



Research Note

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EARLY PERFORMANCE OF *PINUS CONTORTA* X *BANKSIANA* HYBRIDS

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ABSTRACT

Four *Pinus contorta* X *banksiana* hybrids developed in California were planted on two sites in Montana and one site in Idaho to determine whether they were suited to climate and soils of these three test locations and whether they were superior to Montana lodgepole pine. Height, diameter, crown width, number of branches per whorl, vigor, and survival were measured 5 and 10 years following establishment.

Hybrids were well adapted to climate and soils. Most hybrids did not exceed height growth of Montana trees except in Idaho, where Montana trees are not indigenous.

A limited test using Montana and Idaho genotypes for the seed parent showed these genotypes to be superior to California genotypes for developing hybrids for these areas.

Natural interspecific hybrids of lodgepole pine (*Pinus contorta* Dougl.) and jack pine (*Pinus banksiana* Lamb.) grow in Alberta, Canada, where the botanical ranges of the two species overlap (Moss 1949). However, few results have been reported on field performance of desirable hybrids of these species. *P. contorta* X *banksiana* hybrids were first developed in 1939 when successful pollinations were made in California (Righter and Stockwell 1949; Righter and Duffield 1951). Juvenile height growth of *P. contorta* X *banksiana* grown in California equaled or surpassed that of jack pine, which surpasses lodgepole pine in juvenile height growth. Duffield and Snyder (1958) reported that *P. contorta* X *banksiana* maintained "hybrid vigor" to 14 years. To combine the faster growth of jack pine and the straighter stem and smaller limbs of lodgepole pine, the Institute of Forest Genetics, Pacific Southwest Forest and Range Experiment Station, developed F_1 lodgepole pine X jack pine hybrids. These hybrids were field-tested at two locations in Montana and one location in northern Idaho.² This paper presents results at 10 years after test planting the California-developed hybrids, together with results at 5 years after test planting indigenous lodgepole pine seed parents.

The objectives of the study were to determine whether F_1 hybrids developed in California were (1) suited to the climate and soils of the three test locations, and (2) superior to indigenous lodgepole pine.

¹Research Forester, headquartered at Forestry Sciences Laboratory, Bozeman, Montana, which is maintained in cooperation with Montana State University.

²Cooperating in this field test were: (1) Institute of Forest Genetics, Pacific Southwest Forest and Range Experiment Station, (2) School of Forestry, University of Montana, and (3) Lewis and Clark National Forest.

The study was installed by A. E. Squillace, formerly with Intermountain Forest and Range Experiment Station, now with Southeastern Forest Experiment Station.

TESTING PROCEDURES

HYBRIDS DEVELOPED IN CALIFORNIA

The hybrids developed in California were planted at each of the following three locations.

Lewis and Clark National Forest. --These test plots are located near White Sulphur Springs, Montana, the Adams Creek drainage at an elevation of 6,400 feet. The area was clearcut in 1948 and broadcast-ned in September 1949. The soil is a deep clay on a gentle (less than 5 percent) southwest slope.

Lubrecht Experimental Forest. --This property, owned by the State of Montana, is administered by the versity of Montana. It is 24 miles east of Bonner, Montana, on the Blackfoot Highway, at an elevation of 00 feet. The area was clearcut in 1934, and prior to planting in 1950 it had supported a few scattered gepole pine and ponderosa pine saplings. The soil is a deep, rocky, very fine, sandy loam on a moderate o 15 percent) northeast slope.

Priest River Experimental Forest. --Plots in this Forest are on Federal land near Priest River, Idaho, are administered by the Intermountain Forest and Range Experiment Station. They are located along Gisborne Mountain Lookout Road at an elevation of 2,400 feet. Prior to planting, the area supported a id of 80-year-old larch and white pine. The soil is a light brown, very fine, sandy loam, 14 to 18 inches p, underlain with rocky clay subsoil on a 25-percent northwest slope.

Seedlings were planted at each location in 1950 and 1952. Parentage of the seedlings was as follows:

<u>Seed parent</u>	<u>Pollen parent</u>
1950 test:	
<u>P. contorta</u> (Calif.)	<u>P. banksiana</u> (Wisc.)
<u>P. contorta</u> (Calif.)	Wind
<u>P. contorta</u> (Mont., Gallatin N.F.)	Wind
<u>P. contorta</u> (Mont., Lolo N.F.)	Wind
<u>P. banksiana</u> (Minn.)	Wind
1952 test:	
<u>P. contorta</u> (Calif., Eld-8-1, ³ 7,300 ft. elev.)	<u>P. banksiana mix</u> ⁴
<u>P. contorta</u> (Calif., Eld-10-1, 6,500 ft. elev.)	<u>P. banksiana mix</u>
<u>F₁ P. contorta X P. banksiana</u> (Calif., 5,700 ft. elev.) ⁵	Wind
<u>P. contorta</u> (Calif., Eld-9-1, 7,100 ft. elev.)	Wind
<u>P. contorta</u> (Calif., Eld-10-1, 6,500 ft. elev.)	Wind
<u>P. contorta</u> (Mont., Deerlodge N.F.)	Wind
<u>P. contorta</u> (Mont., Lewis & Clark N.F.)	Wind
<u>P. banksiana</u> (Minn.)	Wind

With the exception of Minnesota jack pine planted in 1952, all seedlings were grown in the Savenac sery in northwestern Montana. The seed from hybrids and nonindigenous sources were supplied to the enac Nursery by the Institute of Forest Genetics. The Minnesota jack pine planted in 1952 was grown he Evaeth Nursery near Duluth, Minnesota.

At each planting site, five 2-year-old seedlings (1-1 stock except Evaeth seedlings, which were 2-0 k) were planted in a completely randomized design, spaced 5 X 5 feet apart in each of two blocks.

³Symbol refers to Eldorado County, California, and numbers assigned to plots and to seed parent s by the Institute of Forest Genetics, California.

⁴Exact source of pollen is unknown; it is probably P. banksiana growing at the Institute of Forest etics Arboretum, California.

⁵This seed was collected from hybrid trees growing at the Institute of Forest Genetics, California.

The few seedlings that failed during the first 2 years were replaced by seedlings from comparable lots that had been planted nearby at the same time as the initial planting. All plots were protected by a deerproof fence.

Survival was recorded and height growth was measured in the fall following establishment. The following measurements were taken 5 and 10 years following establishment:

1. Total height (feet).
2. Diameter (inches) outside bark at the root collar.
3. Crown width (feet).
4. Number of branches in current whorl.
5. Vigor.

HYBRIDS DEVELOPED IN MONTANA AND IDAHO

To produce a lodgepole pine X jack pine hybrid using local lodgepole pine seed trees,⁶ controlled pollinations were made in 1951 on two lodgepole pine trees near Deer Creek, Lolo National Forest, Montana, and on two lodgepole pine trees near Clarkia, Idaho. The Pacific Southwest Forest and Range Experiment Station supplied jack pine pollen from two trees in the Institute of Forest Genetics Arboretum. Seed produced from these pollinations were collected in 1952 and sown at the Savenac Nursery in May 1953, as indicated below:

<u>Seed parent</u>	<u>Pollen parent</u>
<u>P. contorta</u> ₁ (Mont., Lolo N.F.)	<u>P. banksiana</u> mix ⁷
<u>P. contorta</u> ₁ (Mont., Lolo N.F.)	Wind
<u>P. contorta</u> ₂ (Mont., Lolo N.F.)	<u>P. banksiana</u> mix
<u>P. contorta</u> ₁ (Idaho, St. Joe N.F.)	<u>P. banksiana</u> mix
<u>P. contorta</u> ₁ (Idaho, St. Joe N.F.)	Wind
<u>P. contorta</u> ₂ (Idaho, St. Joe N.F.)	<u>P. banksiana</u> mix
<u>P. contorta</u> mix ⁸ (Mont., Missoula County)	Wind
<u>P. contorta</u> mix (Idaho, St. Joe N.F.)	Wind

In addition, seed from wind-pollinated parent trees and from mixed seed parent trees on the St. Joe National Forest and the Lubrecht Experimental Forest were collected in 1952 and planted at the Savenac Nursery on the same date as the hybrids. The seedlings were transplanted the following spring and were outplanted in the spring of 1955 as 1-1 stock.

A randomized block design, replicated twice, was used on the Lubrecht Experimental Forest and on the Priest River Experimental Forest. Within each block, six of the eight lots were represented by five seedlings planted in rows at a spacing of 5 X 5 feet. Unfortunately, there were not enough seedlings to complete the experimental design. The hybrid P. contorta₁ (Mont.) X banksiana was not planted at Priest River where P. contorta₁ (Mont.) X wind seedlings were planted. P. contorta₁ (Idaho) X wind seedlings were not planted at Lubrecht where P. contorta₁ (Idaho) X banksiana trees were planted. At both the Lubrecht and Priest River Experimental Forests, two additional hybrids were planted: P. contorta₂ (Idaho) X banksiana (at Priest River) and P. contorta₂ (Mont.) X banksiana (at Lubrecht).

At the end of the first, third, and fifth growing seasons, trees were measured as described above for the other test plantings.

⁶This phase of the study was started by A. E. Squillace, Principal Plant Geneticist, and established by David Tackle, Research Forester, now with Pacific Northwest Forest and Range Experiment Station.

⁷Pollen was supplied by Institute of Forest Genetics, California, and was taken from two P. banksiana designated "V14" and "V21."

⁸Seed collected from several trees.

RESULTS

CALIFORNIA HYBRIDS

1950 Test Plantings

Height growth of the California hybrid at the end of 10 years did not significantly exceed height growth of Montana lodgepole pine in the 1950 test (table 1) except at Priest River, where the hybrid was significantly taller than the Gallatin lodgepole pine. Seedlings from all lots grew faster at the Lubrecht site, but growth of the California hybrid did not differ significantly from that of the native lodgepole pine.

Jack pine usually grew significantly taller than the indigenous pines in this test; but at Lewis and Clark it did no better than indigenous trees. California lodgepole pine grew consistently slower than any other lot at all locations. Because many of the data for diameter growth of the 1950 test were missing, the data remaining were not analyzed statistically. However, average diameter growth outside bark at the root collar is presented in table 1.

In the 1950 test, both the hybrid and jack pine had grown wider crowns than Montana trees; but the Montana trees, in turn, were wider than California trees.

Trees did not vary significantly among lots in number of branches per whorl.

Trees from all lots survived well, but indigenous trees had the best survival rate. There was little variation in vigor among lots, but California lodgepole pine was rated less vigorous than other lots.

Table 1. --Average height and diameter by seed lot and study area, 1950 test plantings

TOTAL HEIGHT					
Seed parent	:	Pollen parent	:	Study area	
				Lewis & Clark	Priest
				N.F.	River
	:		:		Lubrecht
	:		:		Forest
----- Feet -----					
P. contorta (Calif.)	:	Wind	:	2.63	2.65
P. contorta (Mont., Gallatin N. F.)	:	Wind	:	5.47	4.67
P. contorta (Mont., Lolo N. F.)	:	Wind	:	¹ 4.39	6.49
P. contorta (Calif.)	:	P. banksiana (Wisc.)	:	3.80	6.86
P. banksiana (Minn.)	:	Wind	:	4.26	9.95
					10.44

DIAMETER ² (outside bark at root collar)					
----- Inches -----					
P. contorta (Calif.)	:	Wind	:	1.43	0.84
P. contorta (Mont., Gallatin N. F.)	:	Wind	:	1.07	1.06
P. contorta (Mont., Lolo N. F.)	:	Wind	:	1.02	1.04
P. contorta (Calif.)	:	P. banksiana (Wisc.)	:	0.90	0.95
P. banksiana (Minn.)	:	Wind	:	0.65	1.20
					2.28

¹Any two means not having a common line are statistically significant at the 95-percent level of probability when compared by Kramer's adaptation of Duncan's multiple range test (Kramer 1956).

²Diameter data were not analyzed because considerable pertinent data were missing.

1952 Test Plantings

Hybrids in the 1952 plantings were tallest at Priest River; both hybrids were significantly taller there than at either of the Montana lodgepole pine lots (table 2). At the Lubrecht site the hybrid *P. contorta* (Eld-8-1 Calif., 7, 300 ft.) X *banksiana* grew significantly taller than the Deerlodge National Forest lodgepole pine, but neither hybrid was significantly taller than the lodgepole pine from Lewis and Clark National Forest. At the Lewis and Clark site the higher elevation hybrid was significantly taller than the Deerlodge trees, but was not taller than the Lewis and Clark trees. Hybrids from the lower elevation were no taller than the Deerlodge lodgepole pine and were significantly shorter than the Lewis and Clark pine. At all locations, California lodgepole pine grew consistently slower than any other lot.

As in the 1950 plantings, jack pine grew significantly taller than the indigenous pines except at Lewis and Clark, where most of the lot failed to survive. At all locations jack pine trees were serpentine and bent.

Admittedly, 10-year results are somewhat premature for analysis of diameter growth of the hybrids, but, for the record, diameters at the root collar are listed in table 2.

Seedlings from the two hybrids, jack pine, and Lewis and Clark lodgepole pine all had significantly wider crowns than Deerlodge trees, but did not differ significantly from each other. The California trees and the hybrid X wind had narrower crowns than all other lots.

The number of branches per whorl did not differ significantly.

All lots survived well except jack pine at Lewis and Clark National Forest. Investigators rated vigor of the hybrids no differently from vigor of either Montana trees or California lodgepole pine.

MONTANA HYBRIDS

Not enough seedlings were available to complete the experimental design on the Montana hybrids. Only four out of eight lots could be analyzed statistically. The four lots not analyzed statistically are included in table 3 for comparison.

Hybrids developed in Montana were taller at 5 years than Montana lodgepole pines at the Lubrecht site. Although measurements of hybrids from the Montana seed parents were not analyzed, the hybrids were taller than the Idaho hybrids, which were significantly taller than Montana trees. At Priest River, the Idaho hybrids included in the analysis did not grow significantly taller than the Lolo pines, but were taller than pines from Missoula County. Unfortunately, the two hybrids that grew tallest at the Lubrecht site were not represented at Priest River.

Table 2. --Average height and diameter by seed lots and study area, 1952 test plantings

TOTAL HEIGHT					
Seed parent	Pollen parent	Study area			Feet
		Lewis & Clark N.F.	Priest River	Lubrecht Forest	
<i>P. contorta</i> (Calif., Eld-9-1, 7,100 ft. elev.) ¹	Wind	² 2.06	2.03	2.84	]
<i>P. contorta</i> (Calif., Eld-10-1, 6,500 ft. elev.)	Wind	1.83	2.14	3.11	
F ₁ <i>P. contorta</i> X <i>banksiana</i> ³ (Calif., 5,700 ft. elev.)	Wind	3.25	4.71	3.56	
<i>P. contorta</i> (Mont., Deerlodge N.F.)	Wind	4.23	3.32	5.96	]
<i>P. contorta</i> (Calif., Eld-10-1, 6,500 ft. elev.)	⁴ <i>P. banksiana</i> mix	3.94	7.47	6.55	
<i>P. contorta</i> (Mont., Lewis & Clark N.F.)	Wind	5.19	3.97	6.77	
<i>P. contorta</i> (Calif., Eld-8-1, 7,300 ft. elev.)	<i>P. banksiana</i> mix	5.40	8.38	6.48	]
<i>P. banksiana</i> (Minn.)	Wind	⁵ 1.40	8.00	8.28	

DIAMETER (outside bark at root collar)

Inches					
<i>P. contorta</i> (Calif., Eld-9-1, 7,100 ft. elev.)	Wind	1.00	0.66	1.16	
<i>P. contorta</i> (Calif., Eld-10-1, 6,500 ft. elev.)	Wind	0.77	0.73	1.36	
F ₁ <i>P. contorta</i> X <i>banksiana</i> (Calif., 5,700 ft. elev.)	Wind	0.80	0.80	0.81	
<i>P. contorta</i> (Mont., Deerlodge N.F.)	Wind	1.24	0.75	1.72	
<i>P. contorta</i> (Calif., Eld-10-1, 6,500 ft. elev.)	<i>P. banksiana</i> mix	1.10	1.53	1.87	
<i>P. contorta</i> (Mont., Lewis & Clark N.F.)	Wind	1.39	0.82	2.21	
<i>P. contorta</i> (Calif., Eld-8-1, 7,300 ft. elev.)	<i>P. banksiana</i> mix	1.53	1.73	1.80	
<i>P. banksiana</i> (Minn.)	Wind	0.20	1.28	1.68	

¹Symbol refers to Eldorado County, California, and to numbers assigned to plots and seed parent trees by the Institute of Forest Genetics, California.

²Any two means not having a common bracket are statistically significant at the 95-percent level of probability when compared by Kramer's adaptation of Duncan's multiple range test (Kramer 1956).

³This seed was collected from hybrid trees growing at the Institute of Forest Genetics, California.

⁴Exact source of pollen unknown; probably *P. banksiana* growing at the Institute of Forest Genetics, California.

⁵Not a significant value; only one tree survived.

Table 3. --Average height by seed lots and study areas, Montana-Idaho hybrids test plantings (1955)

TOTAL HEIGHT					
Seed parent	:	Pollen parent	:	Study area	
	:		:	Priest	: Lubrecht
	:		:	River	: Forest
- - - - -Feet- - - - -					
Lots analyzed:					
<u>P. contorta</u> mix ¹ (Mont., Missoula Co.)		Wind		2.39	² 2.05
<u>P. contorta</u> ₁ (Mont., Lolo N.F.)		Wind		3.95	2.13
<u>P. contorta</u> ₁ (Idaho, St. Joe N.F.)		³ <u>P. banksiana</u> mix (Calif.)		3.37	2.34
<u>P. contorta</u> mix (Idaho, St. Joe N.F.)		Wind		3.70	2.43
- - - - -					
Lots not analyzed:					
<u>P. contorta</u> ₂ (Mont., Lolo N.F.)		<u>P. banksiana</u> mix (Calif.)		**	2.70
<u>P. contorta</u> ₁ (Mont., Lolo N.F.)		<u>P. banksiana</u> mix (Calif.)		**	2.93
<u>P. contorta</u> ₁ (Idaho, St. Joe N.F.)		Wind		4.02	**
<u>P. contorta</u> ₂ (Idaho, St. Joe N.F.)		<u>P. banksiana</u> mix (Calif.)		4.22	**

¹ Seed collected from several trees.² Any two means not having a common bracket are statistically significant at the 95-percent level of probability.³ Pollen was received from the Institute of Forest Genetics, California, and was taken from two P. banksiana trees designated "V14" and "V21."

**Missing lots.

DISCUSSION AND CONCLUSIONS

The wide differences between Montana lodgepole pine and California lodgepole pine shown by this study indicate great variation in height and diameter growth within species. Except for number of branches per whorl and vigor classification, Montana lodgepole pine performed significantly better than California lodgepole pine. Obviously, combining these particular California genotypes with jack pine did not provide the best genetic composition for superior performance at the two Montana locations.

For these reasons, the pollination project using Montana lodgepole pine seed trees was begun in 1951. Unfortunately, the test of the Montana-developed hybrid was not complete enough to provide a basis for sound comparisons, but it suggested that local trees are superior to California trees for developing hybrids for use in Montana and Idaho.

Generally, the hybrids were adequately suited to the climate and soils of the three locations but did not prove superior to Montana lodgepole pine. After 10 years from planting, most hybrids failed to show much advantage in the traits measured. The hybrids test-planted at Priest River were an exception to this. Most of them performed significantly better than Montana lodgepole pine in height growth, and possibly in diameter growth and crown width. However, at Priest River the Montana trees, themselves, were not indigenous.

The existence of geographic variation and elevational clines in lodgepole pine is well known (Critchfield 1957). Thus, lodgepole pine represents a vast reservoir of genotypes that may be reflected in a variety of responses of developed hybrids at different locations. As shown in this study, a strong interaction of genotype and environment exists between a particular taxon and location of planting. In lodgepole pine, hybrids would need to be developed for a variety of sites. Long-term, careful, and extensive testing using indigenous genotypes for seed parents apparently is needed to develop hybrids superior to indigenous lodgepole pine.

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