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PINUS CONTORTA X *BANKSIANA* HYBRIDS TESTED IN NORTHERN ROCKY MOUNTAINS

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ABSTRACT

*Between 1950 and 1955 hybrid progenies of lodgepole pine (*Pinus contorta *Dougl.) X jack pine (*Pinus banksiana *Lamb.) were tested to determine whether adaptation and performance in Montana and Idaho justified improvement of lodgepole pine by hybridization. Average heights, diameters, and survival rates of hybrids, of jack pines native to the Lake States, and of lodgepole pines native to Montana and Idaho were similar after 15 to 20 years of field tests. Poor growth and survival characterized progenies of California lodgepole pines, which represented the maternal parents of several hybrid groups. It was concluded that programs which rely on intraspecific variability are most feasible for the improvement of lodgepole pine in the northern Rocky Mountains.*

Pinus contorta X *banksiana* hybrids were first produced in 1939 (Righter and Stockwell 1949; Righter and Duffield 1951) to combine the fast growth of jack pine (*Pinus banksiana* Lamb.) with the good form of lodgepole pine (*P. contorta* Dougl.). Field tests conducted in California indicated that hybrid seedlings grew at a slightly slower rate than jack pine seedlings, but had the characteristic form of lodgepole pine (Righter and Duffield 1951; Righter and Stockwell 1949). At older ages, hybrids may even surpass jack pine in growth (Duffield and Righter 1953; Duffield and Snyder 1958).

Field tests of F_1 hybrids were established between 1950 and 1955 in Montana and Idaho to determine whether hybrid adaptation and performance justified hybridization

[1]Respectively, Plant Geneticist, stationed in Moscow, Idaho, at Forestry Sciences Laboratory, maintained in cooperation with University of Idaho; and Silviculturist, stationed in Bozeman, Montana, at Forestry Sciences Laboratory, maintained in cooperation with Montana State University.

as a means of improving lodgepole pine.[2] After 5 to 10 years of growth in the field, it was evident that hybrids were able to survive in Montana and Idaho but did not grow taller than lodgepole pines indigenous to Montana (Lotan 1967). The present paper reports hybrid performance after 15 to 20 years of field tests.

MATERIALS AND METHODS

Three series of tests involving hybrids of different origin were field-planted between 1950 and 1955 in Idaho and Montana. Tests I and II were established in 1950 and 1952, respectively, and involved hybrids developed in California; Test III was established in 1955 with progenies derived from lodgepole pines native to Idaho and Montana. The parental lines of hybrid progenies are listed in tables 1, 2, and 3.

Tests I and II were planted on three sites: Lewis and Clark National Forest in west central Montana, Lubrecht Experimental Forest in western Montana, and Priest River Experimental Forest in northern Idaho. Test III was established on the Lubrecht and Priest River Experimental Forests. The basic design specified that ten 2-year-old seedlings be spaced 5 feet apart in randomized complete blocks replicated twice on each site. Irregularities of design and methods of establishment have been discussed previously (Lotan 1967).

Data on tree height, diameter, crown width, and number of branches in the uppermost whorl were scored at intervals following establishment. In 1969, only height, diameter, and vigor were scored because crown competition and shoot injuries were prevalent. Moreover, a severe outbreak of western gall rust (*Peridermium harknessii* Moore) in Tests I and II at Priest River prevented meaningful height or diameter measurements. Thus, results are available for Test I after 20 years of field growth, for Test II after 18 years, and for Test III after 15 years.

Due to inequalities in survival and irregularities in experimental design an analysis of variance of tree height and diameter was made for each site; analyses of variance were calculated from data on survival (percent live trees) and vigor (percent nondefective[3] trees) from all sites. Arcsin transformations were used for all percentage data. Mean values for hybrids, jack pines, California lodgepole pines, and lodgepole pines indigenous to Montana and Idaho were compared by means of Scheffé's S test for multiple mean comparisons (Scheffé 1959).

RESULTS

Test I--1950 California Hybrids

After 20 years of field testing, the mean height of California lodgepole pines (table 1) was significantly less (1% level of probability) than that of hybrids, jack pines, and Montana lodgepole pines on the Lubrecht site. At the Lewis and Clark site, only indigenous trees were significantly taller (1% level) than California progenies. Lack of hybrid superiority over jack pines and indigenous lodgepole pines was also apparent; in fact, indigenous trees significantly surpassed (5% level) the height of hybrids on the Lewis and Clark site.

[2]This study was established by A. E. Squillace, now with the Southeastern Forest Experiment Station. Establishment of field tests was made with the cooperation of the Pacific Southwest Forest and Range Experiment Station, the University of Montana, and the Lewis and Clark National Forest. All hybrids developed in California and sources of jack pine pollen were supplied by the Institute of Forest Genetics, Placerville, California.

[3]Each defective tree was scored primarily on the basis of general health and of forkedness resulting from biotic and environmental injuries to the terminal shoot.

Table 1.--*Mean performance of 22-year-old trees in Test I*

Seed source	Pollen source	Survival (live trees)	Vigor (nondefective trees)	Diameter at root collar		Height	
				Lewis & Clark	Lubrecht	Lewis & Clark	Lubrecht
		Percent		*Inches*		*Feet*	
LP (Calif.)[1]	JP (Wis.)[2]	85.4	60.1	2.1	3.2	9.6	19.1
LP (Calif.)[3]	Wind	84.3	6.2	2.2	3.8	6.2	10.6
LP (Mont., Gallatin N.F.)[3]	Wind	98.7	75.8	3.9	4.3	17.6	19.2
LP (Mont., Lolo N.F.)[3]	Wind	98.8	73.3	3.1	3.9	12.1	18.9
JP (Minn.)[3]	Wind	52.8	37.7	2.6	4.0	13.8	20.7
JP (Wis.)[3]	Wind	--	--	--	3.8	--	21.0

[1]Represented by two or three trees; elevation 5,700-7,200 feet. LP = lodgepole pine.
[2]Represented by unknown number of trees. JP = jack pine.
[3]Probable stand collections.

Low mean values characterized survival and vigor of jack pines, vigor of California lodgepole pines, and diameter of hybrids. None of these values, however, deviated significantly (5% level) from corresponding values for other groups.

Test II--1952 California Hybrids

After 18 years of field testing, the mean height (table 2) of California trees was significantly less (1% level) than those of hybrids and jack pines on the Lubrecht site and of Montana lodgepole pines on both sites. No differences in performance could be detected between hybrids and indigenous trees. Moreover, diameters of California trees were significantly less than those of hybrids (1% level) on the Lubrecht site and of indigenous trees (5% level) on both sites. Survival and vigor of jack pines and F_2 materials were low, but the values were not significantly lower (5% level) than those of other progenies.

High survival values characterized hybrid and wind-pollinated progenies of one California lodgepole pine, Eld-10-1 (table 2). At the Priest River site, where western gall rust was prevalent, all uninfected trees were progenies of this tree; 40% of its hybrids and 80% of its wind-pollinated progenies were alive and uninfected. Tree Eld-10-1 may carry resistance to western gall rust.

Test III--1955 Montana and Idaho Hybrids

After 15 years of field tests, no differences (5% level) were detected in either height or diameter of hybrids and lodgepole pines native to Idaho and Montana (table 3). Survival and vigor were not analyzed because of the unbalanced design.

Table 2.--*Mean performance of 20-year-old trees in Test II*

Maternal tree	Pollen source	Survival (live trees)	Vigor (nondefective trees)	Diameter at root collar		Height	
				Lewis & Clark	Lubrecht	Lewis & Clark	Lubrecht
		Percent		*Inches*		*Feet*	
LP(Calif., Eld-8-1, 7,300' elev.)[1]	JP(Mich.)[2]	85.2	35.5	2.8	4.0	10.7	16.9
LP(Calif., Eld-10-1, 6,500' elev.)[1]	JP(Mich.)[2]	99.4	70.0	2.6	3.9	10.2	16.6
F_1 LP(Calif., 5,700' elev.) X JP[3]	Wind	31.4	5.2	--	2.1	--	11.1
LP(Calif., Eld-9-1, 7,100' elev.)[4]	Wind	79.8	18.7	2.1	2.3	5.3	8.2
LP(Calif., Eld-10-1, 6,500' elev.)[4]	Wind	92.0	45.1	1.8	2.2	5.1	8.4
LP(Mont., Deer-lodge N.F.)[5]	Wind	87.2	52.2	3.4	3.4	14.0	15.6
LP(Mont., Lewis & Clark N.F.)[5]	Wind	85.4	45.2	3.7	4.1	15.4	16.0
JP(Minn., Superior N.F.)[5]	Wind	38.3	13.1	--	3.9	--	19.0

[1]Symbols refer to Eldorado County, the stand and the maternal tree as assigned by the Institute of Forest Genetics. LP = lodgepole pine.

[2]Represented by two trees from the same provenance. JP = jack pine.

[3]Seeds collected from several F_1 hybrids at Placerville, Calif.; progenies are F_2.

[4]Seeds collected from a single tree.

[5]Probable stand collections.

Table 3.--*Mean performance of 17-year-old trees in Test III*

Maternal tree	Pollen source	Diameter		Height	
		Priest River	Lubrecht	Priest River	Lubrecht
		Inches		*Feet*	
LP-1 (Mont., Lolo N.F.)	JP (Mich.)[1]	--	2.9	--	17.4
LP-1 (Mont., Lolo N.F.)[2]	Wind	3.7	3.3	20.6	15.6
LP-2 (Mont., Lolo N.F.)	JP (Mich.)[1]	--	3.4	--	18.0
LP-3 (Idaho, St. Joe N.F.)	JP (Mich.)[1]	4.1	--	21.0	--
LP-3 (Idaho, St. Joe N.F.)	Wind	4.0	--	21.4	--
LP-4 (Idaho, St. Joe N.F.)	JP (Mich.)[1]	3.2	3.1	20.9	15.7
LP (Mont., Missoula Co.)[3]	Wind	2.5	3.5	15.0	15.8
LP (Idaho, St. Joe N.F.)[3]	Wind	3.5	3.9	20.3	16.9

[1]Represented by two trees of different provenances. JP = jack pine.
[2]Seeds collected from a single tree. LP = lodgepole pine.
[3]Probable stand collections.

DISCUSSION

After 15 to 20 years of field testing, the growth of *P. contorta* X *banksiana* hybrids was similar to that of lodgepole pines native to Montana and Idaho. Moreover, the growth of jack pines from Minnesota and Wisconsin equaled that of hybrids and indigenous (Montana and Idaho) trees. However, growth of lodgepole pines from California was comparatively poor.

The present results are similar to those presented by Lotan (1967) after the test trees had completed 5 to 10 years of growth in the field. Furthermore, statistically significant (1% level) correlation coefficients of 0.54 to 0.65 related the heights of individual trees in 1969 (tree ages, 17 to 22 years) to heights at age 5; these coefficients increased up to 0.98 as the age interval decreased. Thus, the relative height of individual trees remained fairly constant from 12 to 17 years.

The progenies of lodgepole pine and jack pine included in this study undoubtedly represent small proportions of the genetic variability within each species. Nevertheless, the data pertained directly to the feasibility of improving lodgepole pine through hybridization. In Tests I and II, growth of the California lodgepole pine progenies contrasted sharply with that of the jack pine progenies; hybrids performed admirably regardless of their genetic relationship to the California trees. It is not surprising that lodgepole pine from relatively southern latitudes but high elevations in California performed poorly in northern Idaho and Montana; such occurrences are common in provenance tests of forest trees. Moreover, the good growth of jack pines suggests that some progenies are preadapted to environmental conditions in Idaho and Montana. Surprisingly good growth of hybrids thus may result from: (1) complementary effects of two relatively foreign genetic systems; or (2) covering effects of an adapted genetic system over a maladapted system (see Clausen and Hiesey 1958, 1960; Clausen 1959; Hiesey 1964).

Although the results suggest a potential for improving lodgepole pine through hybridization with jack pine, interspecific hybridization does not appear to be warranted. If the potential is to be utilized, provenances must be screened for jack pines that exhibit high general ability to combine with lodgepole pines native to Montana and Idaho. Moreover, those hybrids in which preadapted genetic systems of jack pine are combined with adapted systems of indigenous trees should also be tested. On the other hand, superiority of hybrids over trees indigenous to Montana and Idaho has not been shown. Therefore, programs that rely on intraspecific variability appear to be most feasible for improvement of lodgepole pine in the northern Rocky Mountains.

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