

White Pine Blister Rust Resistance Research in Minnesota and Wisconsin

Andrew David, Paul Berrang, Carolyn Pike

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Genetics of Host-Parasite Interactions in Forestry*

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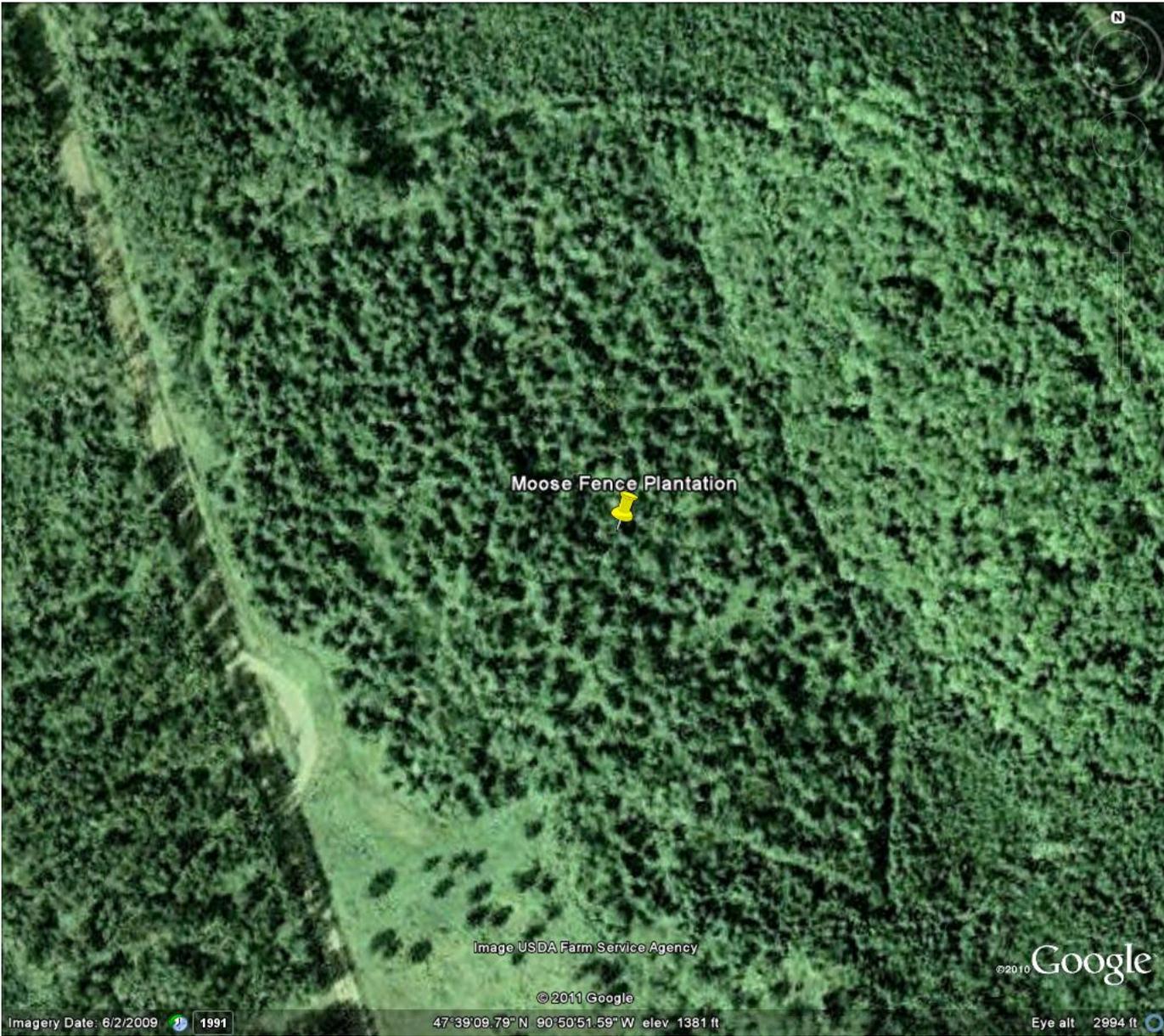
Outline

- Moose Fence planting near Tofte, MN
- P327
- USFS ORSO seedling screening efforts
- Minnesota Tree Improvement Cooperative

Moose Fence planting

- Cliff and Isabelle Ahlgren of the QSWRF
- Late 1960's cooperative agreement
 - QSWRF, USFS, UMN
- Create the largest eastern white pine disease garden experiment in the world.
- Established near Tofte, Minnesota on north shore of Lake Superior.





Moose Fence Plantation

Image USDA Farm Service Agency

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Imagery Date: 6/2/2009 1991

47°39'09.79" N 90°50'51.59" W elev 1381 ft

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Eye alt 2994 ft



Moose Fence Plantation

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A Nursery for the Future

*You are looking at a living experiment.
These trees may hold a key to the future of our majestic eastern white pine.*

Why is eastern white pine in danger of disappearing?

White Pine in the Great Lakes forests are declining for several reasons: disease, deer browsing, fire suppression, and turn-of-the-century cutting all play a role. White pine blister rust, an exotic disease unwittingly introduced from Europe is the main reason Minnesota white pine has declined.

How did blister rust travel from Europe to America?



In the late 1800s, America was a fast-growing country. Demand for new houses was high. Vast pine forests were cut to meet the need for lumber.

After logging, Americans shipped white pine seedlings from European nurseries to plant in cut-over forests. We weren't expecting that barely visible fungus that rode across the Atlantic with the seedlings.

The fungus, white pine blister rust, was a new disease in America, one to which trees had no natural resistance. The effect on native white pine trees was much the same as the effect of smallpox on Native American peoples: devastating.



Photo courtesy of U.S. Forest Service

Is there hope for white pine forests?

With blister rust now widespread, one strategy is to encourage white pine that is genetically resistant to the disease using this plantation.



A possible solution ...

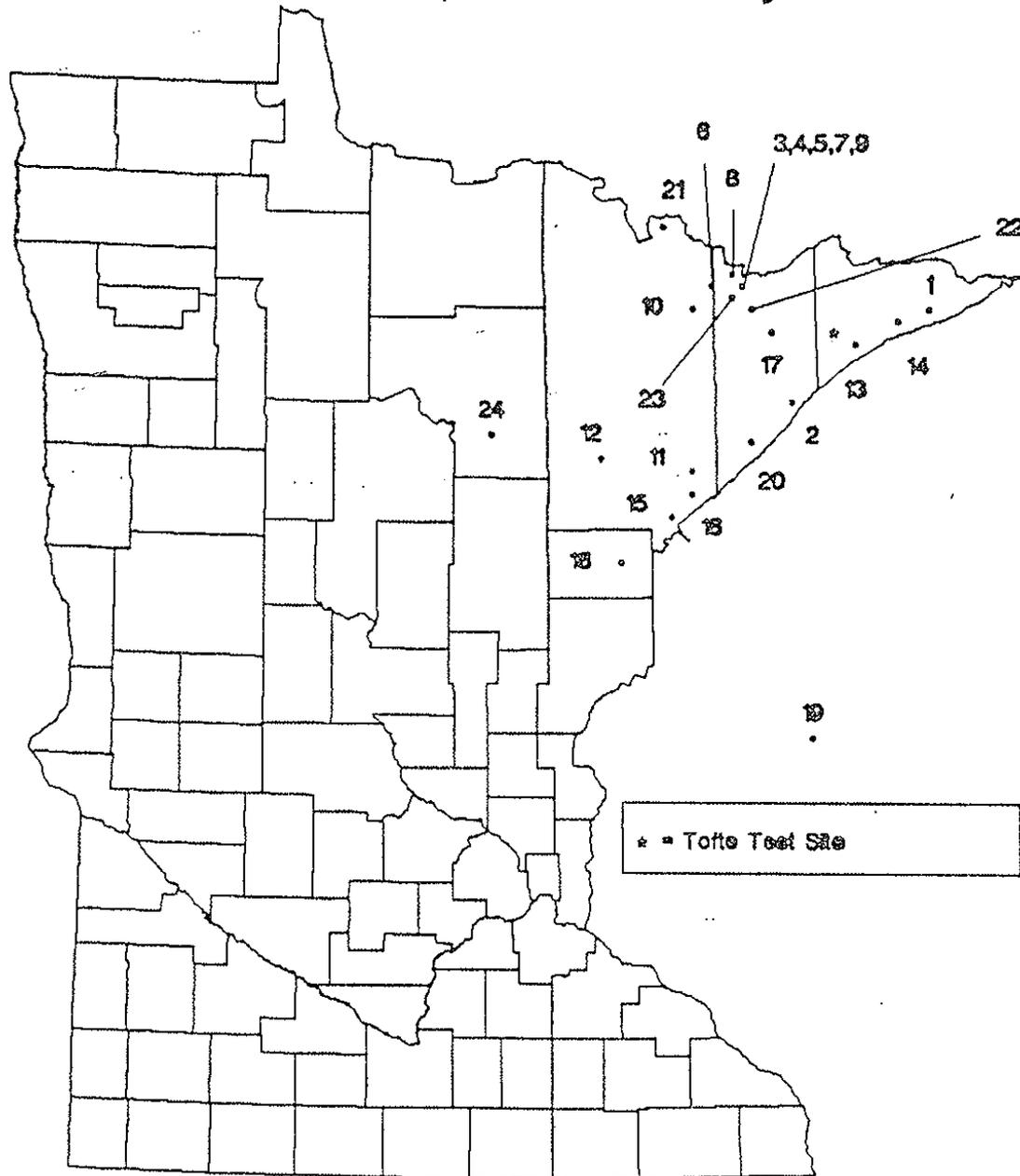
In 1972, white pine from a variety of genetic sources and gooseberry, blister rust's alternate host, were planted here. As the plants mature, scientists take cuttings and harvest seeds from the cones of healthy trees.

These cuttings and seeds are taken to nurseries where they are used for research. Scientists hope to learn more about blister rust and how white pine can avoid the disease.

We hope this "nursery for the future" will help perpetuate a majestic part of our natural heritage.



Figure 1. Location of mother tree regions
Tofte white pine blister rust study

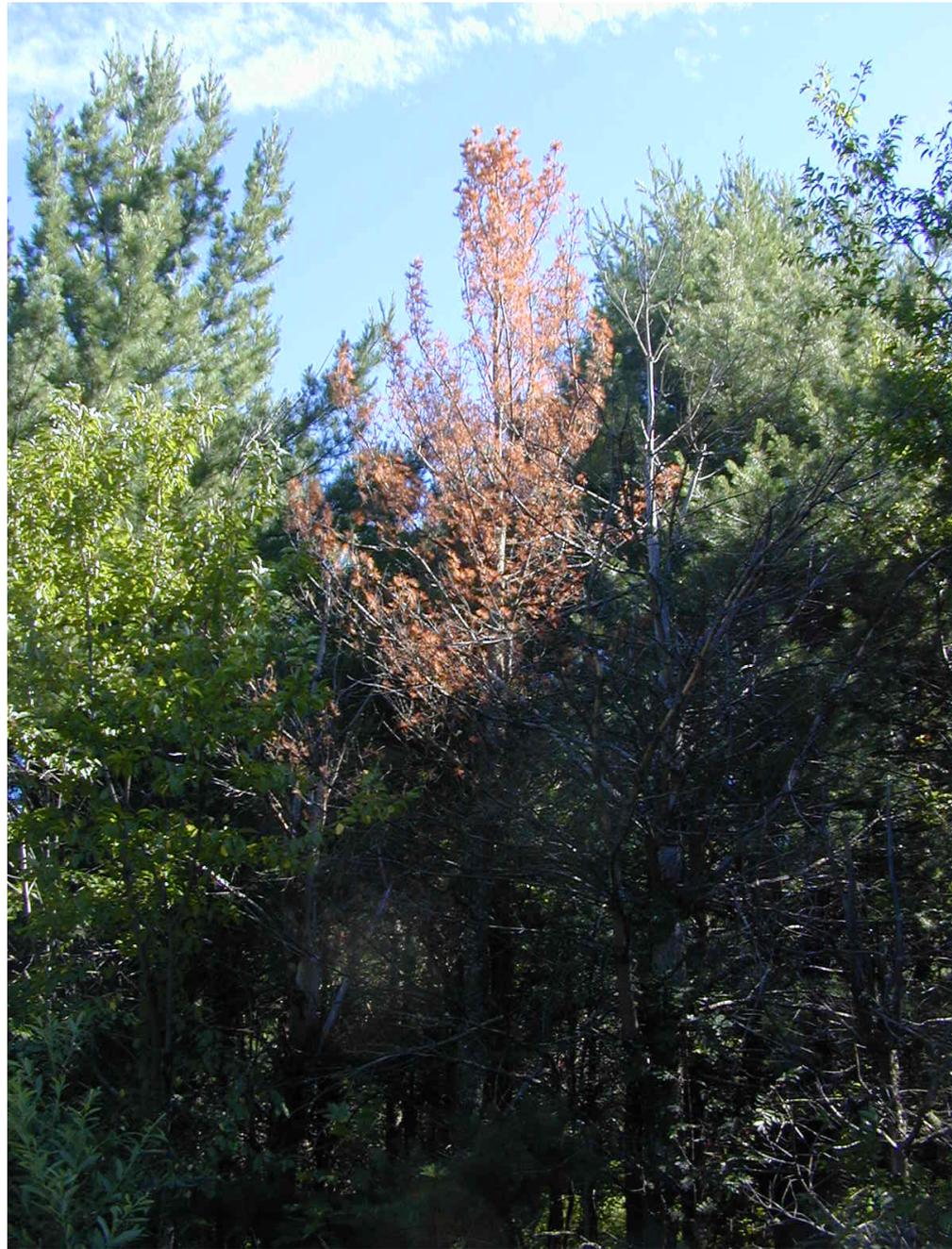


Tofte establishment

- 874 op families
- ~43,200 seedlings
- 1972 and 1974
- RCB design
 - 5 replications
 - 10 tree row plots
- Ribes interplanted
- 22 acres
- Fenced







Tofte 1984 results

	1972 Planting	1974 Planting
Survival	38%	41%
Non-infected	1.0%	0.5%

1. Non-infected or clean trees occur at a very low frequency, i.e. $< 1.0\%$.
2. No data to support existence of MGR in sampled mother trees.

Tofte 1993 tagging trees

- 888 exceptional trees permanently tagged
- Scored for rust and vigor on ~10 year intervals (1984, 1993, 2003, 2010)
- Collect scion and seed from best





A Nursery for the Future

Forest nurseries are important for providing seedlings for reforestation and restoration projects. They provide a controlled environment for growing young trees, protecting them from pests and diseases, and ensuring they are healthy and ready for planting. Forest nurseries also play a role in research and education, helping scientists and the public learn more about forest ecology and management.



Search for slow-rusting phenotypes





- Search for slow rusters is NOT a search for plodding forest geneticists
- Rather a search for a phenotype that appears to co-exist with the fungus



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Tofte 2010 results

Category	# Alive
Orange tagged trees	674
Blue (poss. slow rusters)	346
Yellow (soon to die)	134
Total	1154

- After 38 years 2.6% of the trees are still alive
- 18 years after being tagged 75.9% of the exceptional trees are still alive.
- 52 slow rusting phenotypes collected and grafted

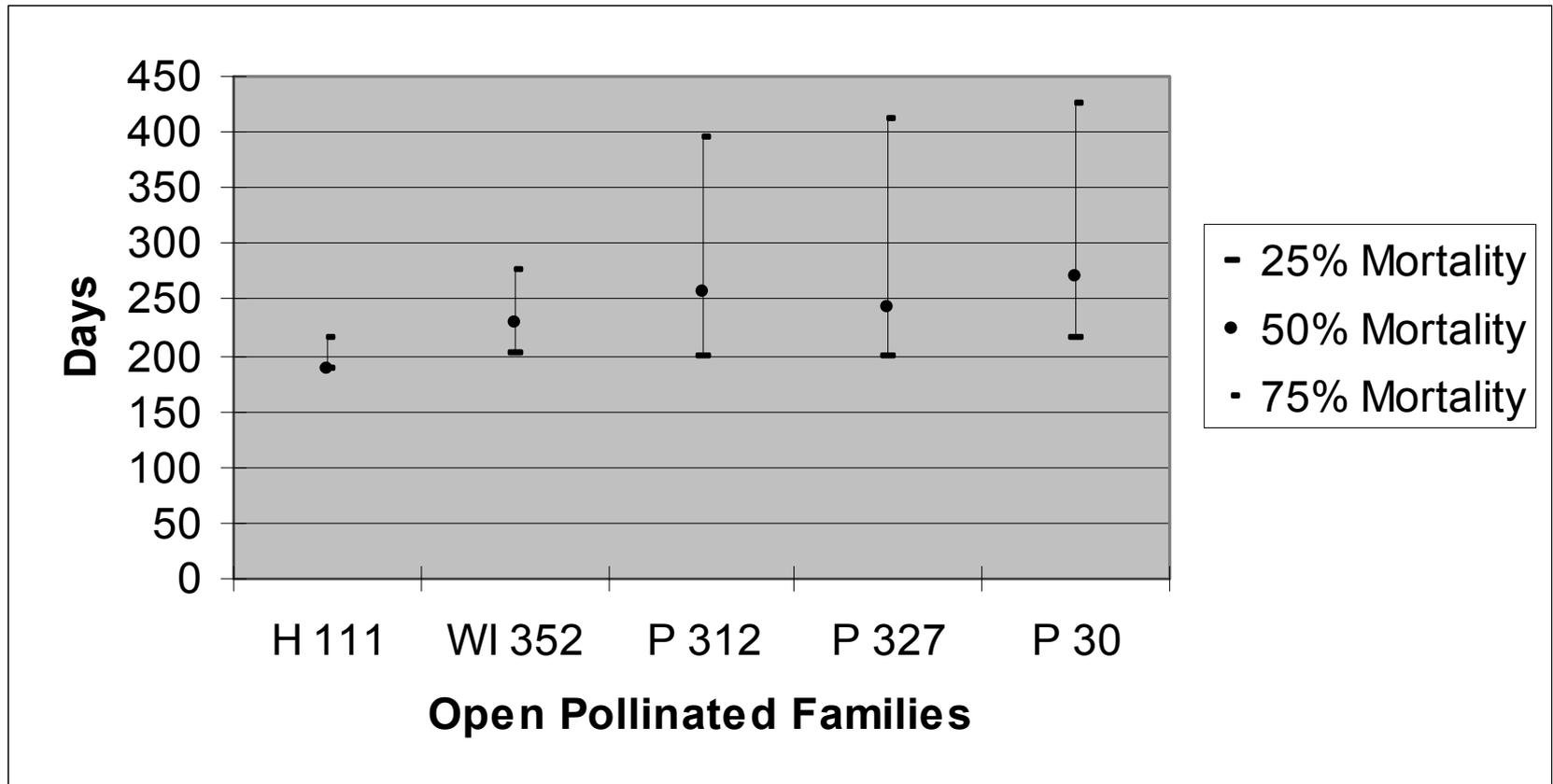
P327

- Single tree selection from Duluth, MN
- Selected by R. Patton
- Progeny perform well in nursery and greenhouse trials.
- Recently more extensive testing.

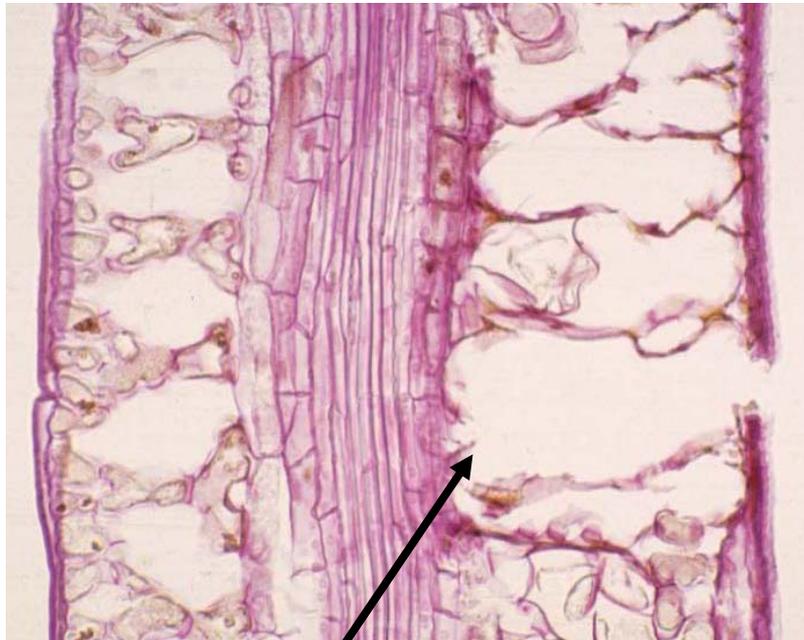




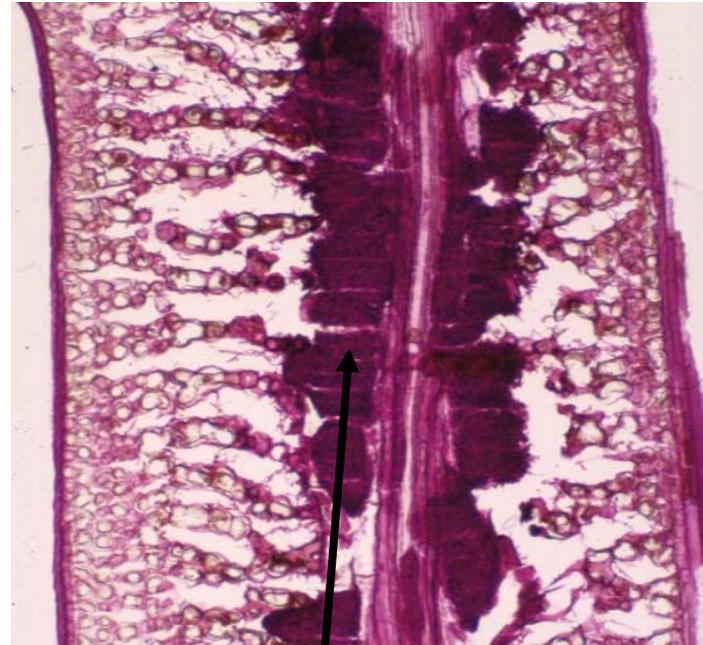
Time to % mortality by family



P327 histology



Reaction that collapses
mesophyll cells



Densely packed mycelium
surrounding vascular bundle

P327 and occluded stomates

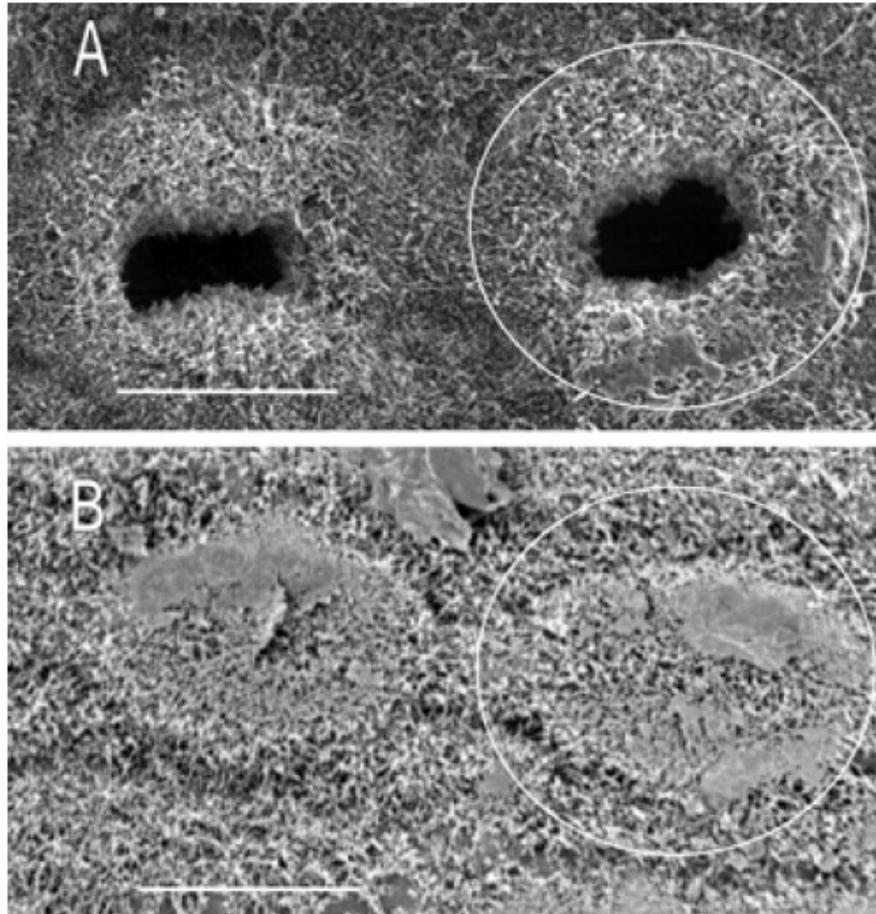


Fig. 2. Environmental scanning electron microscopy image of stomata of secondary needles of A, susceptible clone H111 (bar = 60 μ m) and B, resistant clone P327 (bar = 60 μ m). Notice the large opening to stomatal chamber and lack of wax occlusion in A and the complete wax occlusion of stomata in B. White circles provide outline of a stoma.

USFS – ORSO Region 9

- Oconto River Seed Orchard
- Breeding and screening objectives





White pine seed orchard provides seed for Region 9



Clone bank and simulated open pollinated (SOP) test



February first year



November first year



May second year

Foliar symptoms; % seedlings with symptoms



May second year

% seedlings with cankers



August second year

Canker severity

Screening results

- Dosage effect with susceptible and resistant families.
- Identification of target spore level.
- Recently 4-5 new genotypes (out of 34 tested) as resistant or increased resistance.

Minnesota Tree Improvement Cooperative

- 14 full members
- 6 supporting members
- 5 native conifer spp

- White pine breeding arboretum
- Manage Moose Fence planting
- Cooperator seed orchards
- Breeding program





214 Tofte genotypes and 94 non-Tofte genotypes



6 grafted seed orchards totaling 14 acres among 4 cooperators

Summary

- No evidence for MGR found
- P327 has reliable resistance but other genotypes do too.
- Unknown if these mechanisms are the same or complimentary
- Rationale for large plantings

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