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Early Performance of Knobcone x Monterey Pine Hybrids . . . on marginal timber sites

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The knobcone X Monterey pine hybrid (*Pinus attenuata* Lemm. X *P. radiata* D. Don) was the first and probably the fastest growing hybrid to be produced by the Institute of Forest Genetics (IFG), Placerville, Calif.¹ Native knobcone pines growing near Camino on the Eldorado National Forest were pollinated with Monterey pine pollen in 1927. The resulting hybrids inherited the exceptional juvenile growth of the Monterey pine and drought and frost resistance from the knobcone parent. The hybrids resist attack by the pine reproduction weevil and the western and mountain pine beetles, but are susceptible to the western gall rust.

Since 1929 many small exploratory plantations have been established by the IFG and Region 5, U.S. Forest Service, in a variety of habitats in California. Before 1963 all knobcone parents were from the Eldorado National Forest.

This note concerns hybrids recently produced by Region 6, U.S. Forest Service, in southwestern Oregon near the northern end of knobcone pine's range. It reports on the first large-scale test in California of hybrids grown from seeds produced on knobcone pines

ABSTRACT: Three plantations of knobcone X Monterey pine hybrids were established on marginal timber sites at elevations of 671 m. (2,200 ft.) to 991 m. (3,200 ft.) in northern California in 1964. After 3 years, the hybrids appear more promising than either parent species. Damage from snow and windthrow suggests high risk of storm damage to hybrids planted at higher elevations.

OXFORD: 174.7 *Coniferae*

RETRIEVAL TERMS: Monterey pine; knobcone pine; *P. attenuata* X *P. radiata*; hybrid seedling performance; low-quality timber sites; plantations; California; storm damage; insect and disease resistance.

in the Siskiyou N.F. (fig. 1). Performance of the Oregon hybrids during their first 3 years of field growth is summarized. Different parent stands of knobcone pines within the Siskiyou N.F. are evaluated on the basis of their hybrids' performance. In addition, all of the Oregon hybrids are contrasted with the California hybrids and with both parental species.

The value of the hybrid now centers upon two uses--as a tree for special purposes and problem sites, and as a tree suitable for wood production on a very short rotation. In the first case the hybrid might be used for brushfield conversion, for stream banks and road stabilization, for screening of camp sites and picnic areas, and possibly for Christmas trees. Its value as a wood producer will be realized if a market develops for pulp or small logs. Here, its success will depend upon the hybrid's ability to produce wood in a short rotation on a wide range of forest sites.

PLANTATION TESTS

This study tests the performance of hybrids on three marginal timber sites in northern California (fig. 1). For such purpose, the locations are suited

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

Little, E.L. Jr., and Righter, F.I. *Botanical descriptions of forty artificial pine hybrids*. U.S. Dep. Agr. Tech. Bull. 1345, 47 pp. 1965.

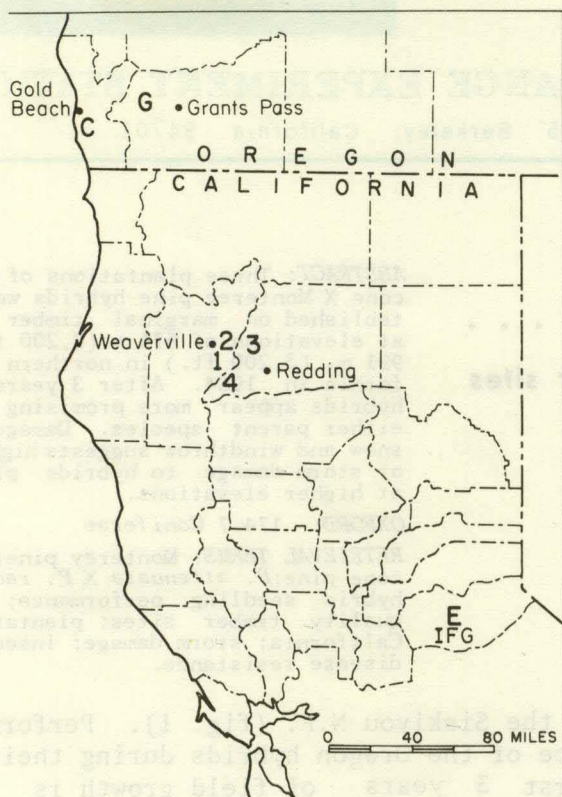


Figure 1.--Parental knobcone pine stands lie on the Chetco and Galice Ranger Districts, Siskiyou National Forest, Oregon (C,G), and on the Eldorado National Forest (E). The three main plantations are: (1) Spring Gulch, (2) Tom Lang Gulch, and (3) East Fork of Clear Creek Burn. (4) is a smaller, supplementary plantation, near Platina.

(table 1). On two of the plantations, the timber potential for any species is questionable--Spring Gulch was cleared of dense chaparral, and Tom Lang Gulch of oak woodland. The site of the East Fork plantation had been timbered but proved difficult to regenerate after a severe wildfire.

SEEDLING ORIGIN

Trees in Oregon and California were pollinated in spring of 1961 (table 2). With minor exceptions, each seed and subsequent seedling lot was kept separate on the basis of single seed-parent trees. Oregon seeds were processed at the Wind River Nursery, Washington; California seeds at the IFG. All seeds--both hybrid and parent checks--were sown in the IFG nursery in spring of 1963. The 1-0 seedlings were lifted in mid-February 1964. All three sites were planted by the same crew within the following 2 weeks. Thus, nursery growing conditions, handling and storage operations, and planting techniques were uniform for all seedlings. The Redding District, U.S. Bureau of Land Management, furnished the land, prepared the sites, and planted the trees on all plantations.

Table 1.--Habitat conditions at three plantations in the Klamath Mountains, northern California

Name and location	Elevation and topographic setting	Soil conditions	Original vegetation
Spring Gulch, Trinity County (Sec. 14, T. 32N., R. 9W.)	975 m. (3,200 ft.) medium to steep slope on east aspect of small spur ridge on major south slope	Los Gatos series loam/clay loam, deep, little rock, on Pre-silurian shale	Dense chaparral, mostly <i>Adenostoma fasciculatum</i> and <i>Arctostaphylos patula</i> ; scattered timber in draws, this slope was probably never well timbered.
Tom Lang Gulch, Trinity County (Sec. 34, T. 33N., R. 9W.)	671 m. (2,200 ft.) gentle north slope on ridge above Trinity River Canyon	Musser series gravelly cobbly loam/gravelly cobbly clay, poor drainage in spots, on Oligocene sediments	<i>Quercus garryana</i> and <i>Pinus sabiniana</i> woodland with patches of <i>Ceanothus cuneatus</i> chaparral, a few poor quality timber trees scattered about, essentially a nontimber site.
East Fork of Clear Creek Burn, Shasta County (Sec. 22, T. 34N., R. 6W.)	991 m. (3,250 ft.) gentle to medium slope on north side of exposed ridgetop	Mariposa series gravelly loam/very gravelly clay loam, medium depth, some rock outcrops, on Carboniferous shale	Brushy, mixed conifer forest medium to poor site quality, forest burned in Aug. 1962, salvage-logged and seeded to annual grass for erosion control; one native knobcone pine grew within the planting site before the fire.

Table 2.--Origin of seedlings used in three test plantations, Klamath Mountains, northern California

SISKIYOU N.F. HYBRIDS		
Type of seedling and seed lot No.	Seed parents	Pollen parents
Chetco Dist. #33-45 (C)	21 native trees, Red Flat, 823 m. (2,700 ft.), rocky serpentine flat	Oregon ¹
Galice Dist. #13-25 (G-2)	13 native trees, Peasoup Campground, 1,097 m. (3,600 ft.), rocky serpentine ridgetop	Oregon and mixed
Galice Dist. #1-12 (G-4)	17 native trees, Briggs Valley, 671 m. (2,200 ft.), colluvial soil in canyon bottom	IFG and Oregon
Galice Dist. #26-32 (G-5)	7 native trees, Chrome Ridge, 1,128 m. (3,700 ft.), rocky serpentine ridgetop	IFG
ELDORADO N.F. HYBRIDS		
Knobcone X Monterey hybrid #46 (E)	1 native tree (IFG At #2-1), Camino, 1,168 m. (3,560 ft.)	3-tree mix of IFG arboretum R
PARENT CHECKS		
Monterey pine #47 (R)	1 arboretum tree, IFG (#R 212)	Wind pollinated
Knobcone pine #48 (At)	Native trees at Peasoup Campground (same as G-2)	Wind pollinated

¹Oregon (R) from plantation trees at Sutton Creek and Carter Lake.

EXPERIMENTAL DESIGN

The same experimental design was followed at each locality. Each plantation had four blocks. Four-tree plots from each of 48 different genetic combinations were randomized within each block. Thus, 16 trees from each seed lot were used at each plantation.

To forestall animal damage, every tree was individually screened when planted. No animal damage occurred to the screened seedlings except at the East Fork plantation, where cattle knocked over some screens during the first year and damaged the unprotected trees. During the second year, the screens themselves caused limited mechanical damage to the larger trees. Screens were removed before the third growing season.

UNIFORMITY

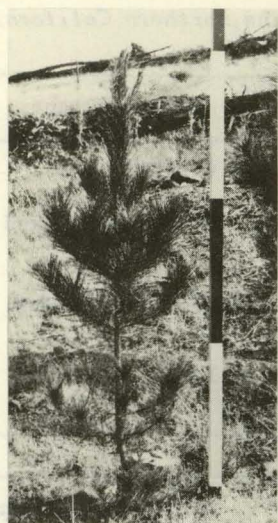
The Spring Gulch plantation had the most uniform habitat. There was no significant brush or herbaceous competition, although a few trees were affected by root competition from bordering vegetation. Seedlings at Tom Lang

Gulch also had no brush competition. Moderate herbaceous competition started the first year. After the second year, survival and growth of the trees seemed to be affected by some soil pattern--perhaps a partial clay pan. The entire East Fork plantation had severe grass competition during the first 2 years because grass was sown on the burn to control erosion. A soil depth gradient runs across the plot. Soil uniformity also was affected in spots by ash accumulations.

CLIMATE

The climate at each plantation is within the limits generally recommended for the hybrids. No weather records are available for the immediate vicinity of any plantation, but climatic data² can be estimated from the closest weather station, Weaverville (fig. 1), which is 672 m. (2,050 ft.) in elevation.

²Climate of Trinity County. U.S. Soil Conservation Service, Redding, Calif. 23 pp. 1966. Climate of Shasta County. University of California Agriculture Extension Service, Redding, Calif. 42 pp. 1965.



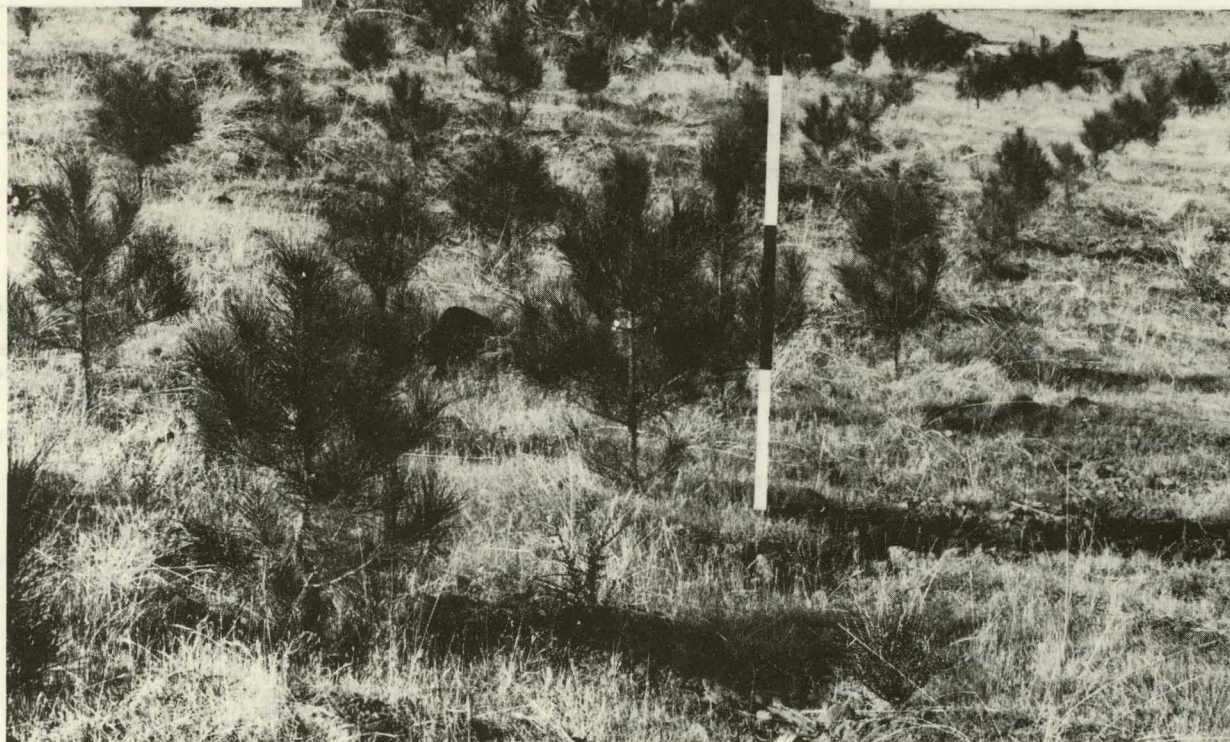
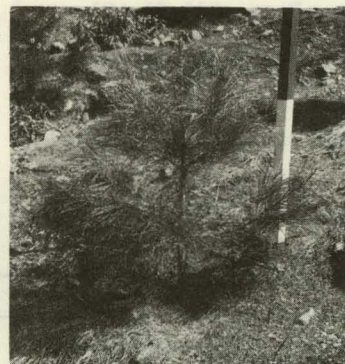
A

Figure 2.--Tom Lang Gulch plantation at end of third growing season. Each division on the range pole marks 50 cm. A, Monterey pine; B, hybrids; C, knobcone pine.

B



C



Summers are always hot and usually dry. Scattered summer showers occur, but little effective precipitation falls between June and October. The average rainfall for July, August, and September at Weaverville is only 2 cm. (.78 in.). August temperatures are: mean minimum 45.5°, mean maximum 93.7°, and extreme maximum 116°F. Summer temperatures probably exceed 100°F. many days of the year at each plantation. The unusual summer of 1966 may have provided

as severe a test of heat and drought as these trees will receive for many years.

Winters are cool and wet. Seasonal precipitation probably is not less than 76 cm. (30 in.) at any plantation --and it may exceed 152 cm. (60 in.) in wet years. Average seasonal snowfall at Weaverville is 79 cm. (31. in.) --half of which falls in January. The plantations would average considerably more than this amount. Each plantation

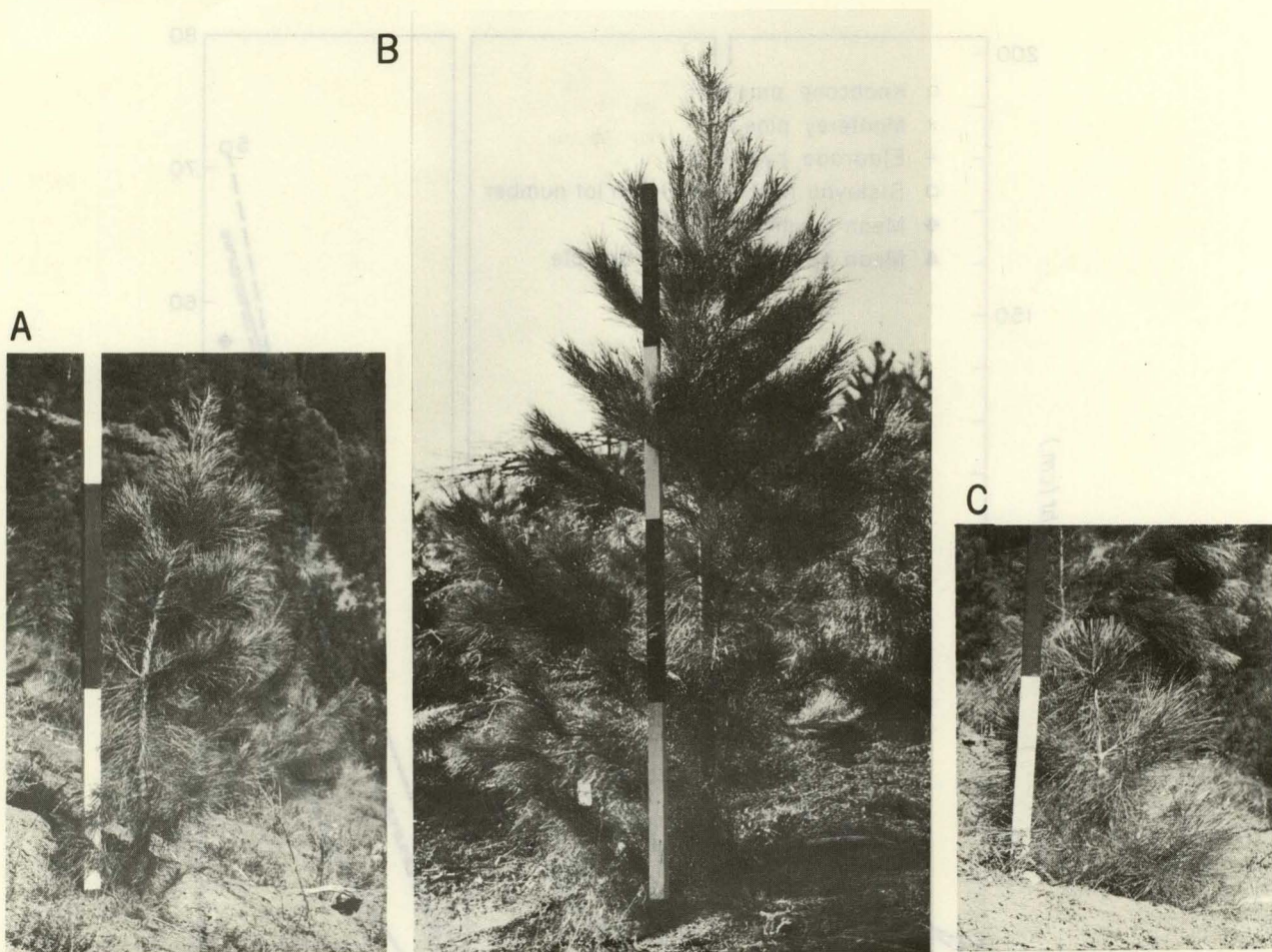


Figure 3.--Spring Gulch plantation at end of third growing season. Each division on the range pole marks 50 cm. A, Monterey pine; B, a large hybrid; C, knobcone pine.

had about 127 cm. (50 in.) during one stormy period in January 1966. January temperatures at Weaverville are: mean minimum 26.6°, mean maximum 46.6°, and extreme low -7°F. Minimum temperatures probably have not dropped below 10°F. at the plantations since planting. Thus, the plantations have had a sample of wet snowfall, but no severe, sudden freeze.

RESULTS AND DISCUSSION

GROWTH

Analyses of variance for 1965 and 1966 total heights indicate highly significant variation (probability less than .01) between plantations, between the various seedling lots, and in the interaction of seedling lots with plantations.

Monterey pine.--Although the growth and survival of the Monterey pine check trees are below coastal California standards, their performance in such montane habitats is good (figs. 2A, 3A). Averaging all lots for the three plantations, Monterey pine was the tallest. It was among the taller lots at both East Fork Burn and Spring Gulch and was the tallest at Tom Lang Gulch.

Knobcone pine.--So far, the growth and form of these Siskiyou knobcone pines is similar to that expected from local Klamath Mountain knobcone pines (figs. 2C, 3C). Knobcone pine was next to the poorest of all lots in over-all performance. The knobcone lot was the smallest at East Fork Burn and Spring Gulch and among the smaller at the other plantation.

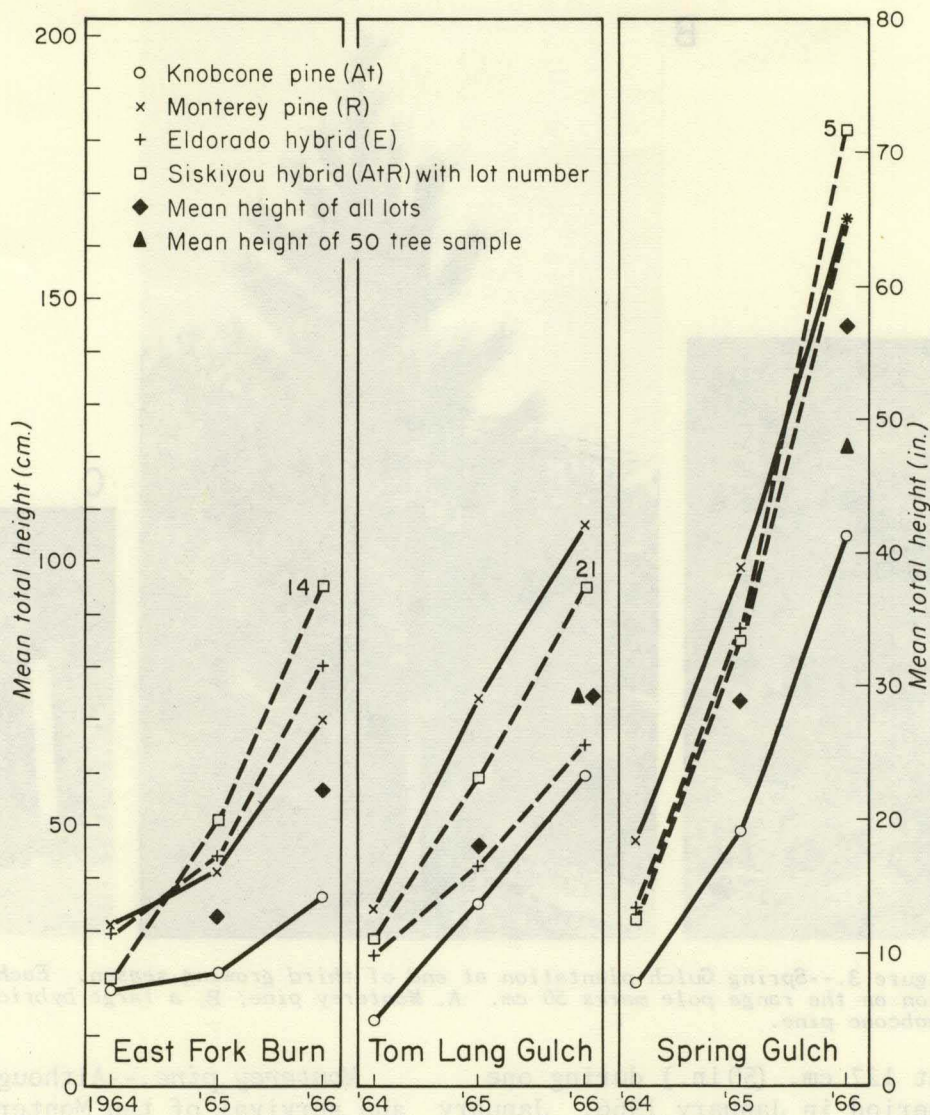


Figure 4.--Height growth of knobcone (At) and Monterey (R) pine compared to that of one Eldorado (E) hybrid and of the tallest Siskiyou hybrid lots. The sample of 50 trees was from Region 5's Eldorado hybrid plantings next to Tom Lang Gulch and Spring Gulch.

Siskiyou hybrids.--Among the Siskiyou hybrid lots, none was consistently large or small at all plantations. Consider the hybrid lots which had the greatest heights at each respective plantation (fig. 4). Lot AtR³ #14 was the tallest at East Fork Burn, was one

of the better lots at Tom Lang Gulch, but was one of the poorer at Spring Gulch. Hybrids at AtR #21 were the tallest at Tom Lang Gulch, were among the taller trees at Spring Gulch, but were near average for all hybrids at East Fork Burn. The tallest lot at Spring Gulch, AtR #5, had average height at Tom Lang Gulch, but was the smallest hybrid at the East Fork Burn plantation.

During these early years, no outstanding differences between the Siskiyou parent stands have appeared (table 3).

³The following abbreviations are used in this report: At = knobcone pine parent; R = Monterey pine parent; AtR = the hybrid in general; E = hybrids from trees on the Eldorado National Forest, California; C = hybrids from trees on the Chetco Ranger District, Siskiyou National Forest, Oregon; G2-5 = hybrids from trees on the Galice Ranger District, Siskiyou National Forest, Oregon.

Table 3.--Range of total height means for single-tree hybrid families from four stands, on the Siskiyou National Forest, Oregon, third growing season in test plantations, California

Seed parent stand	Range of single-tree lot mean height						Mean height, all plantations	Trees, all plantations	
	East Fork		Tom Lang Gulch		Spring Gulch				
	<i>Cm.</i>	<i>Inches</i>	<i>Cm.</i>	<i>Inches</i>	<i>Cm.</i>	<i>Inches</i>	<i>Cm.</i>	<i>Inches</i>	<i>No.</i>
G2	52-95	20-37	48-95	19-37	115-166	45-65	98	39	494
G4	37-69	15-27	65-88	26-35	137-182	54-72	98	39	485
G5	45-79	18-31	42-92	16-36	130-178	51-70	100	39	237
C	39-66	15-26	47-93	19-37	83-161	33-63	89	35	480

In terms of over-all means, there are no significant differences between stands. The range of means from each stand overlap considerably within each plantation. The greatest deviation involves the Chetco trees at the Spring Gulch plantation where several lots were relatively small.

Eldorado vs. Siskiyou hybrids.--The one Eldorado lot (E) compares favorably with the Siskiyou hybrids at East Fork and Spring Gulch, where lot E mean heights approached that of the tallest Siskiyou means. The (E) lot at Tom Lang Gulch had relatively poor survival, and mean height growth of the remaining trees was not much above that of the At check (fig. 4).

At both East Fork and Spring Gulch plantations, the tallest Siskiyou hybrid lot (AtR) and the Eldorado hybrid lot (E) have greater growth rates than either parental species for the 1966 season (fig. 4). At East Fork Burn these same growth relationships were evident for the 1965 growing season. At Tom Lang Gulch--the lowest in elevation of the three plantations--the growth rate of Monterey pine is equal to that of the tallest hybrid lot.

Region 5 hybrids.--Blocks of several hundred AtR hybrids were planted adjacent to the Tom Lang and Spring Gulch plantations. They were produced by Region 5 personnel on native knobcone pines at Pennsylvania Point, Eldorado National Forest with pollen from the I F G. These hybrids were unprotected and consequently browsed

by deer, but their average height is greater than that of the screened (E) trees at Tom Lang Gulch (fig. 4). Large blocks of these same Region 5 hybrids were planted near the Spring Gulch plantation. Deer and rodent damage has slowed their growth, and their average height is less than that of the E trees (fig. 4).

Platina plantation.--In addition to the three main plantation locations, about 250 of the Oregon hybrids were planted in a cleared brushfield near Platina (No. 4, fig. 1). This small plantation at 792 m. (2,600 ft. elevation) in the Sacramento Valley foothills is warmer--and probably drier--than the others. The survival, growth, and general appearance of all hybrids were intermediate between those of the Tom Lang and Spring Gulch plantations.

HAZARDS

Mortality.--After three growing seasons in the field, 98 percent of the seedlings were alive at Spring Gulch, 77 percent at East Fork Burn, and 78 percent at Tom Lang Gulch. At East Fork Burn and Tom Lang Gulch, where mortality was greatest, Monterey pine sustained more loss than any other seedling lot. For Monterey pine at both plantations, 17 of an original 32 plants were dead in 1966. Knobcone pine losses were also high: 11 dead out of 32 at the end of their third growing season. Except for three lots, the hybrids had less mortality than trees of the parental

species. No consistent trend in mortality was noted within the hybrid lots, and high mortality at one plantation was not accompanied by high mortality at another.

Snow and wind damage.--The vigorous top growth of these hybrids contributes to the more serious growth problems noted. The long internodes and bushiness of the branches may create more crown volume than the young root systems can support during winter storms and heavy snow loads. Some snow bending and wind throw has occurred at all plantations. Most of the affected trees were permanently damaged or are susceptible to future storm damage. The problem is most evident at Spring Gulch where the height growth is greatest (fig. 5). The Region 5 hybrids planted around the Spring Gulch plantation have not yet been seriously affected. Browsing on these unscreened trees has kept the crown area reduced and in addition may have increased their stability. Storm damage, though a definite factor, is not presently serious enough in any plantation to discourage future planting.

Drought and heat damage.--During summer of 1966 some general foliage discoloration developed at all of the plantations. This yellowish color increased during the winter months. There may be some association between needle color and degree of exposure. Protected branches on less exposed trees had a pleasant greenish yellow color (7.5 GY 3/4). Some exposed trees had a marked yellowish color (5 Y 6/6).⁴ If cultural practices on similar sites cannot correct this color problem, it could limit the use of the hybrid for Christmas trees. Trees growing in old ash piles at East Fork had attractive colors, suggesting that fertilization might help control color variation.

A top die-back appeared during summer of 1966 (fig. 6). No pathogens were evident and the damage seemed attributable to desiccation of treetops during the unusually hot, droughty summer. The 1966 leaders had scalded-looking patches on the more exposed surfaces. Needles on such branches were often short and chlorotic. In the worst examples, the upper third of the new growth was dying by September. In other cases, damage was present; but it was not clear whether the shoots would die. In the Spring Gulch plantation, 5 to 10 percent of the trees were affected to varying degrees. In the adjacent planting of Region 5 hybrids, scattered trees were also affected.

Insects and diseases.--No significant insect or disease problem has developed in any plantation at the present time. The only insect damage has been partial defoliation of some trees by grasshoppers at Tom Lang Gulch and East Fork. This damage may have contributed to the death of a few small, weak trees at Tom Lang Gulch. The needle disease, *Dothistroma pini*,⁵ which is beginning to damage this hybrid in coastal California, is not evident. Perhaps the low humidity during summers may help to prevent serious *Dothistroma* trouble. The western gall rust, however, is a potential threat.

CONCLUSIONS

In these habitats in the Klamath Mountains, the hybrid clearly has a greater growth potential than knobcone pine. The better Siskiyou hybrids and the Eldorado hybrid appear more promising than Monterey pine. The plantations have not yet had a severe freeze which might remove Monterey pine from any serious competition with the hybrids. The greatest damage to hybrids, so far, is attributable to snow and windthrow. Planting

⁴Munsell color charts for plant tissues. Munsell Color Company, Baltimore, Maryland. 1952.

⁵California Forest Pest Control Action Council. *Forest pest conditions in California 1966*. pp. 9-12. 1967.



Figure 5.--Spring Gulch plantation in March 1967 showing a group of large hybrids pushed down by winter storms. Most of the affected trees were pushed over intact. A few trees remained upright, but had serious bends in their stems.

the hybrid at higher elevations would involve a high risk of storm damage. Trees of medium growth rate may be better adapted to habitats at higher elevation because of the wind and snow problems.

The economic future of this hybrid on marginal timber sites cannot be determined yet. But enough trees have been established to furnish many answers during the next decade. In brush conversion projects the hybrids might serve well as an initial cover crop. With good site preparation they are easily established. Their rapid juvenile growth would keep them ahead of

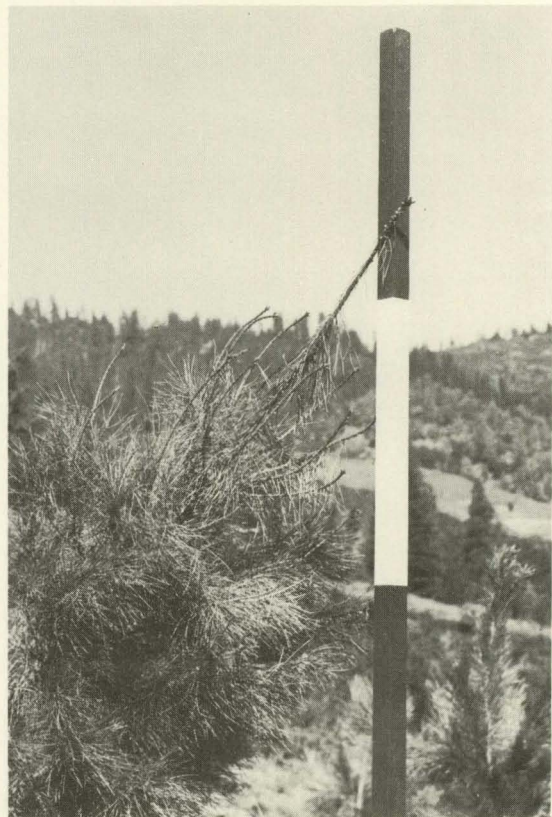


Figure 6.--Hybrid at Spring Gulch plantation with a portion of the 1966 growth dead from unknown causes--perhaps heat damage. Photographed in March 1967, after the trees had been tilted and bent by winter storms.

brush competition. With proper management, they might have good Christmas tree potential. And for such special-

ized uses as screening of recreation areas, the hybrids show great promise.

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