

Dorena Genetic
Resource Center

USDA Forest Service
Umpqua National Forest
34963 Shoreview Dr.
Cottage Grove, OR 97424
(541) 767-5700

PORT-ORFORD-CEDAR RESISTANCE BREEDING PROGRAM

ANNUAL UPDATE

July 2005

Issue #6

ISSUE HIGHLIGHTS:

- *Latest status of field selections*
- *First test results of orchard seed*
- *Providing resistant seed*
- *Breeding zone revisions*
- *New genetic studies in progress*



Figure 1. (starting from the top left clockwise) Dorena containerized seed orchards; validation outplanting on the Powers Ranger District; cone collection from containerized orchards; and seedlings being tested for resistance at Oregon State University.

Program Overview

Port-Orford-cedar root disease, caused by the non-native pathogen *Phytophthora lateralis*, continues to spread and cause mortality of native Port-Orford-cedar within its natural range of northwestern California and southwestern Oregon.

As part of the overall program for managing Port-Orford-cedar, the Dorena Genetic Resource Center coordinates the disease resistance screening and implements the breeding program. Our goal is to identify naturally resistant trees and provide seed using traditional breeding techniques that generate populations of genetically diverse, adapted, and resistant trees.

The program at Dorena is a cooperative effort involving five National forests, three Bureau of Land Management (BLM) Districts, Oregon State University; and a variety of other federal, state, and local agencies as well as industrial and non-industrial private landowners.



Figure 2. Cinnamon-colored stain from POC Root Disease on a seedling from the Redwood National Park.

Resistance Testing

Field Selections – Over 1000 additional field selections were made this year and went into stem dip testing. This testing is conducted in greenhouses at Oregon State University and provides the **initial step towards identifying resistance**. The selections that perform well in the stem dip test undergo a second test using a root dip technique. This test, which is more time-intensive, is used to confirm resistance.

Total Selections to Date Screened in Phase I Testing (stem dip technique) is over 12,000 trees.

In general, the top 10% of stem dip tested trees are selected for root dip testing. To date, 453 selections have been root dip tested (or are currently being tested) and thus far 210 have exhibited sufficient resistance to be placed into the seed orchard and breeding program. Currently “sufficient resistance” is defined as showing <50% mortality in the root dip test. However, as more selections are tested, the criteria for orchard placement will likely require a higher survival percentage and orchards will be rogued accordingly. Future refinement of testing techniques may also result in orchard roguing. Several additional years will be required to finish testing the top stem dip selections.

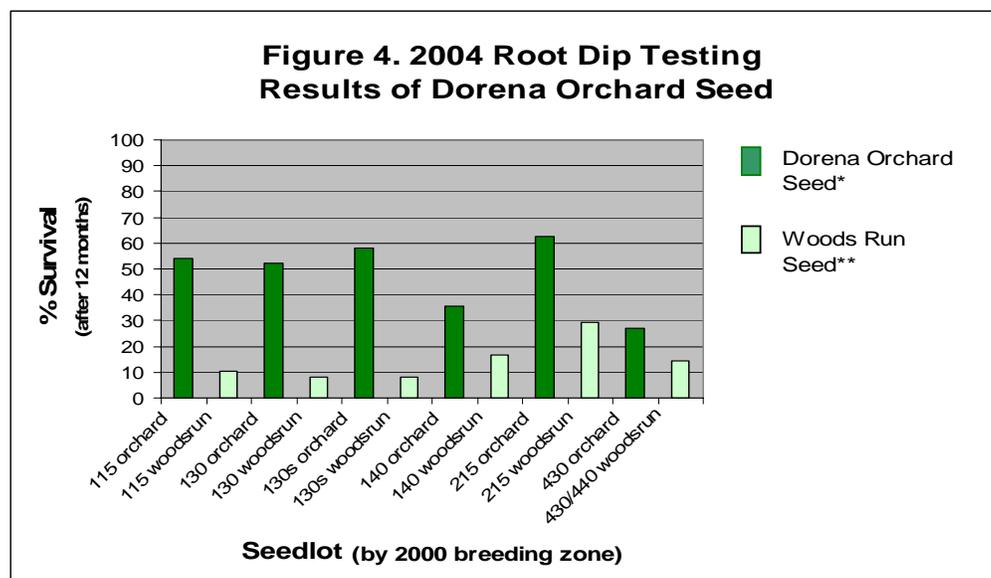
If you have any questions about the testing results of trees sampled in your area, please give our Port-Orford-Cedar Operations Coordinator, Leslie Elliott, a call at (541) 767-5713.



Figure 3. 2005 Allen Gulch validation outplanting in Northern California.

Validation Outplantings – Two more validation outplantings were established in 2005. A total of 28 planting sites are currently being monitored. Most of the plantings have been established since 1999, but a few were put in as far back as 1993. The plantings are monitored annually for mortality and provide the basis for field validation of the short-term greenhouse testing results. Over time, these plantings will help evaluate the durability of resistance being identified in greenhouse testing and the implications for seed use.

Orchard Seed Testing – Seedlings, grown from the first resistant seed crop produced in Dorena’s operational seed orchards in 2002, were root dip tested in 2004. The results (see Figure 4) show that in the short-term greenhouse test (12 months) seedlings from the orchards averaged 27 to 63% survival versus random field selection seed (woodsrun) which averaged 8 to 29% survival. These results are very encouraging but ultimately it is the long-term field survival that will be important for reforestation and restoration. The resistance level of the orchards should increase further as 1) parents are added as root dip testing continues, 2) orchards are rogued as the orchard selection criteria changes (see “Field Selections” section), and 3) second generation breeding further increases resistance. Most of these seedlots were also planted into long-term validation plantings to examine the durability of the resistance.

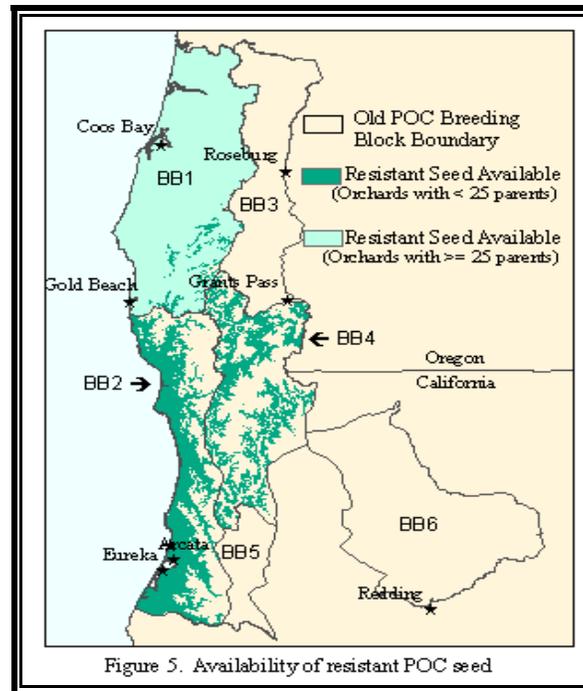


*Dark green indicates seed from the orchards from various breeding zones (i.e. 115 orchard is the orchard for breeding block 1, 0-1500' elevation).

**Light green indicates seed selected across the breeding zone with no regard for presumed resistance level.

Seed and Orchard Management

Status of Seed Available – The operational seed orchards at Dorena provided the Rogue-Siskiyou National Forest with 71 grams of resistant seed this year for reforestation. We currently have seed in storage from six orchards representing breeding zones covering a large part of Port-Orford-cedar’s natural range (see figure 5).



Seed to Oregon Department of Forestry - 2.5 pounds of surplus seed were sold to the Oregon Department of Forestry, Oregon Seed Bank. This seed bank provides seed and seedlings to non-federal landowners. See the “Orchard Testing” section for information regarding the level of orchard seed resistance. For further information regarding the availability of this seed please contact Sara Lipow, Oregon Department of Forestry at (503) 945-7389.

Breeding Zones Revision –Twenty-nine preliminary breeding zones, covering the natural range of Port-Orford-cedar, were established in 2000. These zones were delineated based on early information from a short-term common garden study that was established in 1996. An additional long-term series of field tests were established in California and Oregon between 1996 and 1998. Recent analysis of five and seven year data from this series of field tests has now been completed. An evaluation of the breeding zones, based on this new data, was conducted this year by a cadre of forest geneticists, ecologists, pathologists and program managers. There are now 13 breeding zones. Dorena is currently updating our database and evaluating the impact on existing orchards and future field selections.

Genetic Studies

Population Genetics Study – In the summer of 2004 Dorena began collecting branch cuttings from paired disease and disease free Port-Orford-cedar populations. The goal of the study is to evaluate genetic diversity throughout the native range of POC in southwest Oregon and northwest California using DNA and protein markers. The study will also determine if genetic variation is altered after mortality from root disease and compare genetic diversity between our resistant orchards and natural populations. 1010 trees from 20 populations have been collected to date from Forest Service, BLM, County, State Park, and National Park lands. The National Forest Genetic Electrophoresis Laboratory (NFGEL) has been busy isolating DNA and proteins and will conduct the molecular marker analysis. Field collections are now in the final stages and analysis should begin this summer.

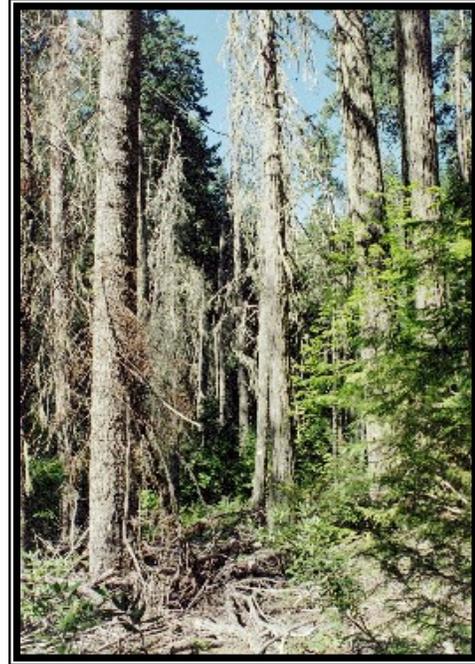


Figure 6. Sampled diseased population near Page Mtn., Rogue-Siskiyou National Forest.



Figure 7. POC female cones (left side) and male pollen cones (right side).

Reproductive Phenology Study -

A study of reproduction phenology began this spring, in cooperation with Dr. Don Zobel of Oregon State University, to compare the timing of reproductive growth in orchard trees representing three distinct geographical areas across the native range. The timing of pollen and ovule growth is an important variable affecting seed orchard management. The contribution of any given parent to the composition of seed produced for a given breeding zone can be greatly affected by the degree of overlap of this period with that of other parents. This study focuses on comparing 1) trees from differing elevations at the northern end of the range and 2) high elevation trees from the northern, coastal end with trees from the southern, inland end of the range. Final analysis should be completed in fall 2005.

Other Studies

1) Dorena is currently cooperating with the University of Victoria, British Columbia on a study involving the analysis of pollination drops in conifers. The goal of this research is to identify and characterize proteins and other compounds found in reproductive structures which may have anti-fungal characteristics. In the spring of 2004 and 2005, researchers from the University visited Dorena to collect pollination drops from Port-Orford-cedar.



Figure 8. University of Victoria researcher collecting pollen drops for study (left) and pollen drops on female cone (right).

2) Eunsung Oh, from Oregon State University, has successfully completed her doctorate this year on “Resistance Mechanisms of Port-Orford-cedar to *Phytophthora lateralis*”. Congratulations to Dr. Oh who continues work as a Post Doc in Dr. Everett Hansen’s lab at Oregon State University.

Personnel

New Center Manager – This year, Dorena welcomes new Center Manager Carol Morehead. Carol has been with the Forest Service for 25 years and recently worked for the Deschutes/Ochoco National Forest as a Natural Resource Financial Coordinator. She looks forward to working in the field of forest genetics and disease resistance and meeting the numerous cooperators in this program.



Figure 9. New Center Manager, Carol Morehead, assisting with the pine program.

Retirements - Rod Stevens, USDI Bureau of Land Management Geneticist, retired earlier this year. Rod has been an integral part of the Port-Orford-cedar disease resistance and breeding program. Rod’s contributions include assisting with the establishment and

monitoring of the 1996 rangewide study; making field selections; working to establish the Wendy Miles POC Conservation Orchard at the BLM Tyrell Seed Orchard; and providing genetic expertise to the POC Final Supplemental EIS as well as the POC Rangewide Assessment. Other contributors to the program that retired this last year include Liang Hsin, USDI Bureau of Land Management Oregon State Geneticist, and Dr. Don Zobel, Professor at the Department of Botany and Plant Pathology from Oregon State University. All have provided valuable time and expertise towards furthering the resistance and breeding program and will be greatly missed.

Outreach

Conferences – Dorena personnel attended numerous meeting and conferences to provide outreach about the resistance testing and breeding program including presenting at the IUFRO Third International Meeting on Phytophthora in Forest and Natural Ecosystems in September 2004.

Publications – Dorena contributed papers to three Conference Proceedings published this year from 2004 meetings attended in the United States and Canada. The papers can be viewed on our website at <http://www.fs.fed.us/r6/dorena>.

Forest Magazine Article – an article featuring Port-Orford-cedar appeared in the spring 2005 issue of “Forest Magazine”. The article, titled “Ensuring Survival - Selective Breeding Helps Port Orford Cedar Beat the Odds” highlights the history of *P. lateralis* spread and how the resistance breeding program is being used as a tool to help POC. For further information visit <http://www.fsee.org> and see Spring 2005 Top Stories.

Future Activities

Some of the activities Dorena will focus on in the next year include:

- ◆ Analysis of latest resistance testing results,
- ◆ Mortality assessment of all validation outplantings to evaluate field survival
- ◆ Establishment of four replicated validation plantings across the range (800-1000 trees each),
- ◆ Completion of the population genetics and reproductive phenology studies,
- ◆ Expansion/revision of operational seed orchards based on resistance testing results and breeding zone revisions,
- ◆ Continuation of the control crossing program to increase levels of resistance.

If you have a potentially high disease hazard site and are interested in cooperating in establishing one of four validation plantings next year, please give us a call.

Funding and Program Management

This program is funded through the USFS Region 6 Genetics and Forest Health Programs and the USDI Oregon Bureau of Land Management and is part of an overall management program for Port-Orford-cedar. We would like to acknowledge the efforts of the two program managers: Frank Betlejewski, POC manager for the U.S. Forest Service, and Kirk Casavan, POC manager for the Bureau of Land Management and thank them for their continuing support.

Visitors and Questions Welcome

We encourage anyone who has questions, or would like to stop by and see our operations, to give us a call at (541) 767-5700 or visit our website at <http://www.fs.fed.us/r6/dorena>. We look forward to continuing to work with all of you on this cooperative effort in developing the Port-Orford-cedar disease resistance program.

Carol Morehead
Dorena Center Manager
cmorehead@fs.fed.us

Richard Sniezko
Dorena Center Geneticist
rsniezko@fs.fed.us

Leslie Elliott
Dorena POC Operations
Coordinator
ljelliott@fs.fed.us