



# Changes to the WSDA Crucifer Quarantine for Black Leg and Black Rot of Brassicas

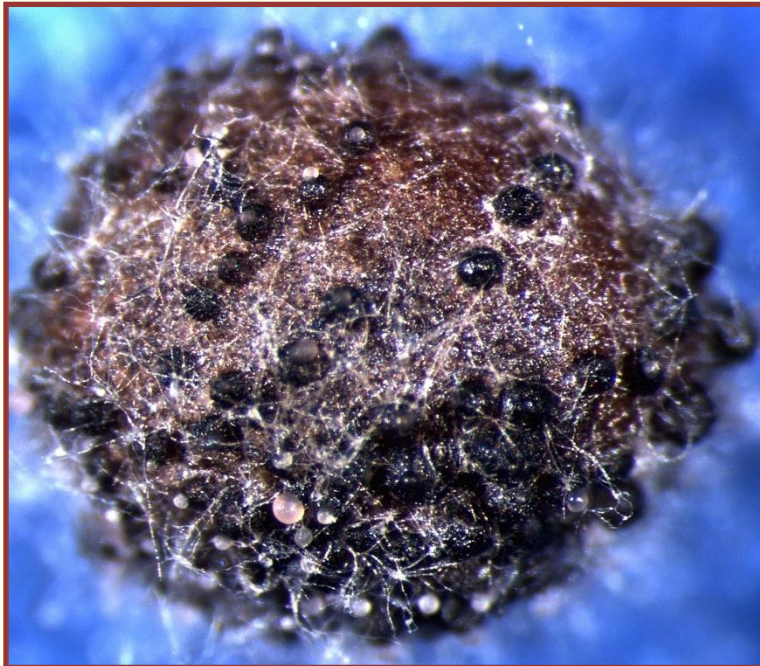
Lindsey du Toit, Washington State University

2023 Pacific Northwest Vegetable Association  
Annual Convention & Trade Show, Kennewick, WA  
15-16 November 2023

# Seedborne Pathogens of Economic Concern (= Zero Tolerance) on Crucifer Vegetable Seed

**Black leg (fungal disease)**

*Phoma lingam*



**Black rot (bacterial disease)**

*Xanthomonas campestris* pv.  
*campestris*



# Dormant Crucifer Seed



Tim Miller, WSU

*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 price of gasoline and other fuels. Biodiesel is

**Skagit Valley Herald, 2 January 2006**





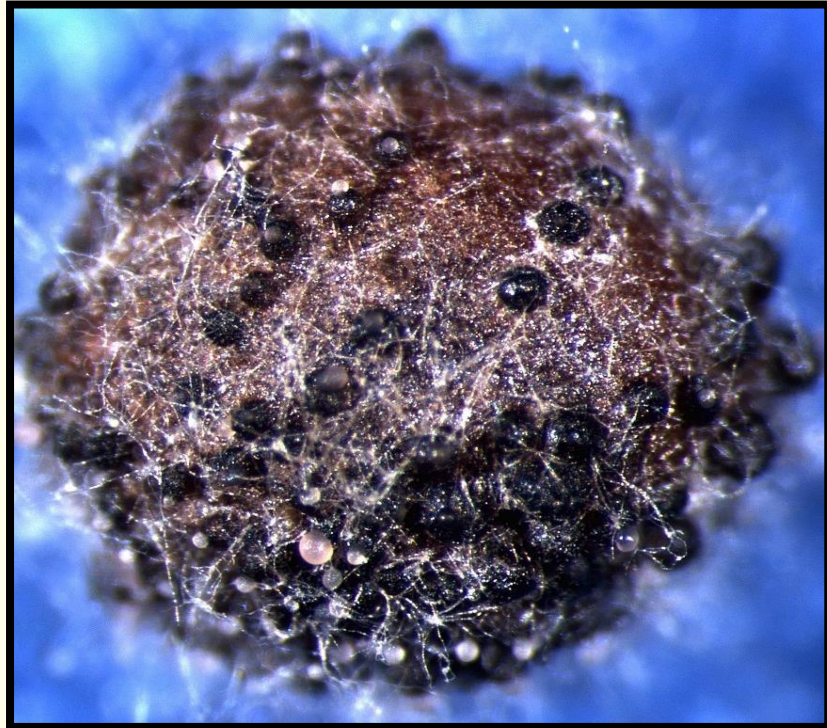
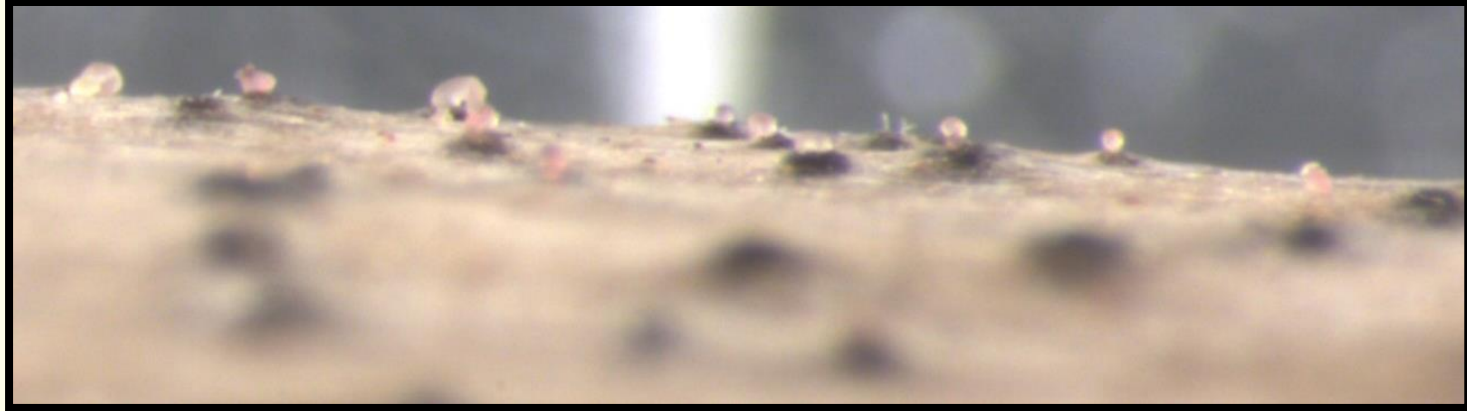
# WASHINGTON STATE LEGISLATURE

## Chapter 16.301-490 to 580 WAC

**Crucifer seed  
quarantine: 20 Jan. 2006**

- 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, Oregon



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

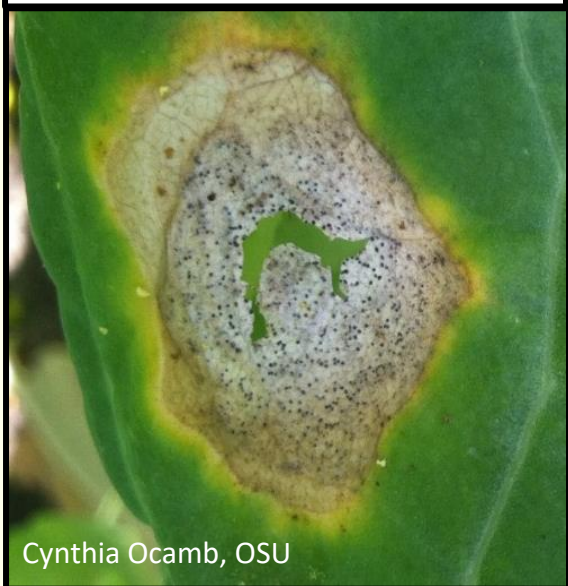
Dr. Cynthia Ocamb, OSU Plant Pathologist, [ocambc@science.oregonstate.edu](mailto:ocambc@science.oregonstate.edu)

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 USA

**Light leaf spot**  
*Cylindrosporium  
concentricum*



Never in USA before

**White leaf spot**  
*Neopseudocercospora  
capsellae*



Rare in PNW, primarily SE USA

# Crucifer plants found infected with *Phoma lingam* in western Oregon by September 2014 (Cindy Ocamb, OSU)

County	Crop/plant	County	Crop/plant
Benton	Fall-planted canola	Marion	Kale
Benton	W. Russian kale	Marion	Cabbage or collards
Benton	Mizuna (organic)	Marion	Russian kale
Benton	Kale	Marion	Fall-planted canola
Benton	Collards	Marion	Fall-planted canola
Benton	Kale	Marion	Fall-planted canola
Benton	Volunteer mustard in wheat	Marion	Forage <i>Brassica</i>
Benton	Fresh market cabbage (spring sown)	Marion	Forage <i>Brassica</i>
Lane	Processing broccoli (spring sown)	Marion	Western yellow cress (weed)
Linn	Volunteer mustard in turnip	Polk	Cabbage
Linn	Chinese cabbage (spring sown)	Polk	Fall-planted canola
Linn	Chinese mustard (spring sown)	Polk	Fall-planted canola
Linn	Pak choi (spring sown)	Polk	Fall-planted canola
Linn	Turnip	Polk	Turnip
Linn	Western yellow cress (weed)	Polk	Turnip
Linn	Chinese cabbage (spring sown)	Polk	Forage <i>Brassica</i>
Linn	Chinese cabbage (spring sown)	Yamhill	Volunteer turnip in wheat
Marion	Forage turnip	Yamhill	Volunteer turnip
Marion	Black mustard (weed)	Yamhill	Fall-planted canola
Marion	Bird's rape (weed)	Yamhill	Turnip
Marion	Bird's rape (weed)	Yamhill	Turnip
Marion	Kale		





Canola crop 2/5/2015

Turnip seed crop 2/5/2015



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

- **Prior to Oregon HB2427:** rapeseed production districts set in 1990 to minimize risks of 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
- **HB2427 implemented in ~2009:** interest in canola production in Willamette Valley - focused on cross-pollination, removed the requirement for seed testing or seed treatment for black leg (?!)
- Widespread planting of brassica cover crops during economic recession, & canola planted in approved areas of Willamette Valley

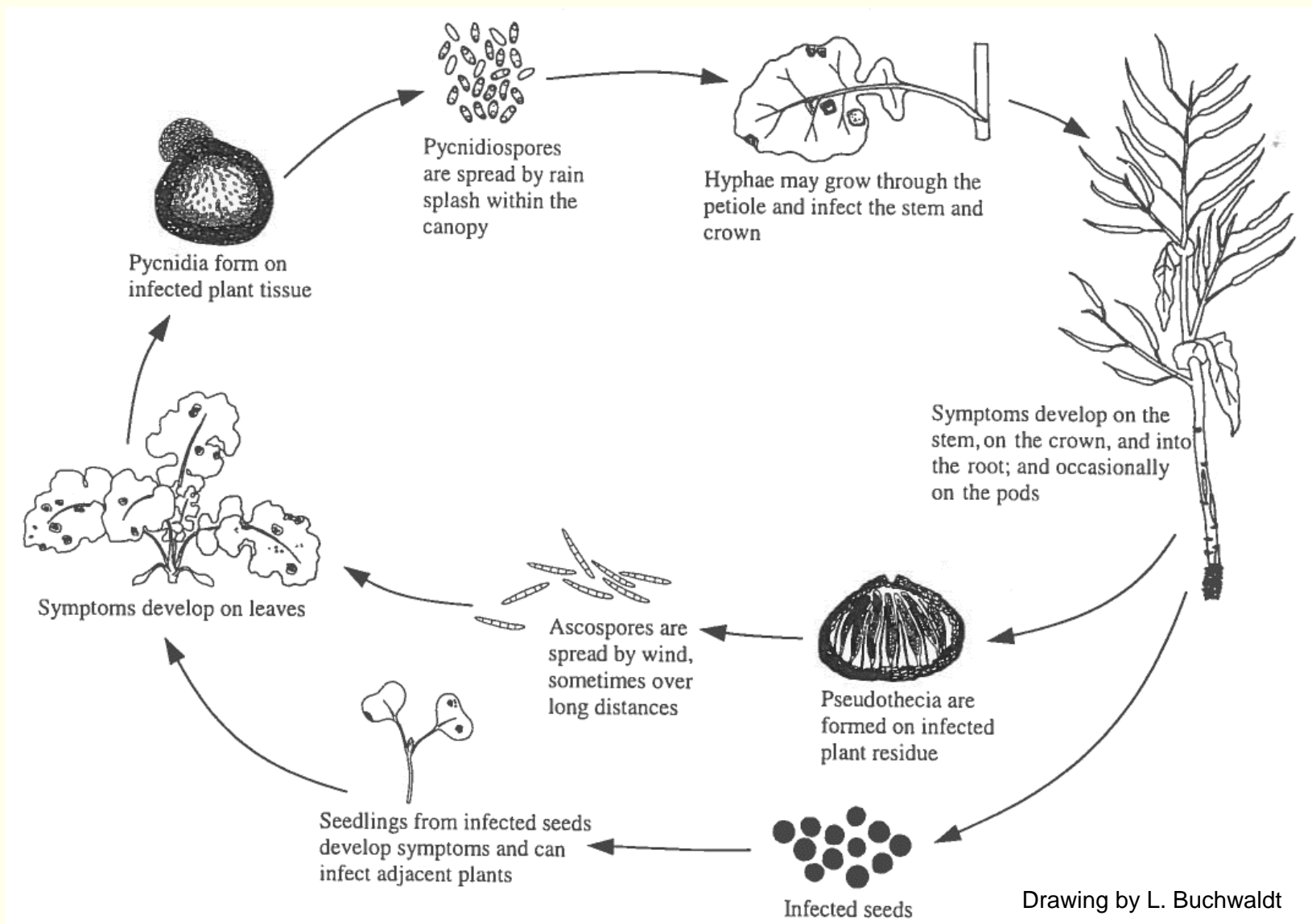
# Response to Crucifer Diseases in the Willamette Valley in 2014

- Emergency/temporary ODA rule proposed: June 2014
- Temporary law effective: July 2014
- **Permanent rule effective: Jan. 2015:**
  - **OAR 603-052-0870**
  - *Leptosphaeria maculans* and *L. biglobosa*
  - Mandatory biennial review of rules
  - Any crucifer seed to be planted must be tested **AND** treated for black leg
- **Rule modified in 2017:** if a seed lot tests negative, treatment is not required



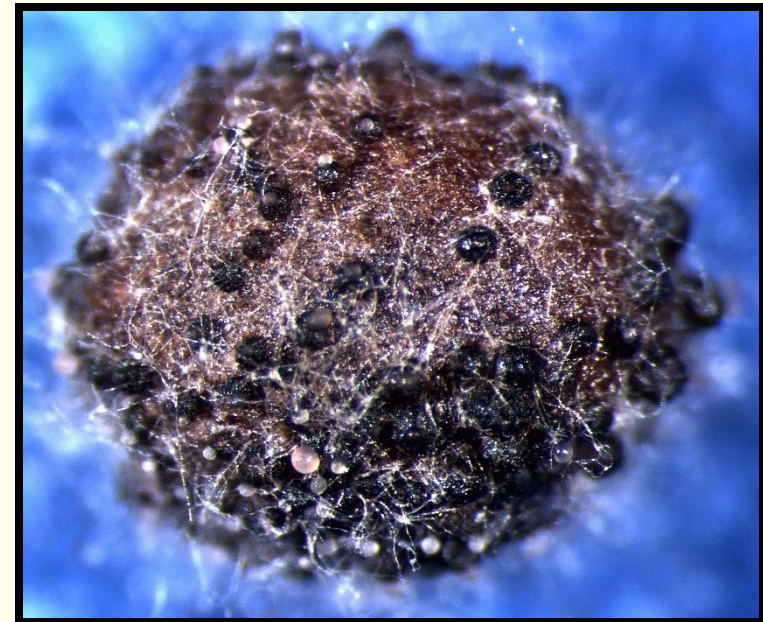
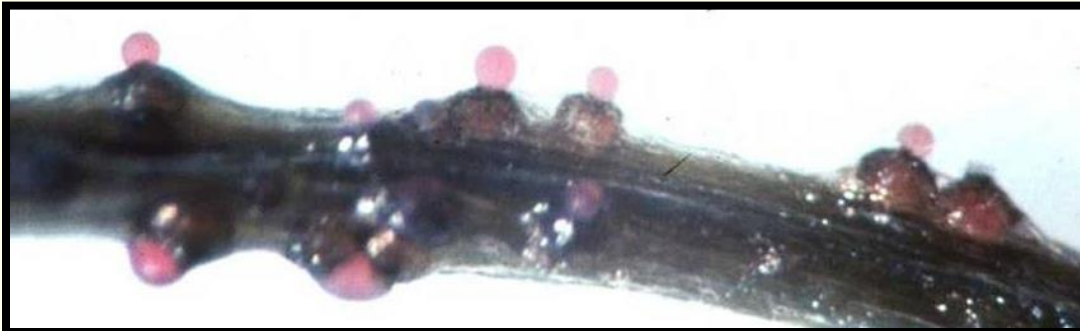
# Black Leg of Crucifers

- *Phoma lingam*: asexual, pycnidia (conidia), splash dispersed
- *Leptosphaeria maculans*, *L. biglobosa*: sexual, pseudothecia (ascospores), airborne



# 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 tested &/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!**



# Treatments for Black Leg

## • Seed treatments

- Hot water: 122°F (50°C) for 25-30 minutes, cold rinse, dry
- Fungicides:
  - Boscalid + pyraclostrobin (Coronet = FRAC Groups 7 + 11)
  - Iprodione (Rovral 4F = Section 18 WA-070001 = FRAC Grp 2)
  - Difenoconazole (e.g., Helix Xtra, FRAC Groups 3 + 4 + 12; etc.)
  - 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 Group M3) – resistance management



# Treatments for Black Leg

## • Foliar applications registered in WA

- 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 Group 7)
- Prothioconazole (Proline = FRAC Group 3)
  - **WSDA SLN 24(c) for non-food/non-feed brassica seed crops approved in 2017. ODA SLN approved in Jan. 2016. Research in 2017 to extend WSDA SLN for 5 years.**
- 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.

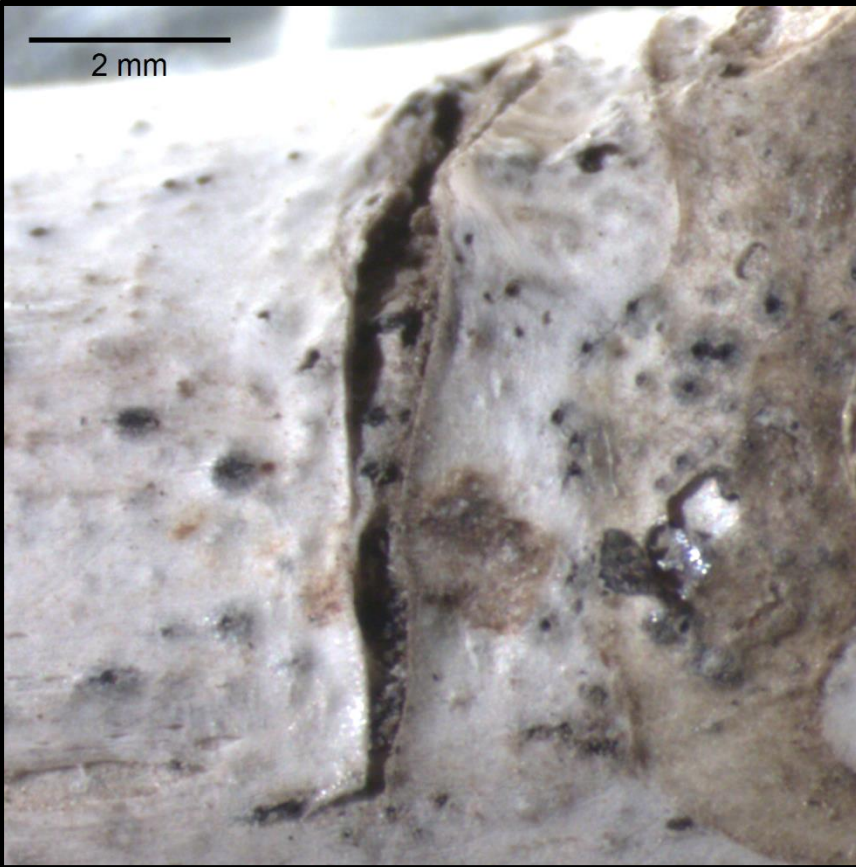
It is your responsibility to check the label before using the product to ensure lawful use and obtain all necessary permits in advance.

# WSDA Crucifer Quarantine: Does the Rule Suffice?

Lewiston, ID rapeseed seed crop residues (Nov. 2014)

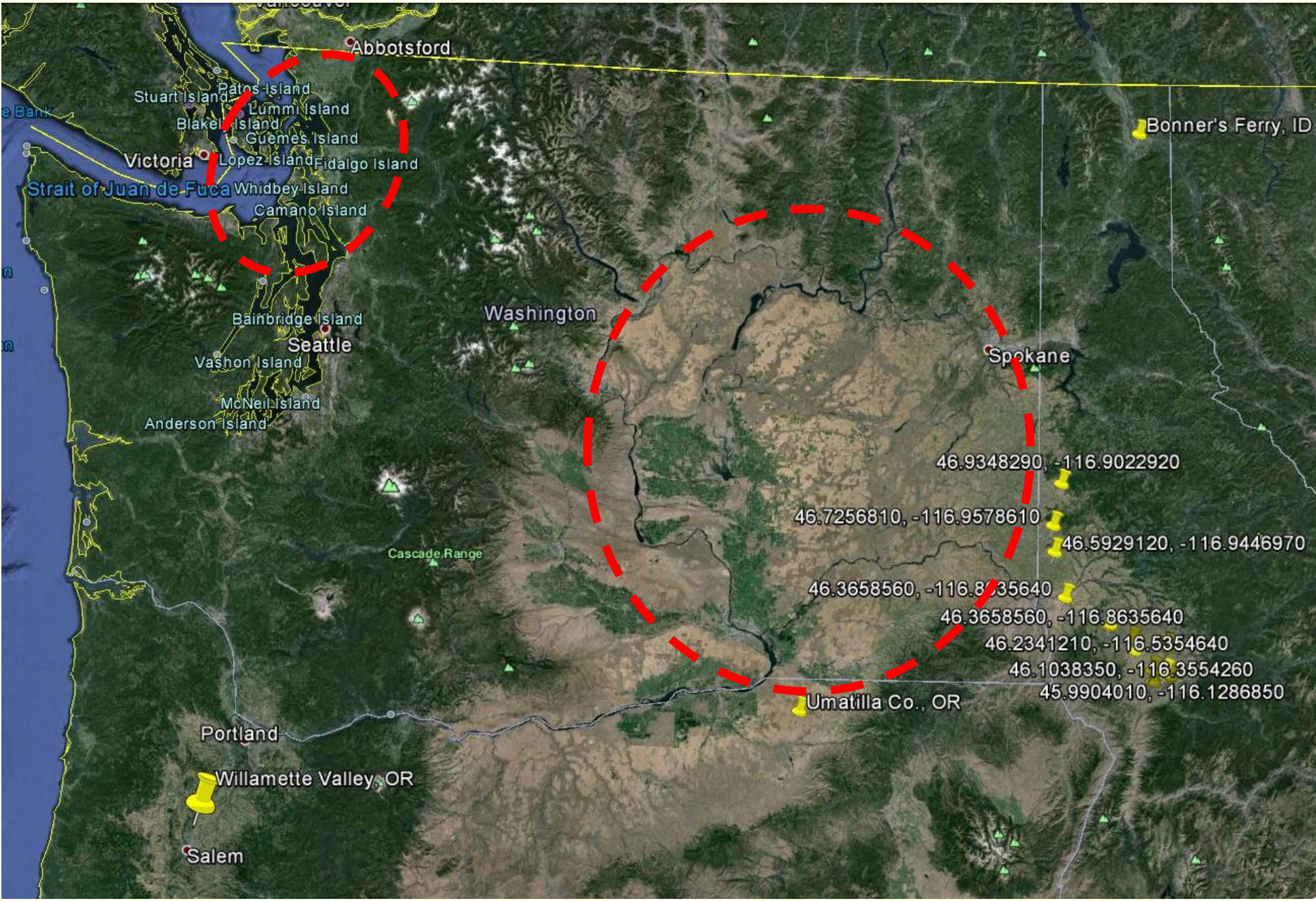


# WSDA Crucifer Quarantine: Does the Rule Suffice?



**Mar.-Apr. 2015:**  
Canola crop residues  
Winter canola crops  
Tumble mustard (*Sisymbrium altissimum*)  
**Grangeville to Moscow**  
>15 fields in Idaho, Latah, Lewis,  
Nezperce Counties, ID  
2 winter canola crops, Umatilla Co., OR

# WSDA Crucifer Quarantine: Rule Expansion



# WSDA Crucifer Quarantine: Does the Rule Suffice?

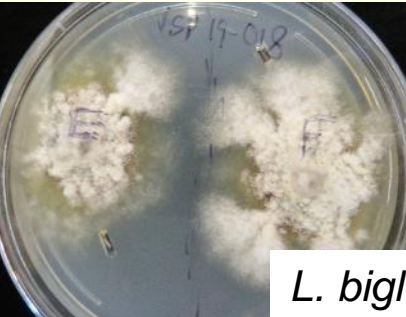
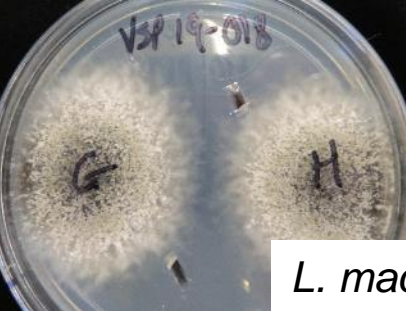
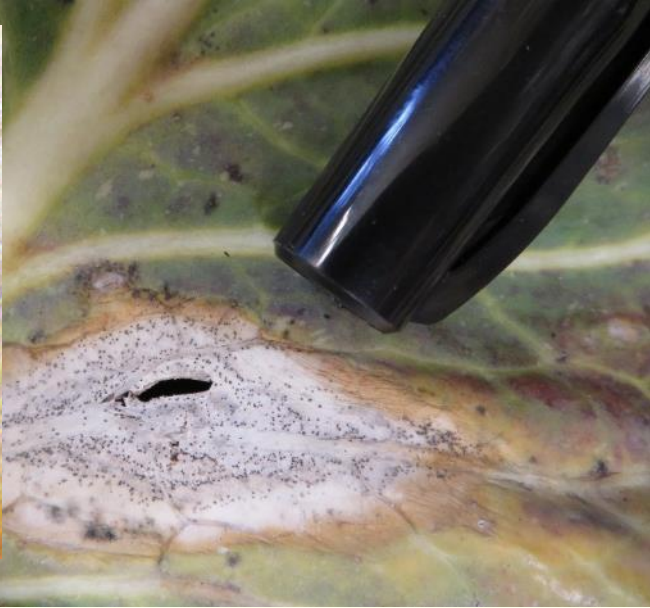
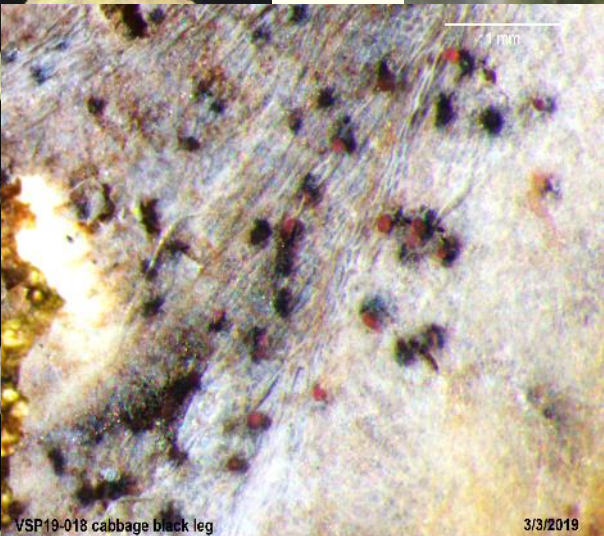
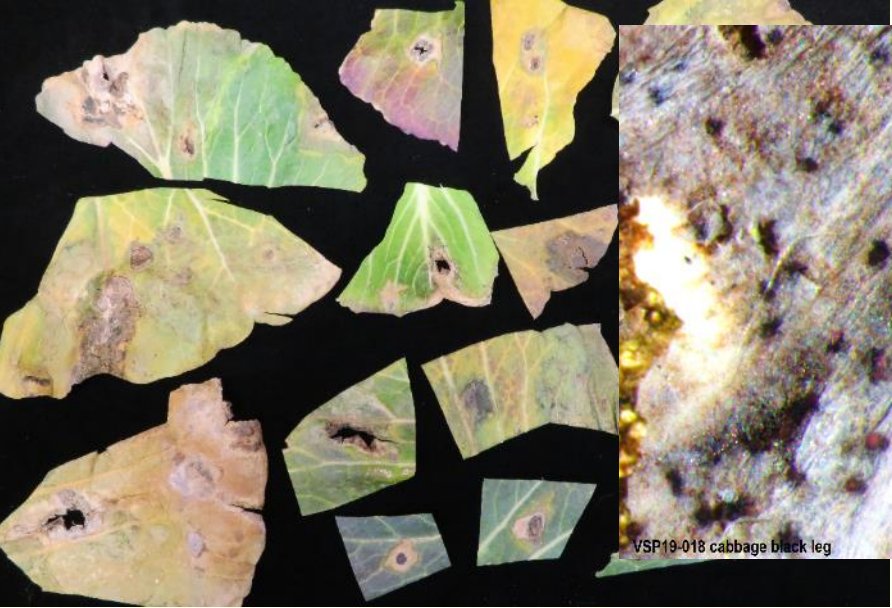
- Columbia Basin: Vegetable & canola seed crops, cover crops
- Dryland production areas: Canola, camelina, cover crops, ...
- Spring-summer 2015 survey of dryland canola crops & residues: Karen Sowers & Tim Paulitz
- WSDA survey of co.'s selling brassica seed east of Cascades:
  - Most, not all, seed lots are tested/treated for black leg/black rot
- **Emergency WSDA rule expanded July 2015:** all counties east of Cascades
- **Amendment to WAC 16-301 for east of Cascades:**
  - Seed testing for black leg only
  - Approved black leg seed health assay
  - WSDA Crucifer Quarantine Tag required
    - mother lot label for daughter lots
  - Exempt if seed is produced (grown) **in** regulated area
  - No seed treatment required if negative black leg seed test

# Black Leg in Eastern Washington

- **Fall 2015:** Winter canola residues from 2014-15 crops (Paulitz et al. 2017)
- **2016-19:** >40 dryland & irrigated canola sites, crucifer cover crops including radish inter-seeded in wheat crops, primarily winter canola but not on pods by summer (Tim Paulitz & Karen Sowers)
- *Leptosphaeria maculans* and *L. biglobosa*
- As close to the Columbia Basin as Odessa, WA and Boardman, OR



# Black Leg in Northwestern WA: 5 cabbage seed crops in 2019



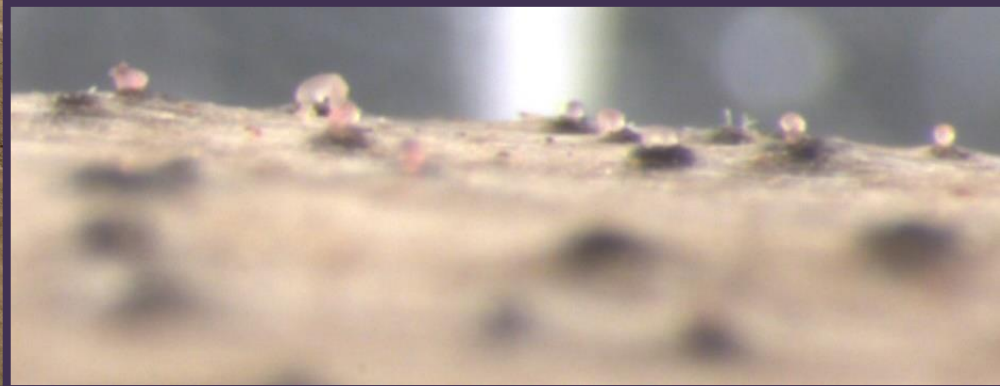
- 3 seed crops in Skagit Co., 2 in Snohomish Co.
- *L. maculans* & *L. biglobosa*
- Multiple seed companies & growers affected
- Crop destruction, surrounding crops monitored in 2019
- Stock seed lots tested negative
- Inoculum source? From nurseries? Other brassica crops?
- Monitor for ascospores in 2019-20



# Brassica Black Leg Ascospore Trapping



- **Monitor airborne ascospores**
- 4 Burkard spore traps: Skagit Co. & Snohomish Co.
- Test for *Leptosphaeria maculans* & *L. biglobosa*: PCR assays, spores on tape
- **1 trap:** Oct. 2019 – May 2020
- **3 traps:** Feb. – May 2020



# Results

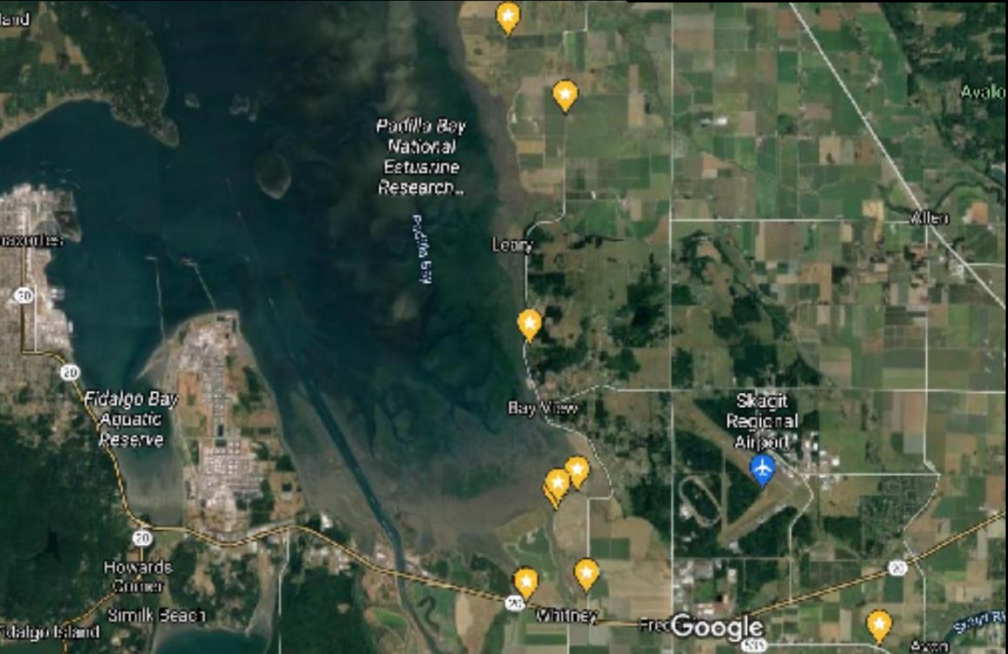
- Ascospores not detected in Skagit & Snohomish Counties
- Black leg not observed in seed & other brassica crops, weeds
- **Conventional fungicides:**
  - Seed treatment (Coronet)
  - WSDA approved  $\leq 2$  fall applications +  $\leq 3$  spring/summer applications of Proline 480 SC (prothioconazole = FRAC group 3) in biennial brassica seed crops
  - Rotate with other FRAC groups (modes of action)



## Acknowledgements

PSSGA (NARF), WSCPR, Sakata, Syngenta, Skagit Seed Services, Universal, Vikima, seed growers

# 2021 Black Leg Outbreak in Stands of Wild Mustard in Northwestern WA



# Burning of wild mustard on Padilla Bay Trail on 4/12/2021



Joseph Shea, WA Noxious Weed Control Board

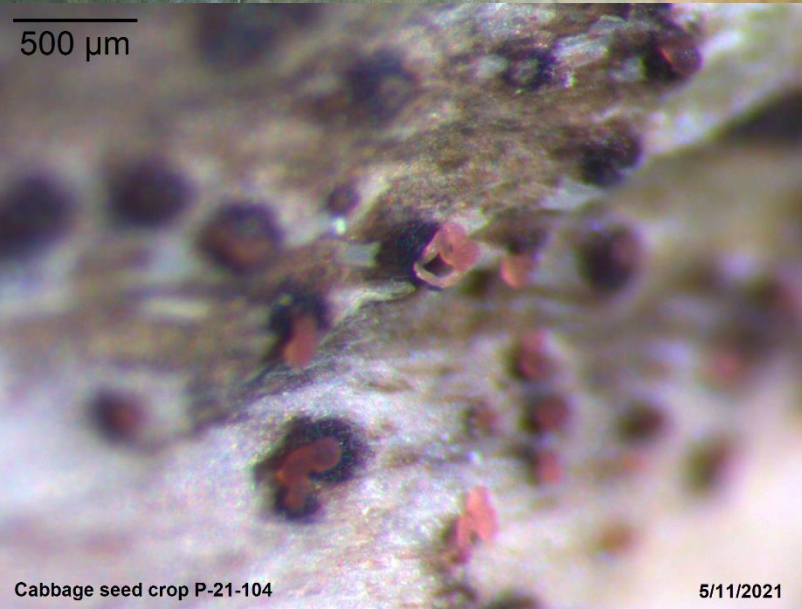
Mustard seedlings on 5/18/2021



Joseph Shea, WA Noxious Weed Control Board

Joseph Shea, WA Noxious Weed Control Board

# April-May 2021 Survey for Black Leg in Biennial Brassica Seed Crops in Western WA



- WSDA Seed Program staff surveyed 69 brassica seed crops in 5 counties
- Suspect leaf spots on samples from 50 crops
- Examined by Lindsey du Toit
- Isolated, DNA sequenced, pathogenicity tested
- 51 isolates: 32 *L. maculans* & 17 *L. biglobosa*
- *L. maculans* in wild mustards & seed crops
- *L. biglobosa* only in seed crops
- 7 seed crops tested positive (2 counties)

500  $\mu$ m

# The Cat is Out of the Bag Across Washington State

## = Post-quarantine world for black leg

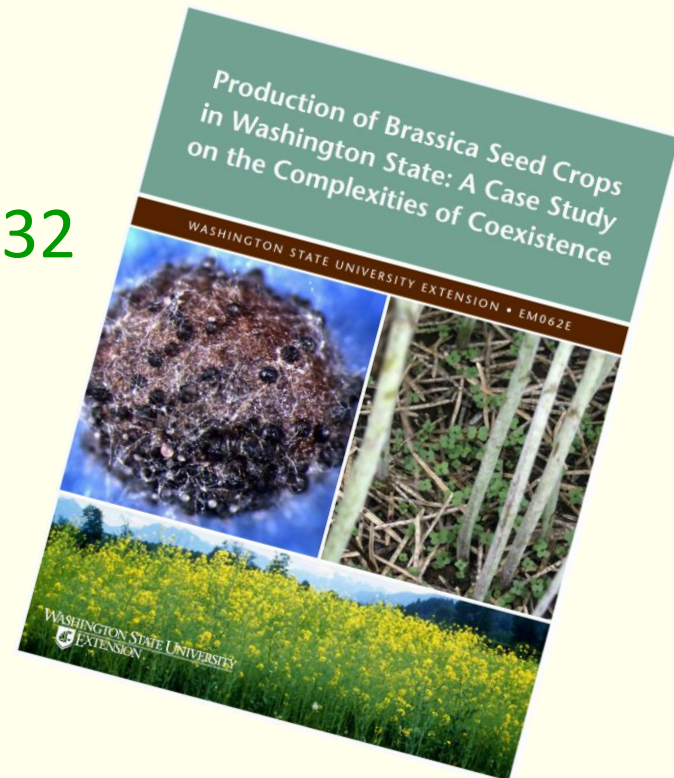
- Multiple meetings with PSSGA, WWSSAC, WSDA Seed Program in 2021-2023
- Black leg is now established in northwestern WA & eastern WA
- Modify WAC 16.301-490 to 580 Crucifer Quarantine rules:
  - Proposed amendments for brassica crops that test positive:
    - No longer require crop destruction
    - Require incorporation of crop residues into the soil after harvest & within a limited timeframe to minimize the sexual stage (airborne ascospores) developing on dead stems & racemes?
    - Require testing of harvested seed?
    - Require 5-year rotation out of brassicas for affected fields?
  - Still require testing and labeling of all brassica seed lots planted in WA?
- Protections for brassica vegetative and seed crops in the Columbia Basin
- Rule is being modified
- **Black rot quarantine** still exists for 6 counties in northwestern WA

**Black rot of brassicas (*Xanthomonas campestris* pv. *campestris*), 2022, western WA**



# WSDA Crucifer Quarantine

- *Production of Brassica Seed Crops in Washington State: A Case Study on the Complexities of Coexistence.* Inglis, Miller, & du Toit, 2013. WSU EM062E.
- WSDA Seed Program:  
Paula Moore, Manager  
[Pmoore@agr.wa.gov](mailto:Pmoore@agr.wa.gov), 509-314-1032





# PNW University Plant Diagnostic Clinics



OSU Hermiston Plant Pathology Lab  
<http://oregonstate.edu/dept/hermiston/>

OSU Corvallis Plant Clinic  
Mana Ohkura  
<http://plant-clinic.bpp.oregonstate.edu/>

WSU Puyallup Plant Clinic  
Jenny Glass  
<http://puyallup.wsu.edu/plantclinic/>

WSU Pullman Plant Clinic  
Cassandra Bates  
<http://plantpath.wsu.edu/diagnostics/>

University of Idaho Parma REC  
James Woodhall  
<https://www.uidaho.edu/cals/parma-research-and-extension-center/plant-pathology>

PNW Disease Management Handbook - <https://pnwhandbooks.org/plantdisease>

PNW VEG - [http://mtvernon.wsu.edu/path\\_team/vegpath\\_team.htm](http://mtvernon.wsu.edu/path_team/vegpath_team.htm)

HortSense - <http://hortsense.cahnrs.wsu.edu/Home/HortsenseHome.aspx>