Phytophthora
ROOT ROT DISEASES
of Lawson Cypress and Other Ornamentals

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All photographs by H. H. Millsap

FRONT COVER: Some horticultural varieties of Lawson cypress in a Willamette Valley nursery sales yard.

Phytophthora Root Rot Diseases of Lawson Cypress and Other Ornamentals

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Introduction

Horticultural varieties of *Chamaecyparis lawsoniana* Parl., known to nurserymen as Lawson Cypress and to foresters as Port Orford Cedar, are used widely in landscape and windbreak plantings in the Pacific Northwest. Consequently, large numbers of cypress are propagated in northwest nurseries. In recent years root rot diseases, caused by two species of fungi in the genus *Phytophthora*, have become increasingly destructive in nursery, landscape and windbreak plantings of cypress in western Oregon. In the past ten years, thousands of two and three year old cypress trees have been killed in nursery plantings and many old established trees in landscape and windbreak plantings have been lost. The cypress fungus *Phytophthora lateralis* Tucker and Milbrath, has been responsible for most of the losses in nursery plantings and has also been isolated from native Port Orford Cedar in southwestern Oregon. Fortunately, this fungus attacks only *Chamaecyparis* species. The cinnamon fungus, *P. cinnamomi* Rands, which causes root rot diseases on many different species of plants over the world, has also killed many cypress trees and in addition has killed yew, heather, rhododendron, and other plants in nursery and landscape plantings. This bulletin discusses the history, symptoms, nature, and control of the *Phytophthora* root rot diseases and lists the plants that are known to be susceptible or resistant to the cypress fungus and to the cinnamon fungus.

History and distribution

In the late 1930's a root rot disease of varieties of Lawson cypress, *Chamaecyparis lawsoniana,* and Hinoki cypress, *C. obtusa* (Sieb. and Zucc.) Endl. was observed in western Oregon nursery and landscape plantings. This disease was found to be caused by a previously unreported fungus, *Phytophthora lateralis* (2), which is referred to in this bulletin as the cypress fungus. The prevalence of cypress root rot in Lawson cypress plantings has increased greatly since the first observation. In recent surveys by the Oregon State Department of Agriculture and Oregon State College, the cypress

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fungus has been found in 26 Oregon nurseries as well as in numerous home and public landscape plantings and farm windbreaks. This disease is also a serious problem in Washington and British Columbia. The cypress fungus has not been reported outside of the Pacific Northwest and is apparently native to this area.

In 1950 another *Phytophthora* species, *P. cinnamomi,* was found to be the cause of a root rot disease of Lawson cypress varieties with symptoms identical to those caused by the cypress fungus (1). *P. cinnamomi* is commonly called the cinnamon fungus because it was originally found causing a disease of cinnamon, *Cinnamomum burmanni* Bl., in Sumatra. In addition to Lawson cypress, the cinnamon fungus causes in Oregon a root rot disease of English yew, *Taxus baccata* L.; Irish yew, *T. baccata* var. *stricta* Laws. *(T. baccata* var. *fastigiata* Loud); Japanese yew, *T. cuspidata* Sieb. and Zucc. var. *nana* Rehd.; rohdodendron, *Rhododendron ponticum* L.; heath, *Erica carnea* L.; and two varieties of heather, *Calluna vulgaris* (L.) Hull var. *alba* (West) Don, and *C. vulgaris* var. *aurea* Don.

The counties in Oregon where the cypress fungus and cinnamon fungus have been isolated from dying plants in one or more instances are shown in Figure 1. The numbers represent isolations from both

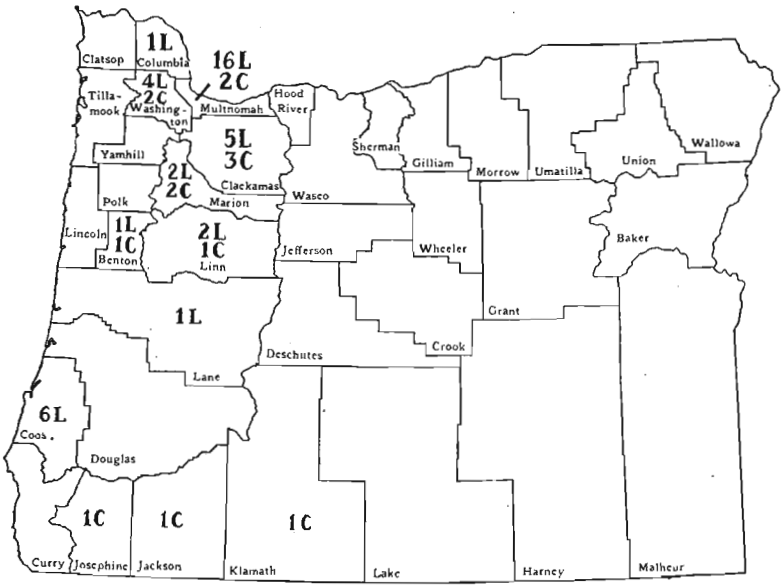

Figure 1. Distribution of the cypress fungus (L), and the cinnamon fungus (C), in nurseries and landscape plantings in Oregon, based on laboratory isolation of the fungi.

nurseries and landscape plantings and indicate the total number of locations from which the fungi have been recovered in each county. These figures by no means represent the total distribution of the pathogens in each county since many obviously diseased plants have not been verified by laboratory isolation. Rather this chart serves to indicate the relative distribution of the cypress fungus and the cinnamon fungus in Oregon. Although the cinnamon fungus has been found in only a few Oregon nursery and landscape plantings, it is potentially a more serious pest than the cypress fungus because of its wider host range. In addition to the plants listed above, the cinnamon fungus is known to attack a large number of other plant species in tropical, sub-tropical, and temperate areas of the world.

How to Recognize the Diseases

The foliar symptoms of cypress root rot are frequently confused with foliar changes that occur when plants die as the result of transplanting injury, winter damage, or poor drainage. However, upon careful examination, it is usually possible to determine whether or not a plant is dead or dying as the result of an attack by one of the organisms causing these root rots.

Symptoms of root rot on cypress

Symptoms of the root rot of cypress caused by the cypress fungus are identical to those of the root rot caused by the cinnamon fungus. Only by isolating the causal fungus in the laboratory can the species of *Phytophthora* responsible be determined. Both fungi invade the roots of plants and spread into the lower part of the main trunk, killing all tissues as they advance. If the outer portion of the bark at the crown of a diseased plant is removed, a sharp line of demarcation between living and dead cells is apparent (Figure 2). About the time the fungus reaches the crown of the plant, foliar symptoms begin to develop. The first foliar symptom in the blue cypress varieties is the gradual disappearance of blue pigments until only the green under-color remains. The color eventually fades to a tan or light brown, and the foliage becomes crisp and dry. The only foliar symptom in the green varieties is a gradual fading of color until the plants are tan or light brown and dead. The first color changes are especially apparent if the diseased plant is adjacent to a healthy plant. When the weather is cool and damp, these color changes may develop over a period of several months, but if the weather is hot and dry the entire sequence may occur in 2 to 3 weeks.

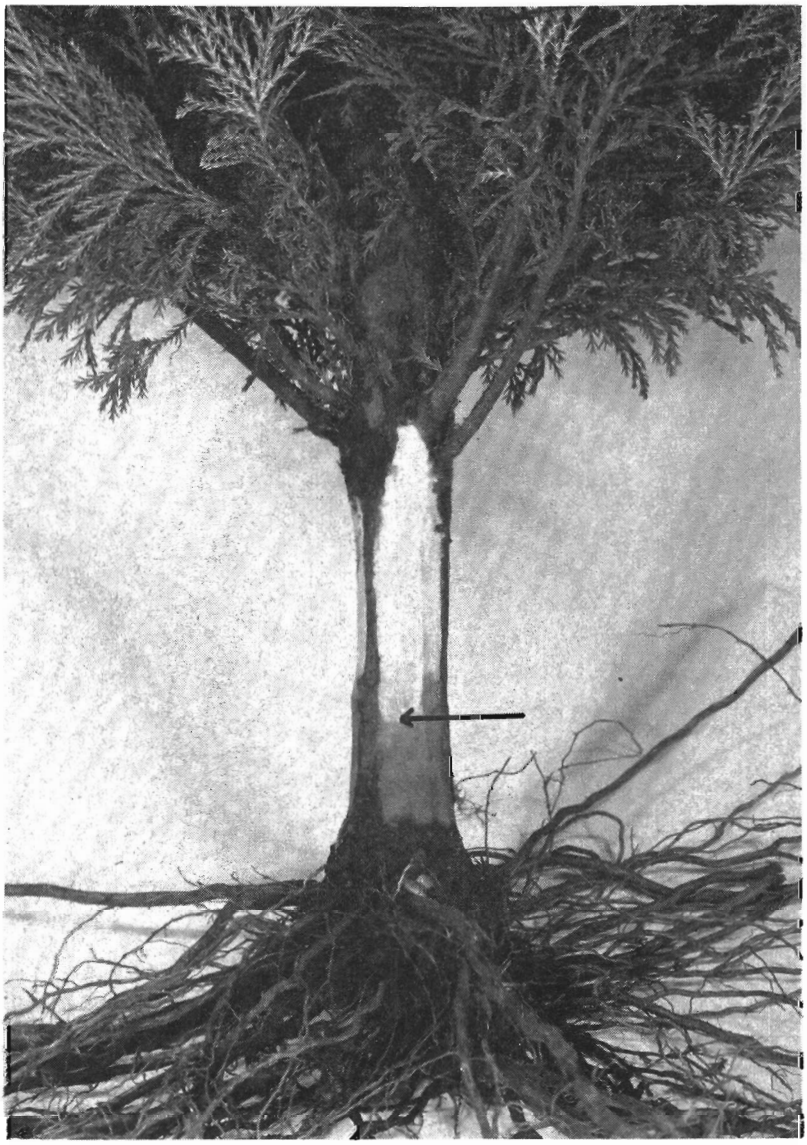

Figure 2. Root rot of Alumi cypress caused by the cypress fungus, which has invaded the roots and is progressing up the stem. Note line of demarcation between living and dead tissue (arrow). Symptoms are identical to those caused by the cinnamon fungus.

Symptoms of root rot of yew

Symptoms of the root rot of English, Irish, and Japanese yew caused by the cinnamon fungus are similar to those of the root rots of cypress. The fungus invades the small feeder roots of the plant, killing them as it advances, and eventually spreads into the main roots and on up the lower portions of the stem (Figure 3). The line of demarcation at the crown between living and dead tissues is not as distinct as in cypress. The dead areas are usually apparent as brown vertical streaks, of varying width, that extend into the wood of the stem. Foliar symptoms begin to develop when all or most of the root system has been killed. The foliage of the diseased plant fades to a tan or light brown and becomes crisp and dry. This color change may be gradual, or if the weather is hot and dry, may occur in a few days.

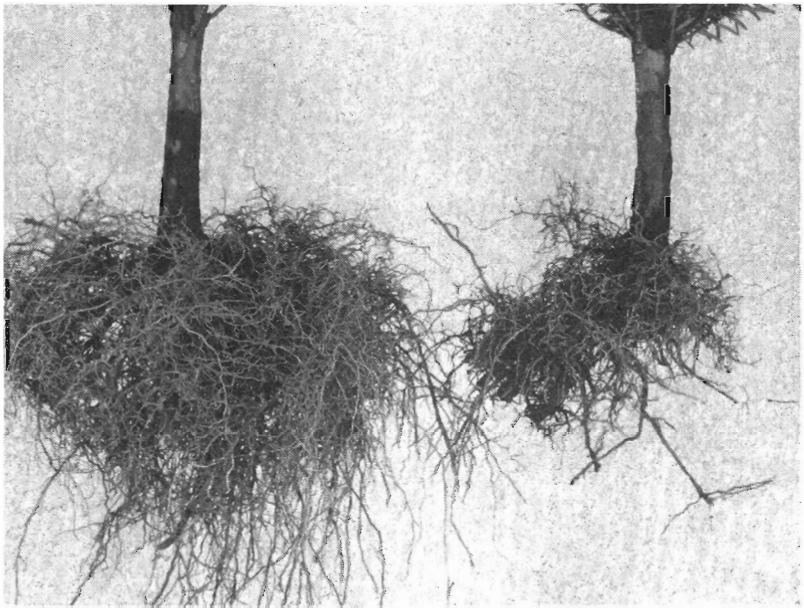

Figure 3. Root rot of English yew caused by the cinnamon fungus. Roots of healthy (left) and diseased (right) plants.

Symptoms of root rot of heaths and heathers

Symptoms of the root rot of the heaths and heathers caused by the cinnamon fungus differ from those of the root rots of cypress and yew in that the foliar symptoms are usually localized. The

fungus invades and kills the feeder roots, slowly advances into the main roots, and may advance up the lower portions of the stems (Figure 4). The first foliar symptoms are the fading and dying of one or more branches. This condition spreads until the entire plant is dead. Several months may be required for a plant to be killed.

Figure 4. Root rot of heath caused by the cinnamon fungus. Roots of healthy (left) and diseased (right) plants.

Symptoms of cinnamon root rot disease of other plants

Symptoms of root rot disease of other plants caused by the cinnamon fungus are usually similar to those of the root rots of cypress, yew or heather. Infection usually occurs in the root system or may occur at the crown. As the fungus gradually advances through and kills the root or crown tissues, the above-ground portions of the plant begin to decline and eventually the plant dies. Larger plants with extensive root systems may be devitalized by loss of feeder roots but may survive for several years following infection.

How the Diseases Spread and Develop

Dissemination of the cypress and cinnamon fungi from one area to another appears to occur primarily through the movement of diseased plants or infested soil. As a large amount of nursery stock is continually being moved from nursery to nursery and from nursery to landscape plantings, both within the state and from state to state, dissemination of these fungi readily occurs.

Both the cypress fungus and the cinnamon fungus are capable of living in the soil for long periods of time. When susceptible host plants are present, these fungi may invade the roots of the plants killing root tissues and eventually the whole plant. The rapidity with which either of the two fungi will spread through and destroy a planting of susceptible plants is influenced by such factors as soil type, moisture content, temperature, pH, and microflora.

Local spread of the fungi from plant to plant is accomplished by the movement of motile spores (zoospores) through the soil water, or by the movement of infested soil by surface drainage water, cultivating tools, and equipment. Since the soil temperature must be about 70° F. before motile spores are produced, dissemination by this means probably occurs only in the late spring or summer.

Within a planting of susceptible plants, the pattern of disease development is similar for the root diseases caused by both the cypress and cinnamon fungi. Initially only a few plants in one or more locations of the newly infested planting will become infected and die. If conditions are favorable for disease development, adjacent plants become infected and so on until all or nearly all of the plants are killed. Several years may elapse before the disease spreads throughout a planting.

Plants Susceptible to Root Rot

Since 1922, when the cinnamon fungus was discovered to be the cause of a disease of cinnamon in Sumatra, a large number of other host plants has been found. A partial compilation of plants found to be susceptible to the cinnamon fungus in this and other countries is given in Table I. Although many of the susceptible plants listed are grown as ornamental or crop plants in Oregon, only a few have been observed to be attacked by this fungus. However, the presence of this fungus in the state represents a threat to Oregon plantings of susceptible plants.

During the last three years the susceptibility of a number of ornamentals to the cinnamon fungus has been determined at Oregon State College. Plants found to be resistant are listed in Table II.

Although all of the plants listed in Table II were resistant to the fungus strain used in the tests, it is possible that other strains of the fungus may be pathogenic to some of the plants. Several cases are known where plants resistant to one strain of *Phytophthora cinnamomi* were susceptible to another strain of the pathogen.

Table I. PLANTS SUSCEPTIBLE TO ROOT ROT CAUSED BY THE CINNAMON FUNGUS[1]

Common name	*Scientific name*
Nordmann fir	*Abies nordmanniana* Spach.
Silver fir	*A. pectinata* D. C.
Siberian fir	*A. siberica* Ledeb.
Birch*	*Betula alba* L.
Spike-heath	*Brunkenthalia spiculifolia* (Salisb.) Reichenb.
Heather*	*Calluna vulgaris* (L.) Hull var. *alba* (West) Don
Heather*	*C. vulgaris* var. *aurea* Don
Camellia	*Camellia japonica* L.
Camellia	*C. sasanqua* Thunb.
American chestnut*	*Castanea dentata* (Marsh.) Borkh.
Atlas cedar	*Cedrus atlantica* Manetti
Deodar cedar	*C. deodara* (Roxb.) Loud.
Alumi cypress*	*Chamaecyparis lawsoniana* Parl. var. *allumi* (R. Smith) Beiss.
Elwood's cypress*	*C. lawsoniana* var. *elwoodi*
Fletcher's cypress*	*C. lawsoniana* var. *fletcheri* (Fletcher) Hornibr.
Yellow cypress*	*C. lawsoniana* var. *lutea* (R. Smith) Beiss.
Birds nest cypress*	*C. lawsoniana* var. *nestoides*
Italian cypress	*Cupressus sempervirens* L.
Irish heath*	*Daboccia cantabrica* (L.) K. Koch var. *alba* (D. Don) Dipp.
Heath*	*Erica arborea* L. var. *alpina* Bean
Spring heath*	*E. carnea* L.
Fringed heath*	*E. ciliaris* L.
Twisted heath*	*Erica cinerea* L.
Heath	*E. hyemalis* Nichols
Heath*	*E. mediterranea*
Heath	*E. nivalis* Andr.

Common name	*Scientific name*
Heath	*E. regerminans* L.
Heath*	*E. terminalis* Salisb. (*E. stricta* Andr.)
Cross leafed heath*	*E. tetralix* L.
Heath	*E. willmoreana* Knowles and Westc.
Cornish heath*	*E. vagans* L.
Black walnut	*Juglans nigra* L.
English walnut*	*J. regia* L.
European larch	*Larix decidua* Mill
Japanese larch	*L. leptolepis* (Sieb. and Zucc.) Gord.
Incense cedar	*Libocedrus decurrens* L.
Norway spruce	*Picea abies* Mill.
Colorado spruce	*P. pungens* Englm.
Little-leaf pine	*Pinus echinata* Mill.
Monterey pine	*P. radiata* Don
Norway pine	*P. resinosa* Ait.
White pine	*P. strobus* L.
Scotch pine	*P. sylvestris* L.
Douglas fir*	*Pseudotsuga taxifolia* (Poir.) Britton
Sycamore	*Platanus orientalis* L.
White oak	*Quercus alba* L.
Red oak	*Q. borealis* Michx. *f.*
Rhododendron	*Rhododendron californicum* Hook.
Rhododendron	*R. carolineanum* Rehd.
Rhododendron	*Rhododendron catawbiense* Michx.
Rhododendron	*R. caucasicum* Pall.
Azalea	*R. indicum* (L.) Sweet (*Azalea indica* L.)
Rhododendron	*R. maximum* L.
Mollis azalea*	*R. molle* (Bl.) D. Don (*Azalea mollis* Bl.)
Rhododendron	*R. mucronulatum* Turcz.
Rhododendron*	*R. ponticum* L.
Black locust	*Robinia pseudoacacia* L.
English yew*	*Taxus baccata* L.
Irish yew*	*T. baccata* var. *stricta* Laws. (*T. baccata* var. *fastigiata* Loud.)
Japanese yew*	*T. cuspidata* Sieb. and Zucc.
Arbor-vitae	*Thuja occidentalis* L. var. *compacta* Carr.

[1] Those plants that have been tested in Oregon are indicated with an asterisk (*). A summary of the host range of *Phytophthora cinnamomi* is included in reference (1).

Table II. PLANTS TESTED IN OREGON AND FOUND TO BE RESISTANT TO ROOT ROT CAUSED BY THE CINNAMON FUNGUS

Common name	*Scientific name*
Alaska cypress	*Chamaecyparis nootkatensis* (Lamb.) Spach. var. *compacta* Beiss.
Hinoki cypress	*C. obtusa* (Seib. and Zucc.) Endl. var. *crippsii* (Cripps) Rehd.
Sawara cypress	*C. pisifera* (Sieb. and Zucc.) Endl. var. *filifera* (Senecl.) Hartw. and Ruempl.
Sawara cypress	*C. pisifera* var. *plumosa* (Carr.) Otto
Sawara cypress	*C. pisifera* var. *squarrosa* (Endl.) Beiss. and Hochst.
White cedar	*C. thyoides* (L.) B.S.P.
Rock daphne	*Daphne cneorum* L.
Daphne	*D. odora* Thunb.
Pfitzer's juniper	*Juniperus chinensis* L. var. *pfitzeriana* Spaeth
Juniper	*J. excelsa* Bieb. var. *stricta* Gord.
Savin juniper	*J. sabina* L.
Meyer's juniper	*J. squamata* Lamb. var. *meyeri* Rehd.
Mugo pine	*Pinus mugo* Turra var. *mughus* (Scop.) Zenari
Rhododendron	*Rhododendron obtusum* (Lindl.) Planch *(Azalea obtusa* Lindl.)
Arbor-vitae	*Thuja occidentalis* L. var. *aureo-variegata* Henk. and Hochst.
Pyramidal arbor-vitae	*T. occidentalis* var. *fastigiata* Jaeg. *(T. occidentalis* var. *pyramidalis* Hort.)
Woodward's arbor-vitae	*T. occidentalis* var. *woodwardii* Spaeth.
Arbor-vitae	*T. orientalis* L. var. *aurea* Senecl.
Arbor-vitae	*T. orientalis* var. *compacta* Beiss.

Unlike the cinnamon fungus, the cypress fungus has a very limited host range. A list of plants found to be susceptible to the cypress fungus in Oregon is given in Table III. A number of plants which have been tested and found resistant to attack by the cypress fungus are listed in Table IV.

Table III. PLANTS TESTED IN OREGON AND FOUND SUSCEPTIBLE TO ROOT ROT CAUSED BY THE CYPRESS FUNGUS

Common name	*Scientific name*
Lawson cypress	*Chamaecyparis lawsoniana* Parl.
Alumi cypress	*C. lawsoniana* var. *allumi* (R. Smith) Beiss.
Cypress	*C. lawsoniana* var. *cerula*
Elwood's cypress	*C. lawsoniana* var. *elwoodi*
Cypress	*C. lawsoniana* var. *erecta aurea*
Cypress	*C. lawsoniana* var. *erecta glauca* (R. Smith) Beiss.
Cypress	*C. lawsoniana* var. *erecta veridis* Beiss.
Yellow cypress	*C. lawsoniana* var. *lutea* (R. Smith) Beiss.
Cypress	*C. lawsoniana* var. *minima glauca* (R. Smith) Beiss.
Birds nest cypress	*C. lawsoniana* var. *nestoides*
Stewart's cypress	*C. lawsoniana* var. *stewarti*
Cypress	*C. lawsoniana* var. *wisseli*
Hinoki cypress	*C. obtusa* (Sieb. and Zucc.) Endl. var. *crippsii* (Cripps) Rehd.

Control of Cypress and Cinnamon Root Rot

The *Phytophthora* root rot diseases are among the more difficult plant diseases to control. The nature of the diseases and the plants attacked rule out the usual methods of plant disease control such as fungicidal sprays used for the control of foliage diseases, crop rotation used to reduce the incidence of root rots attacking annual crop plants, and the breeding of resistant varieties. However, attention has been given to the use of resistant root stocks, chemical treatment of the soil, and modifying cultural practices as possible means of combatting *Phytophthora* root rot.

The use of resistant rootstocks

From the species and varieties of conifers resistant to *P. lateralis*, the following were selected for testing for use in propagation of Alumi cypress: *Chamaecyparis pisifera* var. *aurea*, *C. pisifera* var. *plumosa*, *C. pisifera* var. *squarrosa*, *Juniperus procumbens*,

Table IV. PLANTS TESTED IN OREGON AND FOUND RESISTANT TO ROOT ROT CAUSED BY THE CYPRESS FUNGUS

Common name	*Scientific name*
Alaska cypress	*Chamaecyparis nootkatensis* (Lamb.) Spach. var. *compacta* Beiss.
Hinoki cypress	*C. obtusa* var. *ericoides* Boehmer
Hinoki cypress	*C. obtusa* (Sieb. and Zucc.) Endl. var. *tetragona aurea* (Barron) Nichols
Hinoki cypress	*C. obtusa* var. *torulose*
Sawara cypress	*C. pisifera* var. *aurea nana*
Sawara cypress	*C. pisifera* (Sieb. and Zucc.) Endl. var. *filifera* (Senecl.) Hartw. and Ruempl.
Sawara cypress	*C. pisifera* var. *plumosa* (Carr.) Otto
Sawara cypress	*C. pisifera* var. *plumosa aurea* (R. Smith) Otto
Sawara cypress	*C. pisifera* var. *squarrosa* (Endl.) Beiss. and Hochst.
Sawara cypress	*C. pisifera* var. *squarrosa nana*
White cedar	*C. thyoides* (L.) B.S.P.
Juniper	*Juniperus excelsa* Bieb.
Creeping juniper	*J. horizontalis* Moench. *(J. prostrata* Pers.)
Pyramidal arbor-vitae	*Thuja occidentalis* var. *fastigiata* Jaeg. *(T. occidentalis* var. *pyramidalis* Hort.)
Berckmans arbor-vitae	*T. orientalis* L. *aurea conspicua*
Western red cedar (Giant arbor-vitae)	*T. plicata* Don

Thuja occidentalis var. *aurea conspicua, T. occidentalis* var. *pyramidalis,* and *T. plicata.*

When scions of Alumi cypress were grafted onto these roots, good union occurred, and the young scions grew very rapidly in the greenhouse. The grafted plants and rooted Alumi cypress plants were then planted in a field plot where they were tested for resistance to *P. lateralis* by inoculating every other plant in each row with a culture of the fungus in pea broth. The inoculated trees on Alumi roots died in the spring following inoculation, and at the termination of the trial most of the uninoculated trees on Alumi roots were

dead also. None of the trees on resistant roots died from infection with *P. lateralis*.

The growth habits of all of the grafted plants were affected by the rootstock used. Although *Juniperus procumbens* produced the best scion growth during the first year in the greenhouse an incompatible union soon developed in the field planting and the plants died. All of the other grafted plants were retarded in growth. The plants were not sheared for form, and the grafted plants were more open and sprawling with weak central trunks.

When the trees were dug after 5 years of growth in the field, a study of the graft union revealed various stages of compatibility between scion and root stock (Figure 5). The trunk caliper of grafted plants was smaller than the caliper of plants on their own roots. From these studies it would appear undesirable for nurserymen to attempt large scale propagation of Alumi cypress on resistant root stocks without first conducting a 4 to 5 year field performance test for compatibility and subsequent growth. The dwarfing effect of the more compatible varieties may not limit their use if the trees can be sheared into a desirable shape. However, if resistant rootstocks are used, care should be taken to prevent rooting above the scion since such roots would offer a point where infection could occur.

Chemical treatment of the soil

Treatment of infested soil with chemicals has frequently been suggested and tried as a means of eradicating the *Phytophthora* root rot fungi from the soil. Although several chemicals will kill the disease-causing fungi in the soil, their use has not been effective due to physical difficulties in distributing the chemicals in the soil. In infested soil, the fungi may be distributed throughout the soil down to such depths that it is impossible for chemicals to penetrate and destroy them. Assuming that total eradication is necessary to prevent the cypress or cinnamon root rot fungi from attacking subsequent plantings of susceptible plants, the limited penetration of presently available fungicidal chemicals in the soil excludes chemical treatment as a practical method of control.

Modifying cultural and management practices

At present, no positive recommendations can be made for the control of cypress or cinnamon root rot in nursery plantings already infested. Diseased plants and the healthy plants immediately adjacent should be removed and destroyed. The remaining plants can sometimes be salvaged by removal to new ground or transplanting into cans or other containers where they can be observed for signs

of root rot. If after a year or more no signs of root rot are observed, the plants probably can be considered free of root rot and then may be sold safely. Infested land should be used for purposes other than the growing of nursery stock. Although resistant plants may be grown safely in infested soil, this practice is unwise since infested soil may be carried with the plants when they are sold and thereby serve as a source of infection for susceptible plants that may be present in the new planting site. In nurseries, great care should be exercised to prevent the movement of soil from infested to non-infested areas.

Nurserymen whose plantings are free from cypress or cinnamon root rot fungi should take the precautions necessary to prevent the introduction of these diseases. The surest way to keep a nursery free from these diseases is to propagate ones own nursery stock. However, if it is necessary to purchase stock from other growers, it is advisable to plant the purchased stock in an area isolated from other nursery stock. The plants can then be observed, and if root rot appears, the main nursery plantings will not have been endangered.

At present no treatments are known that will save plants with either cypress or cinnamon root rot. The owner of a diseased landscape planting, therefore, has no recourse other than to replant with plants known to be resistant to root rot. A number of plants resistant to the cypress and/or the cinnamon fungus are listed in Tables II and IV.

Like the nurseryman, the landscape planter must take the precautions necessary to prevent the introduction of the cypress or cinnamon fungus into his plantings. Only plants known to be free from root rot should be obtained for planting in a landscape planting.

It is not advisable to use Lawson cypress for large plantings such as hedges or windbreaks. If either the cypress or cinnamon fungus is by chance introduced into such a planting, the entire planting may eventually be destroyed with considerable economic loss to the owner. Such loss can be avoided by using resistant species of plants where plantings of this type are desired.

The Bureau of Nursery Service of the Oregon State Department of Agriculture in cooperation with Oregon nurserymen has established a regulatory program designed to prevent further spread of the cypress and cinnamon fungi in Oregon nurseries. This program should result in mutual benefits to both the growers and the buyers of nursery stock. Information concerning this program can be obtained from the Oregon State Department of Agriculture offices in Portland or in Salem.

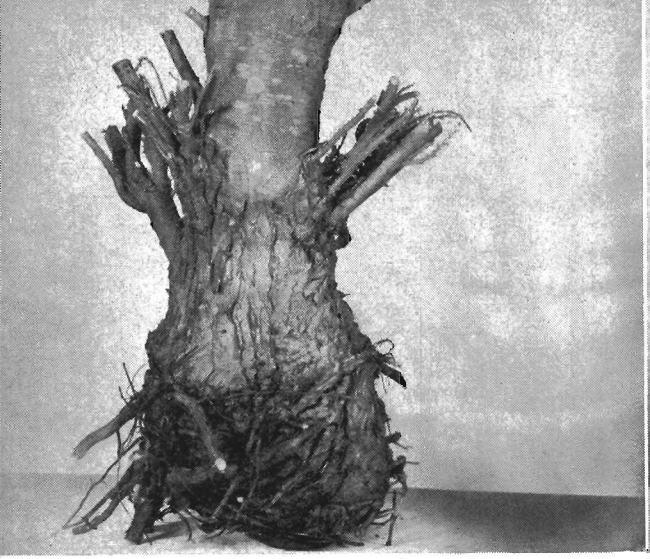

Figure 5. Growth of Alumi cypress after 5 years. Rooted cutting (above) and grafts on *Chamaecyparis pisifera* var. *plumosa* (above right), *C. pisifera* var. *squarrosa* (right), *Thuja occidentalis* var. *pyramidalis* (below right), and *T. plicata* rootstocks (below).

Summary

► Root rot diseases of *Chamaecyparis lawsoniana* (Lawson Cypress, Port Orford Cedar) varieties, caused by two species of fungi in the genus *Phytophthora,* annually kill many plants in Pacific Coast nursery, landscape, and windbreak plantings and threaten large native stands of Port Orford Cedar. Whether or not the fungi can kill large established Port Orford Cedar trees in native stands is not known, although trees 15 to 20 feet high have been killed in windbreak plantings.

► *Phytophthora lateralis,* known as the cypress fungus, attacks only *Chamaecyparis* species, whereas *P. cinnamomi,* the cinnamon fungus attacks a wide range of ornamental conifers and broad-leaf plants.

► The disease-producing fungi live in the roots of infected plants or in the soil where infected plants have grown and may be spread from one area to another when plants or soil are moved, or in soil water.

► Both fungi kill plants by infecting the roots and gradually destroying the root system.

► Sixty-one ornamental plants that are susceptible to the cinnamon fungus and nineteen plants that were resistant to the cinnamon fungus in greenhouse inoculation trials are listed. Thirteen plants that are susceptible to the cypress fungus and sixteen plants that are resistant to the cypress fungus are listed.

► The best means of preventing losses from cypress root rot is to carry out practices designed to avoid the disease organisms. Growing disease free propagating stock in new soil or soil known to be free from the root rot fungi is at present the only sure means of avoiding the disease. Chemical treatment is not practical with the chemicals that are available at present; however, new chemicals are being tested. Use of resistant rootstocks has not proven feasible due to incompatibility of Lawson cypress varieties and rootstocks of resistant varieties.

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