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GROWTH OF TEN REGIONAL RACES OF PONDEROSA PINE IN SIX PLANTATIONS¹

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Ponderosa pine occurs over a wide range--from the Great Plains to the Pacific and from British Columbia to Mexico. Within this range there is great variation in the form and life habits of this tree. It has been long recognized that "regional races" or strains are present. Some of these regional races have been recognized by some botanists as varieties, such as var. scopulorum or var. benthamiana.

Which of these races is best to use in artificial reforestation: the local strain, or a more rapid-growing strain from another region? Are the strains from distant localities as hardy and resistant to diseases as the local strains?

To throw light on these questions, in 1926 the seed from ten regional races was sown at the Wind River Nursery, and two years later plantations from this stock were established in six quite contrasting sites. Each plantation has since then been watched carefully and measured periodically. Some were fenced against grazing animals; on some, rodent poison was placed; on some, the competing brush was chopped out. In spite of this the plantations suffered mortality, as almost always happens, from rodents and browsing animals, as well as from physiological causes such as drought and frost heaving. Growth of surviving trees has now been recorded for twenty years. Besides showing the performance of several strains, the record shows a need for similar studies of wider scope.

¹/ A resume of a mimeographed office report by the same author entitled "A 20-year Record of Six Plantations of Ten Races of Ponderosa Pine" dated April 23, 1947.

The seed was collected and donated by various people in the U. S. Forest Service. Most lots of seed represented a composite group of parent trees. There was no uniformity in age of parent or character of tree. The sources were as follows:

Bitterroot National Forest, western Montana
Harney N. F., Black Hills, South Dakota
Carson N. F., New Mexico
Coconino N. F., Arizona
Eldorado N. F., west side of Sierra Nevada, N. Calif.
Lassen N. F., east side of Sierra Nevada, N. Calif.
Rogue River N. F., east side of Cascades, S. Oregon
Deschutes N. F., central Oregon
Steilacoom, near Tacoma, western Washington
Willamette, near Corvallis, western Oregon

The seed of the Steilacoom and Willamette lots was sown in 1927, and hence the plantations of these lots are a year younger.

The plantations were located three on national forests, and three on state lands through the cooperation of the forest schools of the University of Washington, the State College of Washington, and Oregon State College. They were located as follows:

Columbia National Forest, Wind River Valley, western Washington
Deschutes N. F., central Oregon near Bend
Whitman N. F., Blue Mts. near Bates, Oregon
Pack Demonstration Forest of Univ. of Wash., near Lagrande, Wash.
McDonald State Forest of Oregon State College, near Corvallis, Oreg.
Washington State College Farm, at Pullman, eastern Washington

The plantations were last examined in 1946, when heights, and some diameters were measured. Mortality, though slight in recent years, varies greatly from plantation to plantation. As was found in previous examinations, the several races have rather distinctive morphological characteristics. The 1946 examination also confirms previous findings as to height growth, namely, that there are great differences between races wherever planted and an extraordinary range in the average height of all races from plantation to plantation.

Mortality--The mortality has been very slight the last 5 years and averages now, as it did in 1941, 49 percent of the trees planted. However, there is a great range, from 19 to 92 percent, in mortality on the several plantations. The west of the Cascades plantation had much higher survival than those east, indicating what may be expected in extensive plantations. In general, the slowest growing races--Carson, Harney, and Coconino-- experienced the highest mortality.

Morphological Characteristics--No systematic observation of the morphological differences in the several lots was made, but even casual comparison reveals marked differences. As reported by Bruce Starker in his thesis study of the McDonald plantation in 1940, some lots are

bushier than others, the color of the foliage, the time of needle retention, and the angle of the needles to the twigs vary. The needle length ranges from 4 inches in one lot to $7\frac{1}{2}$ inches in another; in the Carson lot a quarter of the needles come two to the bundle.

Average Height Growth by Races--Table A shows the average height of each lot of trees at the beginning of the 1946 growing season. The slowest growing races are the two from the Southwest and the one from South Dakota. The best races, judged by average total height on all plantations, are the three from Oregon--Rogue River, Deschutes, and Willamette (after allowing for the last being one year younger). These three are not consistently best on all plantations, nor are they most superior in the plantations most like their locality of origin.

Table A.--Average height of trees in six plantations as of the spring of 1946

Origin of seed	Columbia	Deschutes	Whitman	McDonald	Pack	Wash. St.Col.	Av. ht. all plantations
<u>Average height - feet</u>							
Bitterroot	11.9	3.2	10.5	21.0	15.4	--	12.4
Carson	9.7	1.2	5.1	11.6	9.9	15.8	8.9
Rogue River	13.8	2.9	9.8	22.4	14.7	23.3	14.5
Deschutes	13.5	3.0	10.3	21.7	15.6	21.9	14.3
Eldorado	10.8	2.2	8.7	28.4	13.1	--	12.6
Coconino	10.1	1.5	4.4	10.9	11.4	20.5	9.8
Harney	8.0	0.8	4.7	11.2	8.9	23.7	9.6
Lassen	9.9	2.2	9.4	9.8	12.2	19.8	10.6
Steilacoom ^{1/}	9.8	1.8	6.5	24.6	9.0	--	10.3
Willamette ^{1/}	13.3	3.3	11.3	23.8	11.3	--	12.6
Average	11.1	2.2	10.0	16.7	12.2	20.8	11.6

^{1/} These two lots were planted a year after the others.

The tallest tree recorded (exclusive of trees in the Washington State College plantation) was of Eldorado National Forest origin; it was on the McDonald Forest of Oregon State College and was 39 feet tall. By contrast, the tallest tree of Harney National Forest origin on the Deschutes National Forest plantation was one foot high.

Rating the Trees According to Tallest One-third--Believing that rating the trees according to the average height of the tallest third of the living trees was the best criterion now available as to their success, this was done. The ratings are presented in table B. The Washington State College plantation was excluded since it included only six seed sources.

It is obvious that by this criterion the South Dakota, Arizona, and New Mexico lots are markedly inferior in the Northwest. When all plantations are averaged, the Oregon races (Willamette, Rogue River, and

Deschutes), though growing on quite diverse localities, get first, second, and fourth places, with the Bitterroot race placing third.

Table B.--Rank of each seed source, by plantations, according to total height of the tallest third of the trees in 1946

Origin of seed	Columbia	Deschutes	Whitman	McDonald	Pack	All plantations
Bitterroot	4	2	2	6	1	3
Carson	9	9	8	7	8	9
Rogue River	1	4	3	4	2-3	2
Deschutes	3	3	4	5	2-3	4
Eldorado	5	5	5	1	4	5
Coconino	6	7	10	8	7	8
Harney	10	10	9	9	10	10
Lassen	8	6	6	10	5	7
Steilacoom	7	8	7	2	9	6
Willamette	2	1	1	3	6	1

Note: The Steilacoom and Willamette are a year younger.

No data for the Washington State College plantation.

It is not easy to explain why the California lots, supposedly coming from a good site and climate, should not rank higher, nor why the Steilacoom and Willamette lots should rank so far apart. Steilacoom and Willamette lots came from the same physiographic region, though localities of origin have some soil and latitudinal differences. Apparently some of these differences in height growth must be caused by other factors than the geographic source of seed. This suggests the need for further study of hereditary traits of ponderosa pine. A much wider range of seed sources and of plantation sites is necessary to tell the whole story about the suitability of the several strains for each plantation site.

Variation in Height on the Several Plantations Regardless of Seed Source--There is a tenfold range in average height growth from the best to the worst of these six plantations, from the Deschutes to the Washington State College farm. The average heights, lumping trees from all seed sources together, were as follows in 1946:

Washington St. Col. (Palouse loess soil)	20.8 feet
McDonald State Forest	16.7 "
Pack Demonstration Forest	12.2 "
Columbia National Forest	11.1 "
Whitman " "	10.0 "
Deschutes " " (sterile pumice soil)	2.2 "

It is unexpected that the growth on the well-watered, long-growing-season plantations of the west side, like Pack and Columbia, is not markedly better than the growth on a dry, short-season climate like the Whitman. It appears that the west-side climate, except perhaps on hot sites, does not give the ponderosa pine races tried the conditions they require for optimum growth.