



## Field Test of Hybrid Pines in Central California

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**ABSTRACT:** Eight hybrid and native pines were planted in 1950 on three locations of the Stanislaus-Tuolumne Experimental Forest. Height, diameter, and survival data were recorded annually. Physical injuries from snow, insects, and animals were surveyed in 1962. After 12 years, the most promising hybrid at 5,200 and 5,400 feet elevation was Jeffrey x (Jeffrey x Coulter). This backcross hybrid showed little damage from insects, snow, or porcupines.

Numerous promising pine hybrids produced by the Institute of Forest Genetics at Placerville, California are under field test at many places in the United States to determine their performance and economic potential on various sites.<sup>1</sup> In 1950 three hybrid tests were set

up in the mixed-conifer zone of the central Sierra Nevada near the Stanislaus-Tuolumne Experimental Forest.

### PLANTATION ENVIRONMENTS

This experimental forest, close to Pinecrest, California, ranges in elevation from 5,200 to 6,400 feet. Above 6,000 feet, the forest begins a transition to the red fir type.

Annual precipitation ranges from 20 to 63 inches, and averages 37 inches. Most of it falls in the winter as snow which commonly accumulates to more than 10 feet.

Annual air temperatures may drop as low as minus 10°, and rise to 96° F. Soil temperatures measured one-quarter inch below the ground surface often reach 150° F.

The terrain shows signs of glaciation. The ridges are mainly of granite. The soils are moderately deep to shallow sandy to fine sandy loams with good drainage.

<sup>1</sup>Duffield, J. W., and Righter, F. I. Annotated list of pine hybrids made at the Institute of Forest Genetics, U.S. Forest Serv., Calif. Forest & Range Expt. Sta. Forest Res. Note 86, 9 pp., 1953.

Righter, F. I. Forest tree improvement through inbreeding and intraspecific and interspecific hybridization. Fifth World Forestry Cong. Proc. 1960:783-787, 1962.

Characteristics of the test locations are:

| <u>Location</u> | <u>Elevation</u><br>(feet) | <u>Aspect</u> | <u>Slope</u><br>(percent) | <u>Soil series</u>      |
|-----------------|----------------------------|---------------|---------------------------|-------------------------|
| 1               | 5,380                      | South         | 16                        | Holland sandy loam      |
| 2               | 5,280                      | North         | 15                        | Holland fine sandy loam |
| 3               | 6,420                      | North         | 15                        | Cohasset sandy loam     |

#### EXPERIMENTAL DESIGN

The eight hybrid and native species planted at the three test locations were:

| <u>Hybrid or species:</u>  | <u>Institute of Forest Genetics Designation</u> |
|--|---|
| 1. <u>P. jeffreyi</u><br>Jeffrey pine  | J   |
| 2. <u>P. ponderosa</u><br>ponderosa pine   | P   |
| 3. <u>P. jeffreyi</u> x ( <u>jeffreyi</u> x <u>coulteri</u> )<br>Jeffrey pine x (Jeffrey x Coulter pine)                   | J, JCl  |
| 4. <u>P. ponderosa</u> x <u>ponderosa</u> var.<br><u>arizonica</u><br>ponderosa pine x Arizona pine                        | PAr   |
| 5. <u>P. ponderosa</u> var. <u>scopulorum</u> x<br><u>ponderosa</u><br>Rocky Mountain ponderosa pine x<br>ponderosa pine   | PS, P   |
| 6. <u>P. ponderosa</u> x <u>engelmannii</u><br>ponderosa pine x Apache pine  | PAp   |
| 7. <u>P. monticola</u> x <u>strobis</u><br>western white pine x eastern white pine   | Mt St   |
| 8. <u>P. (attenuata</u> x <u>radiata)</u> x ( <u>attenuata</u> x<br><u>radiata</u> )<br>knobcone x Monterey F <sub>2</sub> | AtR <sub>F<sub>2</sub></sub>                    |

The seedlings were planted in April 1950 as 1-1 stock with 25 trees of one species or hybrid for each plot. One plot of each species or hybrid was randomly placed in each of four blocks at locations 1, 2, and 3. The spacing between trees was 3 by 3 feet.

The heights and diameters at breast height greater than 1 inch were measured each fall through 1960. Averages of height, diameter, and survival were compared for the three locations at the end of 10

years (tables 1, 2, and 3). Height data were analyzed by a weighted regression and analyses of variance.<sup>2</sup>

In 1962, trees were checked for insect, rodent, and disease damage. Extent of lean from snow weight was estimated using the methods of Callaham and Liddicoet<sup>3</sup> (table 4).

## PERFORMANCE

The statistical treatments of height data showed no significant difference between the weighted regression analysis and the analysis of variance, indicating that the number of trees in each sample did not influence the results. There was no significant difference, at the 5 percent level, in heights for either varieties or locations except for location 2. At this location, there was a highly significant difference between mean heights of varieties.

1. P. jeffreyi (J). --Native Jeffrey pine was the tallest, and survived better than ponderosa pine on location 1 and 2. Its height at location 3 ranged from 1.1 to 9 feet after 10 years. Vigorous and healthy, these trees averaged about 1 foot per year in height growth on locations 1 and 2. The Jeffrey parent survived 7 percent better than Jx(JC1) and had the least insect and porcupine damage of all test trees. The degree of snow lean averaged only 0.29, which indicates that Jeffrey pine is a hardy snow species (table 4). The trees generally were free of any serious diseases or insects, but the red turpentine beetle (Dendroctonus valens (Le Conte)) was found in the bark of several trees.

2. P. ponderosa (P). --The ponderosa pine used in these tests grew best on the south slope at 5,400 feet elevation. The trees showed little snow damage, but the tip-mining caterpillar (Eucosma sp.) and red turpentine beetle caused minor injury to 22 percent of the trees (table 4); porcupine damage was evident on nearly 30 percent. Although this species is now the main planted tree in the central Sierra Nevada, at least one backcross hybrid (JJC1) offers promise of potentially exceeding ponderosa pine in resistance to insect, porcupine, and snow damage.

3. P. jeffreyi x (jeffreyi x coulteri) (JJC1). --This backcross hybrid grew well on north and south slopes between 5,200 and 5,400 feet elevation. Its height growth was not significantly greater than that of the native Jeffrey and ponderosa pines, but it was the tallest and straightest of all the hybrids. The leaders were stout and not easily broken or bent by snow. It ranked second to Jeffrey pine in survival on locations 1 and 2.

This backcross hybrid retained living needles on the stem longer, than most other hybrids. Needle retention could favor growth by

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<sup>3</sup>Callaham, R. Z., and Liddicoet, A. R. Altitudinal variation at 20 years in ponderosa and Jeffrey pines. Jour. Forestry 59(11): 814-820, illus. 1961.

providing greater photosynthetic area. The bark does not become corky and rough as soon as the bark of ponderosa pine hybrids.

This tree was not seriously damaged by insects, porcupines, diseases, or snow. The tip-mining caterpillar was found on a number of trees, but did not appear to offer a serious threat to the trees, which were putting on nearly 2 feet of height growth annually. This tree did not grow or survive well at 6,400 feet elevation. The hybrid is reported to be more cold resistant, however, than its Coulter pine parent.<sup>4</sup>

4. P. ponderosa x P. Ponderosa var. arizonica (PAr). --This hybrid grew and survived nearly as well as (JJCl) on the south slope. Poor height and diameter growth occurred on both north-slope locations. On south slopes at 5,400 feet, the hybrid was vigorous, and grew about a foot each year. The average degree of lean was 1.9 indicating a weakness to snow damage (table 4). This hybrid appeared to be a warm site tree. The tip-mining caterpillar and red turpentine beetles caused some damage to the trees. This hybrid's susceptibility to porcupine damage is one of the most serious limitations to its widespread planting.

5. Ponderosa var. scopulorum x P. ponderosa (PS, P). --This hybrid grew well on the south slope, averaging 9.6 feet height growth in 10 years (table 1). It was taller than all hybrids and native trees planted on the north slope at 6,400 feet, although the height difference was not significant.

6. P. ponderosa x engelmannii (PAp). --This hybrid grew nearly as well as PS, P on the south slope, but poor growth and survival resulted from both north slope plantings. Snow produced severe lean (average of 1.87), insects caused considerable damage, and 29 percent of the trees were killed or damaged by porcupines (table 4). The hybrid does not show promise as a timber tree at 5,200 feet elevation.

7. P. monticola x strobis (Mt St). --All but nine trees of the 100 planted on location 2 died. The remaining trees were small and of poor color. The vigor of this hybrid has been studied previously.<sup>5</sup>

8. P. (attenuata x radiata) x (attenuata x radiata) (AtRF<sub>2</sub>). --This hybrid failed completely at all three locations.

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<sup>4</sup>Libby, W. J. The backcross hybrid Jeffrey x (Jeffrey x Coulter) pine. Jour. Forestry 56: 840-842. 1958.

<sup>5</sup>Bingham, R. T., Squillace, A. E., and Patton, R. F. Vigor, disease resistance, and field performance in juvenile progenies of the hybrid *Pinus monticola* Dougl. x *Pinus strobus* L. Zeitschrift Forstgenetik Forstpflanzenzüchtung 5: 104-112. 1956.

Table 1. --Tree height of hybrid plantings at Stanislaus-Tuolumne  
Experimental Forest, 1960

| Species<br>or<br>hybrid | Heights of trees 10 years after planting |            |            |            |            |            |
|-------------------------|--|------------|------------|------------|------------|------------|
|                         | Location 1                               |            | Location 2 |            | Location 3 |            |
|                         | Average:                                 | Range      | Average:   | Range      | Average:   | Range      |
| -----Feet-----          |  |            |            |            |            |            |
| J, JCl                  | 11.71                                    | 6.6 - 16.1 | 10.91      | 4.0 - 13.1 | 4.10       | 1.4 - 7.3  |
| PAr                     | 11.00                                    | 3.2 - 16.6 | 8.02       | 1.0 - 11.3 | 4.95       | .8 - 7.8   |
| PS, P                   | 9.62                                     | 2.0 - 16.3 | --         | --         | 6.83       | 1.5 - 10.6 |
| PAp                     | 9.51                                     | 2.9 - 13.4 | 7.17       | 2.4 - 9.9  | 5.46       | 2.6 - 7.4  |
| AtR <sub>F2</sub>       | 0  | 0          | 0          | 0          | 0          | 0          |
| J                       | 10.21                                    | 3.3 - 15.8 | 10.21      | 5.1 - 15.0 | 5.57       | 1.1 - 9.0  |
| P                       | 9.97                                     | 3.6 - 15.1 | 6.96       | 2.3 - 10.6 | 6.72       | 1.5 - 9.2  |
| MtSt                    | --                                       | --         | 3.10       | 1.6 - 5.8  | --         | --         |

Table 2. --Tree diameters of hybrid plantings at Stanislaus-Tuolumne  
Experimental Forest, 1960

| Species<br>or<br>hybrid | Diameters of trees 10 years after planting |          |            |          |            |          |
|-------------------------|--|----------|------------|----------|------------|----------|
|                         | Location 1                                 |          | Location 2 |          | Location 3 |          |
|                         | Average:                                   | Range    | Average:   | Range    | Average:   | Range    |
| -----Inches-----        |  |          |            |          |            |          |
| J, JCl                  | 2.40                                       | <1 - 4.8 | 2.05       | <1 - 3.3 | 1.09       | <1 - 1.2 |
| PAr                     | 2.27                                       | <1 - 4.5 | 1.66       | <1 - 3.7 | 1.30       | <1 - 1.5 |
| PS, P                   | 1.82                                       | <1 - 3.7 | --         | --       | 1.45       | <1 - 2.9 |
| PAp                     | 1.84                                       | <1 - 3.4 | 1.59       | <1 - 2.2 | 1.25       | <1 - 1.4 |
| AtR <sub>F2</sub>       | 0  | 0        | 0          | 0        | 0          | 0        |
| J                       | 1.98                                       | <1 - 3.6 | 2.14       | <1 - 3.8 | 1.32       | <1 - 1.9 |
| P                       | 2.21                                       | <1 - 3.7 | 1.52       | <1 - 2.4 | 1.48       | <1 - 2.3 |
| MtSt                    | --   | --       | 0          | <1       | --         | --       |

Table 3. -- Tree survival of hybrid plantings at Stanislaus-Tuolumne Experimental Forest, 1960

| Species<br>or<br>hybrid | Tree survival 10 years after planting |          |            |         |            |         |
|-------------------------|---------------------------------------|----------|------------|---------|------------|---------|
|                         | Location 1                            |          | Location 2 |         | Location 3 |         |
|                         | Average:                              | Range    | Average:   | Range   | Average:   | Range   |
|                         | -----Percent-----                     |          |            |         |            |         |
| J, JCl                  | 86                                    | 76 - 100 | 83         | 60 - 96 | 49         | 36 - 64 |
| PAr                     | 85                                    | 84 - 92  | 65         | 44 - 60 | 53         | 40 - 68 |
| PS, P                   | 84                                    | 76 - 88  | 20         | 0 - 20  | 47         | 32 - 80 |
| PAp                     | 80                                    | 48 - 100 | 39         | 24 - 56 | 48         | 24 - 64 |
| AtRF <sub>2</sub>       | 0                                     | 0        | 0          | 0       | 0          | 0       |
| J                       | 93                                    | 88 - 96  | 89         | 80 - 96 | 49         | 24 - 80 |
| P                       | 69                                    | 44 - 88  | 60         | 32 - 88 | 59         | 28 - 88 |
| MtSt                    | --                                    | --       | 9          | 4 - 16  | --         | --      |

Table 4. -- Damage by insects, porcupines, and snow in hybrid plantings, Stanislaus-Tuolumne Experimental Forest, 1962

| Species | Extent of damage to surviving trees by-- |           |                               |
|---------|--|-----------|-------------------------------|
|         | Insects <sup>1</sup>                     | Porcupine | Snow                          |
|         | -----Percent-----                        |           | Lean index <sup>2</sup> ----- |
| J, JCl  | 22.00                                    | 4.80      | 0.84                          |
| PAr     | 26.24                                    | 33.99     | 1.93                          |
| PS, P   | 20.10                                    | 24.84     | 1.66                          |
| PAp     | 14.06                                    | 29.62     | 1.87                          |
| J       | 14.42                                    | 4.05      | .29                           |
| P       | 22.02                                    | 29.95     | .98                           |

<sup>1</sup>Insect damage data show distribution of damage, but do not indicate severity of infestation. In most cases, damage was light.

<sup>2</sup>Index numbers (Callaham and Liddicoet 1961, p. 819. See footnote 3):

| Rating | Amount of lean      |
|--------|---------------------|
| 0      | None                |
| 1      | Slight (up to 5°)   |
| 2      | Moderate (6° - 20°) |
| 3      | Extreme (21° - 45°) |
| 4      | Horizontal (46° +)  |