Geographic and Local Variation in Pacific madrone (*Arbutus menziesii*) Leaf Blight

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Introduction

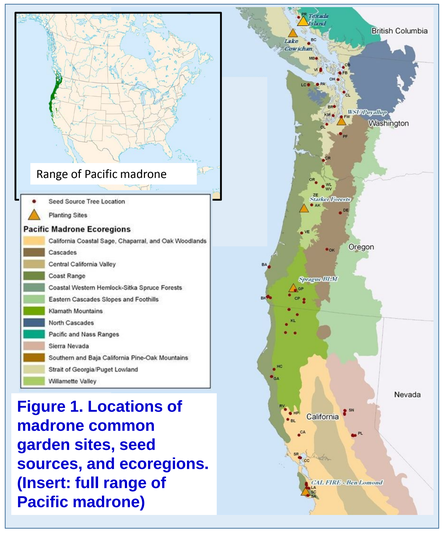


Figure 1. Locations of madrone common garden sites, seed sources, and ecoregions. (Insert: full range of Pacific madrone)

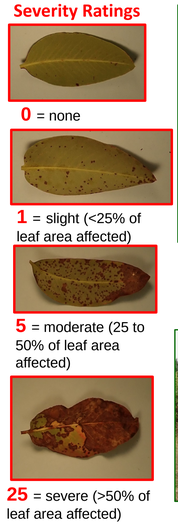
- Pacific madrone is an evergreen hardwood species in western North America, occurring from southern California to British Columbia.
- Very little is known about the genetics of this species, including variation in resistance to pathogens and other adaptive traits.
- The WSU Pacific madrone seed collection contains seed from 320 families in 7 ecoregions. Using this seed collection, common garden plantings consisting of 104 half-sib families were planted at 7 locations in 2011 in CA (1 site), OR (2), WA (2), & in 2013 in British Columbia (2).
- Common garden sites are located in 4 of the 7 ecoregions where seed was collected (**Figure 1**).
- Assessments have been made of growth, disease, cold damage, flowering, and phenology.
- **This poster summarizes variation in leaf blight in the OR & WA common gardens.**

Assessing Leaf Blight

Incidence and severity of leaf blight were assessed annually using metrics developed at WSU.

- **Severity** rating of symptoms on the most severely impacted current season leaf.
- **Incidence** rating of leaves on the whole tree with that severity rating
  - 1 = <25 of leaves with severity rating
  - 2 = 25-50% of leaves
  - 3 = 51-75% of leaves
  - 4 = >75% of leaves
- Severity and Incidence scores are multiplied together for an overall rating score ranging from 0 to 100, with 100 being highly susceptible.

Severity Ratings



0 = none

1 = slight (<25% of leaf area affected)

5 = moderate (25 to 50% of leaf area affected)

25 = severe (>50% of leaf area affected)

Progression of Leaf Blight at Starker Forest in 2017-2018

Nine cameras were set up at the Oregon Starker Forest site to capture progression of blight over the winter/spring 2017-2018

- 1 camera = control tree scored as no blight, May 2017
  8 cameras = trees with relatively high blight scores in May 2017
- Cameras were set up Nov 17 and photographs are taken daily at 9 am, Noon & 3 pm
- Photographs shown are the Detroit, OR source
  - → Note: apical buds swollen on Apr 27
  - → Apical buds elongated May 1
  - → New flush May 8

Leaf blight variation at the Starker Forest Site in Oregon in May 2018

Figure 2. Average leaf blight severity score for each growing season year
PH & PV = Puyallup Hill & Puyallup Valley, WA
SF & SO = Starker Forest & Sprague Seed Orchard, OR

Figure 3. Blight severity score averaged across common garden sites for each seed source for each year. Seed sources are arranged south to north latitude from left to right starting with California

Fungi identified from madrone foliage samples using morphological and molecular techniques at the common garden sites, from south (SO) to north (PV) in 2018

	SO	SF	PH	PV
Large leaf spots				
Cryptostictis arbuti		x		
Didymosporium arbuticola	x	x	x	x
Rhytisma arbuti	x			
Small leaf spots				
Epicoccum nigrum	x	x	x	x
Mycosphaerella sp.			x	
Shoot and leaf blight				
Diaporthe spp. (=Phomopsis spp.)		x		x
Phacidiopycnis washingtonensis		x	x	x
Endophytes				
Allantophomopsis cytisporea		x		
Aureobasidium pullulans	x	x	x	x
Colletotrichum clavatum		x		
Fusarium sp.			x	x
Stemphylium sp.		x		
Sydowia polyspora	x		x	x

Results and Discussion

- **Blight tended to be more severe at the WA sites (PH, PV) compared to the OR sites (SF, SO) (Figure 2)**
  - → Patterns of blight severity among sites might be related to site conditions such as moisture and temperature. Typically precipitation decreases and temperatures increase from north to south latitude, thus the WA sites would be cooler and wetter than the SF site, which would be cooler and wetter than the SO site.
  - → Blight variation among sites is also affected by time of assessment (winter in WA vs fall in OR) because blight expression increases over the winter/spring (see time lapse photos), and thus fall assessments in OR would tend to underestimate severity. Future blight assessments should be taken in spring (March-May), before new foliage is expanded, at all sites.
  - → Nevertheless, short visits to all four sites in May, 2018 revealed little to no blight at SO compared to more severe blight at PH, PV and SF.
- Blight severity is difficult to distinguish from cold damage which could lead to overestimates of severity in years where damaging low winter temperatures occurred (*e.g.,* winters of 2014-15 and 2015-16*)*
- ***Fungi associated with severe leaf blight were not found at the southernmost site (SO) in 2018 samples.***
- Due to confounding issues associated with time of assessment, sites and years are not statistically compared to each other.

- **Blight severity within sites varied significantly (p<0.01):**
  - → Among seed sources for all years at all sites except for SO where sources only differed in 2012 **(See Figure 3)**
  - → Among half-sib families within sources also varied significantly (p<0.01) for all years and at all sites except at SF where families only differed in 2015
- **Averaged across all sites, variation in blight severity among sources was not related to longitude of origin but was significantly (p<0.01) related to:**
  - → Latitude of origin, with R^2 values ranging from 9% in 2012 to 69% in 2014
  - → Elevation of origin (except in 2014), with R^2 values ranging 13-16%
- **When analyzed separately by site, variation in blight severity among sources:**
  - → Was not related to longitude at any site, and at SO variation was also not related to latitude or elevation
  - → Relationships with latitude were strongest for PH (R^2 48-65%) but at PV latitude was only significantly related in 2014
  - → ***The strongest relationships between seed source origin and site were at the most northern common gardens (PH & PV)***

- **Averaged across sites, trends in Figure 3 show:**
  - → In general, southern sources had higher blight severity than northern sources
    - ✓ ***Sources with the lowest blight severity were from the north***: OH, CL (Oak Harbor & Clinton, WA), OR (Cornelius, OR)
    - ✓ ***Sources with the highest blight severity were from the south***: e.g., HC, HP, LA (Humboldt County, Hopland, Los Altos, CA)
  - → However, some northern sources such as PA, DE (Port Angeles, WA , Detroit, OR) had relatively higher blight severity while some southern sources such as PL, CA (Placerville & Calistoga, CA) had lower blight severity
  - → The source by common garden site interaction (i.e., genotype X environment) was significant for all years (p<0.001)
- **These results suggest:**
  - → ***Wetter, cooler conditions seem to increase blight severity***
  - → Sources moved the farthest north generally had more severe blight
    - ✓ These sources may have been less well adapted thus more stressed and less able to resist leaf blight
    - ✓ Relative blight severity of some sources was not consistent across all common garden sites
  - → ***Resistance to leaf blight might exist***
    - ✓ Local sources had both high and low blight severity
    - ✓ Blight severity varied among half-sibling families within seed sources

Severe leaf blight attributed to the fungus *Phacidiopycnis washingtonensis,* OR 2011

Didymosporium arbuticola from Starker Forest site. Leaf spot with acervuli (L) and conidia (R). Conidia were found on the lower leaf surface in February 2018 samples, and asci and ascospores were observed in acervuli on the upper leaf surface in May 2018 samples.

Elliott, M, Chastagner, GA, Coats, KP Sikdar, P, & Xiao, CL (2014). First report of a new leaf blight caused by *Phacidiopycnis washingtonensis* on Pacific madrone (*Arbutus menziesii*) in Western Washington and Oregon. Plant Disease 98:1741.

Zeller, SM. 1934. Some new or noteworthy fungi on Ericaceous hosts in the Pacific Northwest. Mycologia 26(4): 291-304.

All institutions affiliated with this project are equal opportunity providers

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