

PACIFIC SOUTHWEST Forest and Range Experiment Station

DAMAGE TO KNOBCONE × MONTEREY PINE HYBRIDS AND PARENTS...by red band needle blight in California redwood sites

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Since knobcone X Monterey pine hybrid (*Pinus attenuata* Lemm. X *P. radiata* D. Don) was first produced in 1927 by the Institute of Forest Genetics, it has been outplanted on many sites in California.¹ Before 1963, the knobcone parents were from the Eldorado National Forest, California. Subsequently, hybrids have been produced by the Forest Service in southwestern Oregon, near the northern end of the knobcone pine's range.

The hybrid inherited the exceptional juvenile growth of the Monterey pine and drought and frost resistance of the knobcone parent. It resists attack by the pine reproduction weevil and the western and mountain pine beetles, but is susceptible to the western gall rust and red band needle blight. Griffin and Conkle² have reported on the growth of hybrids and parents on marginal timber sites in interior northern California. After 3 years, the hybrids appeared more promising than either parent species.

Forest managers in north coastal California are interested in planting both Monterey pine and the hybrid. They want a fast-growing species to supply extra wood fiber on short rotation and to balance stand-age deficiencies in existing stands of redwood and Douglas-fir. Both Monterey pine and the hybrid have also been considered for special purpose planting, such as roadsides, problem sites, and Christmas trees. Before any extensive plantings are made in northern California or in southwestern Oregon, knowledge about any limiting factors in establishment and growth would be useful.

In 1960-63, the hybrids and parents were planted on the Redwood Experimental Forest and vicinity to determine their response to the north coastal California environment. The test plantations lie on medium to high-site redwood timberlands. They extend the natural range of knobcone pine by only a few miles westward; but extend the range of Monterey pine about 300 miles north.

ABSTRACT: The knobcone X Monterey pine hybrid (*Pinus attenuata* Lemm. X *P. radiata* D. Don) has been outplanted in many places in California, among them the Redwood Experimental Forest and vicinity in north coastal California. Survival and growth in the early years were satisfactory. In 1966, red band needle blight was found to be infecting the plantations. Many of the trees have died. It appears that most of the trees on the best site will die from the needle blight. But one hybrid plantation so far shows no evidence of infection. It lies on a site four times higher in elevation and farther inland, where presumably there is less summer fog. The results suggest that small differences in climate may be the key factor in limiting needle blight infection.

OXFORD: 174.7 *Pinus* X *attenuradiata*: 443-172.8 *Scirrhia pini*: 232.13 + 443-172.8 *Scirrhia pini* [+ 174.7 *Pinus attenuata* + 174.7 *Pinus radiata*].

RETRIEVAL TERMS: *Pinus* X *attenuradiata*; hybrid trials; plantation establishment; leaf blight; *Scirrhia pini*; *Pinus attenuata*; *Pinus radiata*; Redwood Experimental Forest.

In 1966, the red band needle blight (*Scirrhia pini* Funk & Parker [*Dothistroma pini* Hulbary]) was positively identified in one of the hybrid plantations. This plantation was among the eight infection centers discovered. Diseased needles had been noted in 1965, and infection may have occurred as early as 1964.³ Many trees have died and others have been severely defoliated (fig. 1). But so far, hybrids planted at higher elevation and further inland from the Pacific Ocean have escaped infection. This difference suggests that the climate there is probably somewhat unfavorable to spread and infection rather than that these crosses are resistant to red band needle blight.

PLANTATION TESTS

All seedlings planted in this study were grown at the Institute of Forest Genetics, Placerville, Calif. The seeds were from three sources: the Institute, two elite

trees from New Zealand, and southwestern Oregon (table 1).

Plantings were made in each of 4 years at three sites on the Experimental Forest. Those in 1960 and 1961 were simple block type of all seedlings of a particular lot on Yurok-4, on high-site land. Plantings in 1962 and 1963 were in randomized blocks on Yurok-8, also high-site land. The other plantings in 1963 were randomized blocks at Turwar, on lower site and at higher elevation, and using Oregon seedlings.

Both Yurok sites are 2 miles from the Pacific Ocean, and about ½ mile apart. Yurok-4 is at midslope at 425 feet elevation; Yurok-8 is at lower slope, at 225 feet elevation. Both sites have mild, humid climate, dry summers, and frequent fog. Precipitation averages 76 inches annually—mostly



Figure 1—Red band needle blight has defoliated these knobcone X Monterey pine hybrids. In 1967, the trees averaged 15 feet tall. All but two trees were dead or dying when photographed in March, 1970.

inches annually. Soil is probably Hugo, moderately to strongly acid, of gravelly clay loam, grayish brown to pale brown, with depths reaching 2 feet.

RESULTS

The initial survival of all seedling lots on Yurok-4 and Yurok-8 plantations was high (*table 2*). Environmental factors were obviously favorable to establishment and growth. Mortality in 1967 and thereafter on the Yurok plantations was all caused by the red band needle blight. Mortality of the two knobcone X Monterey pine lots planted in 1960 and of Monterey and knobcone pines planted in 1961 increased greatly by 1969. All of the hybrids planted in 1961 were alive in 1968, then many died within a year.

The hybrids planted in 1962 on Yurok-8 had survival of 97 to 100 percent through 1968, then the three lots suffered moderate losses in 1969. The three knobcone pine lots had survival rates of 93 to 100 percent through 1968, but by 1969, survival dropped drastically, ranging from 4 to 30 percent (*table 2*).

Elite Monterey pines from New Zealand seed planted in 1963 were surviving well through 1969.

To date, no red band needle blight has been found in the Turwar plantation. Unfavorable site caused by logging and comprised of rocky subsoil on about 75 percent of the plantation area has been a contributing factor to uneven survival (*table 2*).

After determining the amount of survival, by years after planting, I next checked the health of the trees as judged by foliage infection. The results suggested the probability that in due time nearly all trees on the Yurok sites would be dead (*table 3*). A few of the hybrids AtR(V30) and the two elite Monterey pines may survive. But there is no basis now for judging any of these latter three pines to be resistant to red band needle blight in the north coastal environment.

To see if tree height made a difference in amount of needle blight infection, I related height to percent of foliage infected in the upper one-fourth crown and in the lower three-fourth crown. Shorter trees were more heavily infected and suffered greater mortality than taller trees (*table 4*). By 1969, all trees under 23 feet were dead.

Besides occupying a poorer competitive position for light and moisture, the shorter trees are in a favorable environment for spread and growth of red

band needle blight. Practically all spread of the disease takes place through rain splash dispersal of spores. In addition, fog and mist enable the spores to infect the foliage.⁴ Both splash and mist should be optimum on shorter trees and in lower crowns.

CONCLUSIONS

Both Monterey pine and knobcone X Monterey pine hybrids have almost no chance of growing in the environment of the Redwood Experimental Forest because of virulence of red band needle blight. Climatic conditions favorable to its spread and growth are present over a wide range of coastal areas with high rainfall and fog. The failure and severe defoliation of all the plantations there support Wagener's⁴ recommendation that Monterey pine and knobcone X Monterey pine hybrids should not be planted in high rainfall, misty, foggy, and mild forest sites of north coastal California.

The Oregon-produced hybrids planted at a high elevation and farther inland from the ocean so far have not become infected with needle blight. They have been subjected to a shorter period of exposure, and perhaps the climate is not too favorable to spread and growth of the disease. Other more inland sites in north coastal California have both Monterey pine and knobcone X Monterey pine hybrids that are similarly uninfected. These forest sites will probably be suitable for growth of both species, but we cannot now define specifically the climatic factors that separate the two areas.

NOTES

¹Stockwell, Palmer, and F. I. Righter. *Pinus: the fertile species hybrid between knobcone and Monterey pines*. Madrona 8: 157-160. 1946.

²Griffin, James B., and M. Thompson Conkle. *Early performance of knobcone X Monterey pine hybrids...on marginal timber sites*. U.S. Forest Serv. Res. Note PSW-156, Pacific SW. Forest & Range Exp. Sta., Berkeley, Calif. 10 p., illus. 1967.

³Cobb, F. W., Jr., and D. R. Miller. *Hosts and geographic distribution of *Scirrhia pini*—the cause of red band needle blight in California*. J. Forestry 66: 930-933, illus. 1968.

⁴Wagener, Willis W. *Red band needle blight of pines...a tentative appraisal for California*. U.S. Forest Serv. Res. Note PSW-153, Pacific SW. Forest & Range Exp. Sta., Berkeley, Calif. 6 p. 1967.

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Table 2—Survival of 1-year-old knobcone x Monterey pine hybrids and parents planted on the Redwood Experimental Forest, California, and vicinity, by planting site and year

Planting site, year, and seedling lots	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Yurok-4 (1960):										
AtR (F ₁)	98	96	—	—	—	96	—	78	56	14
AtR (E-2-1)	88	88	—	—	—	88	—	72	52	28
Yurok-4 (1961):										
AtR (V30)	—	100	100	100	100	100	100	100	100	84
AtR (V30)	—	100	100	—	96	96	96	96	96	36
R (SC)	—	100	96	—	88	88	88	84	76	40
Yurok-8 (1962):										
AtR (53)	—	—	100	100	—	—	100	—	100	92
AtR (55)	—	—	100	100	—	—	100	—	97	87
AtR (57)	—	—	100	100	—	—	100	—	100	90
At (53)	—	—	100	100	—	—	100	—	96	4
At (55)	—	—	100	100	—	—	100	—	100	30
At (57)	—	—	100	100	—	—	100	—	93	17
Yurok-8 (1963):										
R (7NZ)	—	—	—	100	—	100	—	95	95	95
R (96NZ)	—	—	—	100	—	100	—	100	100	95
Turwar (1963):										
AtR (G-8017)	—	—	—	77	—	77	—	69	—	69
AtR (G-8025)	—	—	—	100	—	100	—	93	—	93
AtR (A-56)	—	—	—	91	—	91	—	91	—	91
AtR (A-24)	—	—	—	73	—	73	—	60	—	60
AtR (G-8010)	—	—	—	100	—	80	—	80	—	80
AtR (A-5)	—	—	—	67	—	67	—	67	—	67
AtR (A-54)	—	—	—	79	—	79	—	79	—	79
AtR (G-8066)	—	—	—	57	—	28	—	21	—	21
AtR (G-8072)	—	—	—	73	—	73	—	73	—	73
AtR (G-8062)	—	—	—	47	—	40	—	40	—	40
AtR (G-8082)	—	—	—	64	—	64	—	57	—	57
AtR (G-8070)	—	—	—	85	—	79	—	79	—	79
AtR (G-8068)	—	—	—	80	—	80	—	80	—	80
AtR (G-8067)	—	—	—	73	—	73	—	73	—	73
AtR (G-8058)	—	—	—	100	—	100	—	100	—	100
AtR (G-8012)	—	—	—	33	—	33	—	33	—	33
AtR (G-8014)	—	—	—	100	—	93	—	93	—	93
AtR (G-1)	—	—	—	100	—	100	—	100	—	100
AtR (A-44)	—	—	—	100	—	100	—	100	—	100
AtR (G-8015)	—	—	—	93	—	86	—	86	—	86
AtR (G-8086)	—	—	—	93	—	93	—	93	—	93
AtR (G-8011)	—	—	—	100	—	100	—	100	—	100
AtR (G-8071)	—	—	—	93	—	93	—	93	—	87
AtR (G-8060)	—	—	—	80	—	80	—	80	—	80
AtR (G-8004)	—	—	—	47	—	33	—	27	—	27
AtR (G-8018)	—	—	—	80	—	73	—	73	—	73
AtR (G-8022)	—	—	—	71	—	71	—	71	—	71

rain; mean temperatures range from 42°F. in January to 55°F in August and light frost may occur in winter months. Mean monthly relative humidity ranges from about 77 to 94 percent. Soil is Melbourne, strongly acid, moderately fine textured, dark brown, clay loams, reaching 4-foot depths.

Turwar is at a ridgetop, at 1,625 feet elevation, about 5 miles from the ocean. It is subject to greater range in temperature and humidity. Although weather records are not available for the plantation there, summer fogs are probably less frequent and they dissipate faster. Precipitation averages about 80

Table 1—Origin of seedlings planted on Redwood Experimental Forest, California and vicinity, 1960-63

Seedling lots	Seed parents	Pollen parents
INSTITUTE FOREST GENETICS (IFG) HYBRIDS PLANTED AT YUOK-4 (1960)		
AtR ¹ (F ₁) AtR (E-2-1)	F ₁ Hybrid Eldorado-2-1 (IFG tree)	Wind pollinated R-mix ¹
IFG HYBRIDS AND PARENTS PLANTED AT YUOK-4 (1961)		
AtR (V30) At (V30) R.(SC)	V30 Mt. Diablo (2,750 ft.) V30 Mt. Diablo (2,750 ft.) Santa Cruz county	R-mix Wind pollinated Wind pollinated
IFG HYBRIDS AND PARENTS PLANTED AT YUOK-8 (1962)		
AtR (53) AtR (55) AtR (57) At (53) (55) (57)	Progeny of V-14 (IFG tree) Progeny of V-14 (IFG tree) Progeny of V-14 (IFG tree) Progeny of V-14 (IFG tree)	R-mix R-mix R-Mix Wind pollinated
ELITE NEW ZEALAND SEEDLINGS PLANTED AT YUOK-8 (1963)		
R (7NZ) R (96NZ)	Elite tree (New Zealand) Elite tree (New Zealand)	Wind pollinated Wind
OREGON SEEDLINGS PLANTED AT TURWAR (1963)		
AtR (G-8017)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8025)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (A-56)	Applegate Ranger District, Rogue River National Forest	R-C59
AtR (A-24)	Applegate Ranger District, Rogue River National Forest	R-C60
AtR (G-8010)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (A-5)	Applegate Ranger District, Rogue River National Forest	R-C60
AtR (A-54)	Applegate Ranger District, Rogue River National Forest	R-C60
AtR (G-8066)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8072)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8062)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8082)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8070)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8068)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8067)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8058)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8012)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8014)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-1)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (A-44)	Applegate Ranger District, Rogue River National Forest	R-C59
AtR (G-8015)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8086)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8011)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8071)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8060)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8004)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8018)	Galice Ranger District, Siskiyou National Forest	R-C59
AtR (G-8022)	Galice Ranger District, Siskiyou National Forest	R-C59

¹At = *Pinus attenuata*; R = *Pinus radiata*; AtR = *Pinus x attenuaradiata*.

Table 3—Percent of Monterey, knobcone, and hybrid pine trees infected by red band needle blight, by percent of infection on crowns, Redwood Experimental Forest, 1969

Planting site, year, and seedling lots	Upper Crown ≤25 percent infected; lower crown . . .		Upper Crown >25 percent infected; lower crown . . .		Tree dead
	<25 percent infected	>25 percent infected	Severely blighted	Foliage dead	
	<i>Percent</i>				
Yurok-4 (1960):					
AtR (F)	0	2	2	10	86
AtR (E-2-1)	0	0	12	16	72
Yurok-4 (1961):					
AtR (V30)	0	4	60	20	16
At (V30)	0	0	4	32	64
R (SC)	0	0	4	36	60
Yurok-8 (1962):					
AtR (53)	0	0	16	76	8
AtR (55)	0	6	13	68	13
AtR (57)	0	0	0	90	10
At (53)	0	0	0	4	96
At (55)	0	0	0	30	70
At (57)	0	0	0	17	83
Yurok-8 (1963):					
R (7NZ)	0	20	50	25	5
R (96NZ)	0	16	37	42	5

Table 4—Percent of Yurok-4 (1960) knobcone x Monterey pine hybrids infected by red band needle blight, by percent of infection on crowns, tree height, and year inspected, Redwood Experimental Forest, California

Year measured and height class (ft.)	Upper crown not in- fected; lower crown . . .		Upper crown < 25 percent infected; lower crown . . .		Upper crown > 25 percent infected; lower crown . . .		Tree dead
	<25 percent infected	>25 percent infected	<25 percent infected	>25 percent infected	Severely blighted	Foliage dead	
INSPECTED IN 1967							
1964:							
2-4	—	—	—	—	—	—	100
5-7	12	—	—	13	25	12	38
8-10	7	14	21	—	10	17	31
11-13	46	6	18	6	—	12	12
14-16	46	12	30	6	6	—	—
INSPECTED IN 1969							
1969:							
8-10	—	—	—	—	—	—	100
11-13	—	—	—	—	—	—	100
14-16	—	—	—	—	—	—	100
17-19	—	—	—	—	—	—	100
20-22	—	—	—	—	—	—	100
23-25	—	—	—	—	—	25	75
26-28	—	—	—	—	—	43	57
29-31	—	—	—	—	—	100	—
32-34	—	—	—	—	25	50	25
35-37	—	—	—	—	—	100	—
38-40	—	—	—	16	50	17	17