

DEVELOPMENT OF *PHYTOPHTHORA LATERALIS* RESISTANT PORT-ORFORD-CEDAR FOR RESTORATION IN THE PACIFIC NORTHWEST



Sniezko, R.A.¹, Elliott, L.J.¹, Goheen, D.J.², Casavan, K.³, Hansen, E.M.⁴, Frank, C.⁵, Angwin, P.⁶

¹USDA Forest Service, Dorena Tree Improvement Center, Cottage Grove, OR; ²USDA Forest Service, SW OR Forest Insect and Disease Service Center, Central Point, OR; ³USDI Bureau of Land Management, Roseburg District, Roseburg, OR; ⁴Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR; ⁵USDA Forest Service, Klamath National Forest, Yreka, CA; ⁶USDA Forest Service, Shasta-Trinity National Forest, Redding, CA.

Introduction

Port-Orford-cedar (*Chamaecyparis lawsoniana* A. Murr.) is an important component of forest ecosystems in southwest Oregon and northwest California (Figure 1). It is also a valuable species for wood and bough production in the Pacific Northwest and horticulturally it has been planted worldwide. The presence of an exotic root pathogen, *Phytophthora lateralis*, is causing extensive mortality of Port-Orford-cedar on sites favorable for the pathogen throughout much of the range of the host.

Currently, few land managers are planting Port-Orford-cedar because of its susceptibility to *P. lateralis*, but interest is high on both federal and non-federal lands in the Pacific Northwest. Management activities to stop or slow the progression of the disease have been initiated. Additionally, a program to identify and breed resistant populations of Port-Orford-cedar is underway.

Figure 1. Port-Orford-cedar range and location of phenotypic selections



Resistant tree (510015) among trees killed by *P. lateralis*



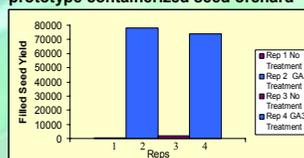
Dead and dying Port-Orford-cedar along Highway 101 north of Coos Bay, Oregon



P. lateralis on young tree in Redwood National Park



Figure 2. Filled seed yields in 1998 from prototype containerized seed orchard



Results of Spraying Growth Hormone (GA3)
Rep Size = 44 Trees

Breeding and Seed Production

Cone and Seed Production in Port-Orford-cedar is relatively easy in potted orchards at an early age (Figure 2) and breeding of new selections can be done in less than five years (Elliott and Sniezko, 2000). A breeding program and an examination of mechanisms of resistance is underway. Preliminary breeding zones have been delineated based upon nursery common garden tests (Kitzmilller and Sniezko, 2000) and field plantings have been established to validate and further refine these zones.

Disease Resistance Testing

The USDA Forest Service and USDI Bureau of Land Management have been working with Oregon State University to screen Port-Orford-cedar for resistance to *P. lateralis*. In 1997, an operational program began to develop resistant Port-Orford-cedar populations. Initial testing is done using a stem inoculation technique. A second phase of testing began in 2000 using a root inoculation technique to validate the initial screening results.

A 1996 study of random selections across the species' range showed most trees in natural stands have very little resistance (unpublished data). However, seedling families of phenotypic selections show much greater range in resistance (Table 1).

Table 1. Percent survival of seedling families tested in 2000. Greenhouse root dip screening and field planting results.

Parent ID	No. of Families Tested	Average Percent Survival	
		Greenhouse ¹	Field Planting ²
118569	3	6	12
510042	4	22	17
510044	5	34	28
118562	5	41	31
510008	2	43	32
CF1	4	46	36
510049	4	47	45
117344	6	48	30
510041	3	51	32
CF2	4	52	47
118573	3	53	33
117490	3	98	81

¹Percent survival measured approx. 9 months after inoculation
²Percent survival recorded approx. 9 months after planting (includes all types of mortality)

Immature cones



Male strobili



Summary

- Over 10,000 parents from throughout the species' range have undergone resistance screening; analyses indicate a small percentage of trees have strong resistance to *P. lateralis*.
- The oldest field validation plantings of Port-Orford-cedar show this resistance is durable for at least thirteen years (Sniezko *et al.*, 2000).
- Tremendous progress has been made in identifying resistant trees and establishing operational seed orchards. Breeding efforts will concentrate on increasing the durability of resistance while maintaining a wide genetic base.
- Resistant seed from orchards will be available in Fall 2002 for some breeding zones.
- Genetic resistance offers a valuable management tool to aid in restoring and sustaining Port-Orford-cedar in forest ecosystems.

Pollination drops on female strobili



Containerized seed orchard at Dorena Tree Improvement Center



Questions For The Future

- What resistance mechanisms are present in Port-Orford-cedar and how are they inherited?
- How long will resistant trees survive under field conditions of high hazard?
- Is there any evidence of virulent strains of *Phytophthora lateralis*?
- How do we best deploy resistant Port-Orford-cedars in the field?

For further information on the Port-Orford-cedar disease resistance and breeding program see Dorena's website at <http://www.fs.fed.us/r6/dorena>.

Literature Cited

- Elliott, L. and R.A. Sniezko. 2000. Cone and Seed Production in a Port-Orford-cedar Containerized Seed Orchard. p. 105-106. In: Everett M. Hansen and Wendy Sutton (eds.) *Phytophthora Diseases of Forest Trees; Proceedings From the First International Meetings on Phytophthoras in Forest and Wildland Ecosystems*. Forest Research Laboratory, Oregon State University.
- Kitzmilller, J.H. and R.A. Sniezko. 2000. Range-wide Genetic Variation in Port-Orford-cedar (*Chamaecyparis lawsoniana* [A. Murr.] Parl.). I. Early Height Growth At coastal and Inland Nurseries. *J. Of Sustainable Forestry*, Vol. 10, No. 1-2, pp. 57-67.
- Sniezko, R.A., E.M. Hansen, A. Bower, D. Goheen, K. Marshall, K. Casavan and W. Sutton. 2000. Genetic Resistance of Port-Orford-cedar (*Chamaecyparis lawsoniana*) to *Phytophthora lateralis*: results from early field trials. pp. 138-140. In: Everett M. Hansen and Wendy Sutton (eds.) *Phytophthora Diseases of Forest Trees; Proceedings From the First International Meetings on Phytophthoras in Forest and Wildland Ecosystems*. Forest Research Laboratory, Oregon State University.

Acknowledgements

We would like to acknowledge the support and cooperation we have received among all the Port-Orford-cedar landowners, both public and private, in assisting with the resistance testing and breeding program. We would also like to acknowledge the Region 6 Genetics Program and the Forest Health Protection Program for providing funding and logistical support. A special thanks to Heather K. May for poster design and to Joe Linn for reviewing the content.