Emerging Brassica Diseases in the PNW: Black Leg, Light Leaf Spot, & White Leaf Spot

Lindsey du Toit, Washington State University
Small-Seeded Vegetable Seed Crops in PNW

Northwestern WA & Willamette Valley (since late 1800s)
Table beet, Brussels sprouts, cabbage, cauliflower, Chinese cabbage, Chinese mustard, collard, cress, kale, kohlrabi, radish, rutabaga, spinach, Swiss chard, turnip, ...

Columbia Basin of central WA (since 1950s), & central OR
Carrot, coriander, dill, kale, mustard, onion, parsley, parsnip, radish, turnip, ...

~35 species, many annual & biennial crucifers
15,000-25,000 total acres/year, $1,000-$8,000/acre
>$100 million annually
50-100% of U.S. seed supply; 10-50% of world seed supply

Other crucifers in PNW: Canola, cover crops, forage crops, fresh market & processing brassica vegetables, ...
Biodiesel “will be the biggest issue that the Legislature will be focusing on.”

Clifford Traisman, a lobbyist for Washington Conservation Voters and the Washington Environmental Council

Environmentalists make strides in legislative session

By RACHEL LA CORTE
Associated Press Writer

OLYMPIA — Washington state’s environmental community

Biodiesel demand grows

Demand for biodiesel ethanol has grown with the use of gasoline and other renewable fuels. Biodiesel is a by-product of the meat and dairy industries. It’s about reducing waste and dealing with the Legislature.

Skagit Valley Herald, 2 January 2006
Seedborne Crucifer Pathogens of Economic Concern
= Zero Tolerance on Vegetable Seed

Black leg (fungal disease)
*Phoma lingam*

Black rot (bacterial disease)
*Xanthomonas campestris pv. campestris*
Dormant Crucifer Seed
Chapter 16.301-490-580 WAC

- Regulated counties in northwestern WA:
  - Clallam, Island, Lewis, Skagit, Snohomish, & Whatcom
- Crucifer materials regulated: seed, seedlings, roots, or transplants for seed, oil, or commercial vegetable production; & crucifer crop residues
- Notice of Intent/Quarantine Compliance Form:
  - Filed with WSDA Seed Program before shipping, moving, or transporting crucifer seed into regulated area
    - Lab analysis or phytosanitary certificate for the 2 regulated diseases
    - Seed analysis certificate for dormant seed (WAC 16-301-510)
- Seed lots that test positive: Must be treated; treated seed can be planted if free of the two regulated pathogens when re-tested
- Exemptions:
  - USDA & University research trial grounds
  - Pre-packaged crucifer seed <0.5 oz, if free of the 2 regulated pathogens
  - Seedlings for home garden use, if free of the 2 regulated pathogens
  - Crucifers produced in greenhouses or indoors (solely)
2014 Epidemic of Black Leg in Crucifer Crops Across the Willamette Valley of OR

Cynthia Ocamb, OSU
2014 Survey of Crucifer Crops in Willamette Valley, after Finding Black Leg in an Overwintered Seed Crop

Cindy Ocamb, OSU Plant Pathologist, ocambc@science.oregonstate.edu

43/61 sites examined by Sep. 2014 = Black leg
24/61 sites = Light leaf spot
17/61 sites = White leaf spot

**Black leg**

*Phoma lingam*

- Occurs across the US

**Light leaf spot**

*Cylindrosporium concentricum*

- Never reported in US before

**White leaf spot**

*Pseudocercosporella capsellae*

- Never reported in PNW before, only southeastern US
Crucifer plants found infected with *Phoma lingam* in w. Oregon in 2014
(as of September 2014, Cindy Ocamb, OSU)

<table>
<thead>
<tr>
<th>County</th>
<th>Crop/plant</th>
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<tr>
<td>Benton</td>
<td>Fall-planted canola</td>
<td>Marion</td>
<td>Kale</td>
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<tr>
<td>Benton</td>
<td>W. Russian kale</td>
<td>Marion</td>
<td>Cabbage or collards</td>
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<td>Benton</td>
<td>Mizuna (organic)</td>
<td>Marion</td>
<td>Russian kale</td>
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<tr>
<td>Benton</td>
<td>Volunteer mustard in wheat</td>
<td>Marion</td>
<td>Forage <em>Brassica</em></td>
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<tr>
<td>Benton</td>
<td>Fresh market cabbage (spring sown)</td>
<td>Marion</td>
<td>Forage <em>Brassica</em></td>
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<td>Lane</td>
<td>Processing broccoli (spring sown)</td>
<td>Marion</td>
<td>Western yellow cress (weed)</td>
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<td>Linn</td>
<td>Volunteer mustard in turnip</td>
<td>Polk</td>
<td>Cabbage</td>
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<tr>
<td>Linn</td>
<td>Chinese cabbage (spring sown)</td>
<td>Polk</td>
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<td>Pak choi (spring sown)</td>
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<td>Linn</td>
<td>Turnip</td>
<td>Polk</td>
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<td>Marion</td>
<td>Forage turnip</td>
<td>Yamhill</td>
<td>Volunteer turnip in wheat</td>
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<tr>
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<td>Black mustard (weed)</td>
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<td>Fall-planted canola</td>
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<tr>
<td>Marion</td>
<td>Bird's rape (weed)</td>
<td>Yamhill</td>
<td>Turnip</td>
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Overwintering kale crop, Willamette Valley, OR
January 2015
Canola crops infected with black leg, Willamette Valley, OR

Photos courtesy of Cynthia Ocamb, OSU
Arugula seed crop, January 2015

Photos courtesy of Cynthia Ocamb, OSU

Volunteer brassica, January 2015
Light Leaf Spot (*Cylindrosporum concentricum*) in Europe, Australia, & Asia

Winter oilseed rape losses due to diseases (£ million)

Based on Defra-funded winter oilseed rape pest and disease survey data delivered through CropMonitor ([www.cropmonitor.co.uk](http://www.cropmonitor.co.uk)), for oilseed rape price of £380/t.

Possible factors behind the brassica disease epidemic in the Willamette Valley in 2014-15

- **Prior to Oregon HB2427**: rapeseed production districts set in 1990 to minimize black leg, cross-pollination, & volunteers
- Crucifer seed lots: Must be tested and treated for *P. lingam* before planting
- Field locations must be pinned
- Crucifers may not be grown in same field more than 2 of 5 years
  - Producers must control volunteers within 1/4 mile of fields
  - Seed transported in a manner that prevents escape
  - Equipment must be cleaned before leaving field and unloading
- *Raphanus*: same rules except for equipment cleaning
- **HB2427 implemented in ~2009**: interest in canola production in Willamette Valley - focused on cross-pollination only, no requirement for seed testing or treatment for black leg
- Widespread planting of brassica cover crops during economic recession, & canola planted in approved areas of Willamette Valley
Temporary ODA Rule in Response to Crucifer Diseases Found in Willamette Valley in 2013-14

(Nancy Osterbauer, ODA, nosterbauer@oda.state.or.us, (503) 986-4666)

• Commodities covered:
  – *Brassica*, *Raphanus*, and *Sinapis* seed and plants
  – Exemption: prepackaged seed lots or transplants for home use

• Stock seed must be:
  – Accompanied by certificate showing seed is black leg-free OR
  – Be treated in an approved manner for black leg

• All transplants must originate from tested &/or treated seed
Temporary ODA Rule in Response to Crucifer Diseases Found in Willamette Valley in 2013-14
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• Management practices to minimize disease increase
  – Covered commodities not grown on same land more than 2 consecutive years, and not more than 2 in every 5 years
  – Volunteer or uncontrolled Brassicaceae in and near production fields must be rogued/eliminated
  – Planting, harvest, and transportation equipment shall be cleaned to prevent inadvertent spread from fields
  – Unbagged loads transported within the Valley must be enclosed in bins or covered containers to prevent seed loss

• Seed dealers must keep copies of all pertinent records for testing and seed treatment, and make these records available to the ODA upon request
• Emergency/temporary ODA rule proposed on 18 June 2014
• Advisory group met on 25 June
• Proposed rules reviewed legally
• Temporary law effective on 7 July
• Permanent ODA rule effective as of 13 January 2015
  – *Leptosphaeria maculans* and *L. biglobosa*
  – Mandatory biennial review of rules
Black Leg of Crucifers

- *Phoma lingam*: asexual, pycnidia with conidia, splash dispersed
- *Leptosphaeria maculans*: sexual, pseudothecia with ascospores, aerially dispersed
Black Leg of Crucifers

- Most crucifer crops & weeds
- Survival:
  - 4+ years on seed
  - 3+ years on crop residues
- Spread:
  - splashing water (conidia)
  - running surface water
  - airborne ascospores
  - seed, transplants
  - machinery, tools, workers
- Optimum conditions: wet & cool
Management of Black Leg

- 4+ year crop rotation
- Avoid wetting transplants
- Separation of crucifer crops
- Site selection
- Some resistant cultivars
- Control crucifer weeds
- Avoid working in wet fields
- Inspection & rogueing
- Sanitation
- Foliar fungicide applications, e.g., strobilurins, iprodione, ...
- Incorporate residues soon after harvest:
  - Do not leave crop residues on soil surface after harvest
- Purchase & plant only certified &/or treated seed
  - hot water (122°F for 25-30 mins)
  - fungicides – benomyl was industry standard, newly registered fungicides
- Region-wide adoption of management practices!
Black leg seed treatment trials: 2004 Results


Greenhouse grow-out assay

% Plants infected with Phoma lingam

Control  Thiram  Rovral 1/2 pt  Tospin M  Merject  Pristine  Dynasty  Rovral 1 pt  Benlate  Endura  Maxim

Control: a, Thiram: b, Rovral 1/2 pt: c, Tospin M: ab, Merject: c, Pristine: c, Dynasty: c, Rovral 1 pt: c, Benlate: c, Endura: c, Maxim: c

Incorporated image showing a plant with visible infection.
Black leg seed treatment trials: 2005 Trial

Blotter seed health assay & greenhouse grow-out assay

Correlation of % seed transmission with % *P. lingam* detected in seed health assay: $r = 0.70$ (at $P < 0.0001$)
WSU Black leg seed treatment trials: Summary

- **2004 (6% infected with *P. lingam***):
  - Benomyl, boscalid (Endura), boscalid + pyraclostrobin (Coronet/Pristine), iprodione (Rovral), & thiabendazole (Mertect) completely prevented seed transmission.
  - Boscalid (Endura) = as effective as benomyl.

- **2005 (28% *P. lingam***):
  - Boscalid + pyraclostrobin (Coronet/Pristine) = most effective at preventing seed transmission
  - 2nd best: benomyl (Benlate), thiabendazole (Mertect 340F) at higher rate, & iprodione (Rovral 4F)
  - Azoxystrobin (Dynasty 100FS) = least effective
Treatments for Black Leg

• **Seed treatments**
  - Hot water: 122°F (50°C) for 25-30 mins, cold rinse, dry
  - Fungicides:
    - **Boscalid + pyraclostrobin** (Coronet = FRAC Groups 7 + 11)
    - **Iprodione** (Rovral 4F = Section 18 WA-070001 = FRAC Grp 2)
    - **Thiabendazole** (Mertect 340F = FRAC Group 1)
    - **Azoxystrobin** (Dynasty = FRAC Group 11)
    - **Fludioxonil** (Maxim 4FS = FRAC Group 12)
    - **Thiram** (e.g., Thiram 42-S, Signet = FRAC Grp M3) – resistance mgmt

• **Foliar treatments registered in WA for brassicas**
  - **Boscalid** (Endura = FRAC Group 7)
  - **Iprodione** (e.g., Rovral 4F, Meteor, Nevado = FRAC Group 2)
  - **Pyraclostrobin** (Cabrio = FRAC Grp 11, Priaxor Xemium = pyraclostrobin + fluxapyroxad = FRAC Groups 11 + 7)
  - **Azoxystrobin** (e.g., Aframe, Azure, Equation, Satori = FRAC Grp 11; Quadris Top = azoxystrobin + difenoconazole = FRAC 11 + 3)
  - **Penthiopyrad** (Fontelis = FRAC 7)
  - **Chlorothalonil, mancozeb** – resistance management
Application of a pesticide to a crop or site that is not on the label is a violation of pesticide law and may subject the applicator to civil penalties. In addition, such an application may also result in illegal residues that could subject the crop to seizure or embargo action. It is your responsibility to check the label before using the product to ensure lawful use and obtain all necessary permits in advance.
WSDA Crucifer Quarantine: Does the Rule Suffice?

• Current rule protects parts of 5 counties in NW WA
• Risks for black leg/black rot in central/eastern WA?
  • Black leg established in Bonner’s Ferry, ID (2011)
  • Rapeseed seed crop residues infected in Lewiston, ID (2014)
  • WSDA survey of co.’s selling brassica seed east of Cascades: Most, but not all, seed lots are tested/treated
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  • WSDA survey of co.’s selling brassica seed east of Cascades: Most, but not all, seed lots are tested/treated
• Columbia Basin? Vegetable & canola seed crops, cover crops
• Dryland areas of WA? Canola, camelina, other brassicas
• Modify current rules for other regions of WA?

• Production of Brassica Seed Crops in Washington State: A Case Study on the Complexities of Coexistence. Inglis, Miller, & du Toit, 2013. WSU EM062E.
• PNW Black Leg Interest Group: dutoit@wsu.edu or 360-848-6140
• WSDA Seed Program: Victor Shaul at Vshaul@agr.wa.gov or 509-249-6950
Play With Your Food