*, and the black leg disease cycle on crucifers in Oregon (figure by Ocamb).

Photo 11. Small indistinct brown spots on a cotyledon after infected radish seed was planted in the greenhouse (image: Ocamb).

Photo 12. Brown decay of the lower stem and upper taproot after infected kale seed was planted in the greenhouse (image: Ocamb).

Photo 13. Stunted plants due to infected seed (image: Ocamb).

Photo 14. Stem cankers on the lower stem of plants grown from infected seeds (image: Ocamb).

Photo 15. Fresh market turnip leaf above with previously healthy leaves developed Phoma leaf lesions due to black leg after 5 days under refrigeration (image: Ocamb).