

PINUS PONDEROSA (DOUGLAS)

Comparison of Various Types Grown Experimentally on Kaingaroa State Forest.

By A. M. MOORE.

Introduction.

The central and southern portions of the Kaingaroa Plains, Rotorua District, are characterised by considerable areas of 'frost flats' carrying a typical vegetative cover of manao (*Dracophyllum subulatum*), stunted manuka (*Leptospermum scoparium*) and tussock. On these areas only two tree species have been successfully established—*Pinus ponderosa* (Dougl.) and *P. contorta* var. *murrayana* (Engelm.).*

Unfortunately, some of the existing stands are of poor type and when raising nursery stock for the planting up of further areas, particular attention should be paid to seed origin. This entails not only purchase of seed from a reliable source but collection from selected trees of a type best suited to this locality.

With this objection in mind, the writer has collected data from an experimental block comprising 13 plots of *P. ponderosa* raised from seed collected from different localities in western North America.

Account of Investigation.

The seed lots were collected during the years 1923 to 1926 and from five zones: (a) British Columbia interior dry belt; (b) British Columbia interior wet belt; (c) California coastal and western Sierra; (d) California eastern dry zone; (e) Colorado-New Mexico inland dry zone (upland region). It will be noted that no seed was collected from that part of the species range lying between a—b (British Columbia) and c—d (California)—that is, from the region of the Cascade Mountains in the States of Washington and Oregon.

Seed was sown in a nursery in the spring of 1927 which was followed by a dry summer in 1927-28. In 1928 the 1-year seedlings were lined out and in winter 1929 the 1-year—1-year transplants were planted out on the plots. Planting failures were not blanked up.

Espacement was 8 ft. by 8 ft. and the plots are long, narrow, adjoining strips extending S.W. to N.E.

Location.

Experimental Block, Compt. 122, Kaingaroa State Forest. Latitude: 38° 32' S. Longitude: 176° 33' E. Altitude: 1,600 ft. above sea level. Topography: Flat. Site: Exposed.

* It is understood that about 75 per cent. of the State plantings of *P. ponderosa*, amounting in all to over 73,000 acres, have been made on the Kaingaroa State Forest.—Ed.

Climatic Factors : (Taken from meteorological records over the past 10 years). Average annual rainfall 51.29 inches—well distributed ; average of 138 rain days per annum ; prolonged dry spells rare ; prevailing winds westerly ; wet winds easterly.

Temperature : Max. summer, shade—82°

Min. summer, shade—28°

Max. winter, shade—60°

Min. winter, shade—23°

Frosts are experienced as early as February and as late as December. There are occasional light falls of snow, generally in June or July.

Soil : Siliceous, shallow sandy loam over pumice. Will not retain moisture for any lengthy period.

Particulars of Plots.

Plots are here numbered in the order in which they appear on the Compartment, No. 1 being the southernmost and No. 13 the northernmost.

1. North Kamloops, British Columbia, interior dry belt. Number planted 75. Mortality 69.3%. Trees range from 10' to 23' in height and from 2" to 6.2" D.B.H. Stems straight, slender. Branches slender, ascending 5-6 per whorl. Leaves slender, sparse, 5½" in length.
2. Klamath, North California, coastal Sierra. Number planted 175. Mortality 26.9%. Of the 128 surviving trees, 86 are malformed by ugly double leaders which developed in 1936. (Meteorological records show that in September, 1936, S.W. gales raged for five days. As this plot is fully exposed to S.W. winds, it is possible that long soft leading shoots were damaged during that period). The 42 potential timber trees average 29' 6" in height and 9.2" D.B.H. Branches 8-9 per whorl, stout, short, contorted, divaricating. Adventitious branches common. Leaves 8-9" in length, stout, dense.
3. Salmon River, British Columbia, interior dry belt. (Listed as optimum site, 2,200 ft.). 5,200 trees planted. Mortality 22.4%. 30% are malformed by double leaders. Potential final crop trees average 21' 3" in height and 6.4" D.B.H. Branches short, slender, ascending, 5-6 per whorl. Leaves slender, sparse, 4½-5½" in length.
4. Seton Lake, British Columbia, interior dry belt, 800'. 4,100 planted. Mortality 30%. 20% are malformed or suppressed and the remainder average 23' 8" in height and 6.2" D.B.H. Branches short, slender, ascending, 5-6 per whorl. Leaves slender, sparse, 4½-5½" in length. In growth habit this type is similar to "Salmon River" but the stand is more uniform in height and diameter growth.

5. Enderby, British Columbia, interior wet belt. 3,500 planted. Mortality 10%. Except for 520 malformed and suppressed trees, this is a uniform stand, trees averaging 28' 8" in height and 7" D.B.H. Branches short, slender, ascending 5-6 per whorl. Leaves slender, sparse, 5½" in length.
6. Santa Fe, New Mexico, inland dry zone. 1,925 planted. Mortality 34%. Trees scrubby, stunted, the best being on the exposed or S.W. end of the plot. They range from 10' 6" to 20' in height and from 3" to 6" D.B.H. Branches short, stout, divaricating, 8-9 per whorl. Leaves stout, dense, 5-5½" in length. Many of these trees bear cones.
7. Lincoln, New Mexico, inland dry zone. 1,200 planted. Mortality 12%. Slow growing but slightly better type than "Santa Fe" and the stand more uniform in composition. Best trees average 21' 2" in height and 6.4" D.B.H. Branches stout, spreading, 7-8 per whorl, leaves fairly stout, dense, 5-6" in length.
8. Tappen, British Columbia, interior wet belt, 1,300'. 725 planted. Mortality 46%. 140 of these died 5 or 6 years after planting and were very stunted, being only 4' high when they succumbed. The balance range from 8' to 24' 6" in height but there are very few tall trees in the stand. The best D.B.H. is 7". Branches are exceptionally slender, ascending, 5-6 per whorl. Leaves slender, sparse, 4-6" in length.
9. Pike, Colorado, inland dry zone, 8,000'. 500 planted. Mortality 29%. Trees stunted and unhealthy. Average height 9' 6". D.B.H. 3.2". Branches short, ascending, 6-7 per whorl. Leaves 3½-4" in length, dense.
10. Kamloops, British Columbia, interior dry belt. 425 planted. Mortality 22%. Average height 23' 2". D.B.H. 6.5". Branches slender, spreading, 5-6 per whorl. Leaves slender, sparse, 5½-6½" in length. This stand is fairly uniform in height and diameter growth.
11. Lassen, California, Eastern Sierra, dry zone. 325 planted. Mortality 24%. Average height 24' 5". D.B.H. 7". Branches stout, spreading, 6 per whorl. Leaves stout, 4½-5" in length. The stand is fairly even.
12. Eldorado, California, Western Sierra zone. 3,000'. 300 planted. 255 survived but 50% of these are malformed by double leaders which developed in 1936 and subsequent years. Average height 33' 8". D.B.H. 10.8". Branches stout, spreading, 6-7 per whorl. Leaves stout, dense, 9¼"-10" in length.
13. Sierra, California, Western Sierra Zone. 275 planted. 226 survived. Trees similar to "Eldorado" and 50% of these, also, are malformed. Average height 33'. D.B.H. 10.5". Branches stout, spreading, 6-7 per whorl. Leaves stout, dense, 9-10" in length.

Conclusion.

- (a) British Columbia, Dry Belt. These types are characterised by a general lack of uniformity in height and diameter growth, "Salmon River" and "Seton Lake" being the best from a growth-habit point of view.
- (b) British Columbia, Wet Belt. "Enderby," similar in growth habit to "Salmon River" and "Seton Lake," has a greater physiognomic uniformity and lower mortality, is faster growing and less branchy. The high mortality, variability of height and diameter growth, and the fact that many trees succumbed six years after planting, seems to indicate that "Tappen" wet belt type is climatically unsuited to this locality.
- (c) Californian Coastal and Western Sierra. These trees overtop surrounding vegetation and are fully exposed to damaging winds. The arboricultural method of lay-out is contributory to wind damage and the percentage of malformation would be considerably reduced if trees were planted in fairly large dense stands where mutual protection would be afforded. "Klamath" is perhaps a doubtful type because of its branching habit (many adventitious branches are persistent and form part of a double whorl), but "Eldorado" and "Sierra" are fast-growing healthy trees eminently suited to this locality.
- (d) and (e) Californian and Inland Dry Zones. Of the eastern types "Lassen" appears to have the best tree form but all are branchy and comparatively slow-growing.

Certain distinguishing features of the west-central California types, and of the British Columbia types, as they grow at Kaingaroo, are noteworthy. The former have stout, almost horizontally spreading branches, stout leaves 8 ins. to 10 ins. in length, and dense foliage: in contrast the latter, excepting the Kamloops type which has spreading branches, have slender, ascending branches, slender leaves $4\frac{1}{2}$ ins. to $6\frac{1}{2}$ ins. in length, and sparse foliage. The two most promising types—those from the western Sierra region—are characterised by the longest leaves, 9—10 ins. in length. It is safe to say that their form would have been distinctly improved had they been planted at an espacement of 6' x 6'.

Summary.

The only exotic tree species successfully established on "frost flats" in the Kaingaroo State Forest are *P. ponderosa* and *P. contorta* var. *murrayana*. Some of these stands are of poor type and attention should be paid to seed origin when preparing for future plantings.

Data has been collected from an experimental block representing tree types of *P. ponderosa* from 13 localities in North America. Of these types those which centre on the Eldorado County in Northern California are the optimum.

Table 1.—PINUS PONDEROSA TYPES—AVERAGE ANNUAL HEIGHT INCREMENT

Origin	Average Internodal Measurement of Several Trees of Representative Height in each Plot in inches													Total Ht. ft. in.	
	1929-32	1932-33	1933-34	1934-35	1935-36	1936-37	1937-38	1938-39	1939-40	1940-41	1941-42	1942-43	1943-44		
1 North Kamloops	10	5	9	15	18	19	22	22	23	22	20	20	21	18	10
2 Klamath	16	20	23	23	32	32	31	24	31	30	35	31	26	29	6
3 Salmon River	11	10	16	19	23	19	22	26	22	24	21	19	23	21	3
4 Seton Lake	13	15	20	20	25	23	23	24	25	27	23	22	24	23	8
5 Enderby	24	16	23	27	30	26	30	30	30	30	30	24	24	24	8
6 Santa Fe	20	18	16	17	18	16	18	12	11	16	13	13	16	17	0
7 Lincoln	16	12	16	23	28	21	22	13	22	25	23	17	16	21	2
8 Tappen	20	12	21	22	25	21	21	22	19	24	24	20	21	22	8
9 Pike	4	7	7	7	12	10	8	14	6	11	10	8	10	9	6
10 Kamloops	11	12	18	23	22	18	22	25	24	25	26	23	29	23	2
11 Lassen	12	15	20	22	30	27	24	28	26	23	15	20	31	24	5
12 Eldorado	17	17	22	25	31	32	40	40	33	43	42	30	32	33	8
13 Sierra	18	16	22	24	30	30	39	40	34	43	40	31	34	33	5

Table 2.—PINUS PONDEROSA TYPES—SUPPLEMENTARY DATA.
(Supplied by the Head Office of the State Forest Service)

Origin	Locality				No. of seeds per lb	In Nursery			Planted 3 growing seasons		Planted 15 growing seasons		
	Province or State	Zone	Alt. ft.	N. Lat.		W. Long.	No. trees resulting per lb seed Jun 1928	Av. Height		Av. ht. Feb. 1932 feet	Mortality to Feb. 1932 p.c.	Av. ht. of crop trees 1944 feet	Mortality to Winter 1944 p.c.
								2yr seedlings Mar. 1928 ins.	1yr-1yr. Aug. 1929 ins.				
1 North Kamloops	B.C.	Interior Dry Belt	1100	51	120	5120	1.3	2.5	0.8	59	18.8	69	
2 Klamath	N. Cal.	Coastal Sierra	3000	41½	122½	*	2.5	4.3	1.4	21	29.5	27	
3 Salmon River	B.C.	Interior Dry Belt	2200	50½	120	4100	1.7	7.0	1.1	17	21.2	22	
4 Seton Lake	B.C.	do	800	51	122	5890	1.5	4.0	1.1	15	23.6	30	
5 Enderby	B.C.	Interior Wet Belt	1200	50½	119	5630	2.2	4.5	1.2	8	28.6	10	
6 Santa Fe	N. Mex.	Inland Dry Zone	8000	35½	106	*	1.1	3.6	1.0	19	17.0	34	
7 Lincoln	do	do	6000	33	105	*	1.5	6.5	1.5	7	21.1	12	
8 Tappen	B.C.	Interior Wet Belt	1300	51	119	6270	1.6	3.5	0.9	26	22.6	46	
9 Pike	Colo.	Inland Dry Zone	8000	38½	105½	*	1.2	3.8	0.5	16	9.5	29	
10 Kamloops	B.C.	Interior Dry Belt	*	51	120	4480	1.4	2.5	0.7	21	23.1	22	
11 Lassen	Cal.	E. Sierra Dry Zone	5000	40½	121	*	1.7	7.3	0.8	14	24.4	24	
12 Eldorado	Cal.	W. Sierra	3000	38½	121	*	2.2	4.8	1.8	16	33.6	15	
13 Sierra	Cal.	do.	*	37½	119	*	3.1	6.0	1.9	12	33.4	18	

* Not Recorded