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The Performance of Eight Seed Sources of Ponderosa Pine in the Denbigh Experimental Forest, North Dakota

The area presently designated as the Denbigh Experimental Forest was established in 1931 as a location where large-scale afforestation could be tested in the Northern Great Plains. More than 40 species of trees have since been planted on 270 acres within the forest, which is located at an elevation of 1,486 feet in the sand hills of McHenry County in north-central North Dakota. The major soil type there is a Valentine fine sand.

The early planting, begun in 1933, was completed in 1940. Ponderosa pine (*Pinus ponderosa* Laws.), one of the most extensively planted species, was used in 48 plantations. The planting stock came from numerous seed collections from four broad geographic areas: western Montana, eastern Montana, the Black Hills of South Dakota, and western Nebraska. Because the seed sources were not fully identified in all plantings, only eight seed sources (see Fig. 1) in 10 plantations were selected for comparison in this report.

Although the ponderosa pine stock in the 10 plantations was not established as provenance studies (several planting techniques and various cultural treatments were used, which may have introduced some differences in survival and growth), the results indicate that some seed sources have obviously fared better than others in the Northern Great Plains environment. This paper is meant to give Northern Plains foresters and nurserymen some indication of which of the eight seed-collection areas are likely to provide the most suitable stock.

The comparisons, shown in table 1, involve two basic features — survival and

growth characteristics — which were measured with different sampling procedures. The details are discussed in the following sections.

Survival

Survival was calculated in 1959 and 1960 for the period since 1941 (to offset to some degree the effects of the varied planting and cultural techniques). The survivals were determined from 31- to 100-percent samples, depending upon the sizes of the plantations.

The highest survivals were recorded for the Custer National Forest and Glendive, Mont., sources, as well as the source from the southern half of the Black Hills National Forest (sources I, III, VI, and VII). As is indicated, however, height growth for sources VI and VII was relatively poor. The trees from the western Nebraska seed source showed the poorest survival.

Growth Characteristics

Although some of the variations in the characteristics recorded in table 1 can perhaps be attributed to site conditions or non-uniform cultural practices, the data seem to indicate that genetic variation does exist among the eight seed sources. Comparisons of these characteristics were obtained in 1959 and 1960, when superior trees were selected and evaluated in the plantations. Since the primary purpose of this measurement project was to select individual superior trees, varying numbers of trees were selected from each plantation. Tree age from seed ranged from 25 to 30 years when the measurements were

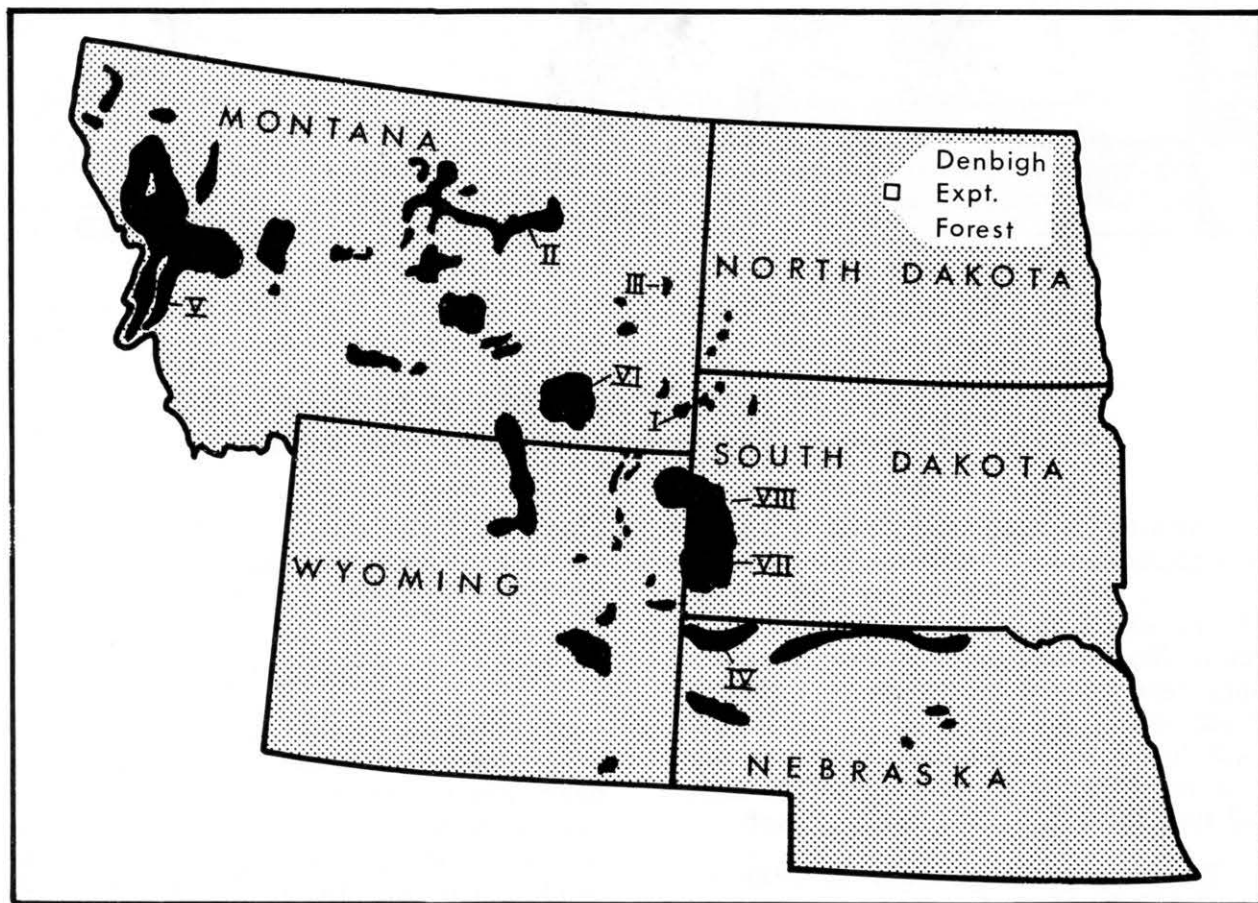


FIGURE 1. — Natural stands (black areas) of ponderosa pine in Montana, North Dakota, South Dakota, Wyoming, and Nebraska. Roman numerals indicate collection points.

taken. The growth characteristics are compared and discussed in the following paragraphs:

Height and diameter growth. — The collections are arranged in the table in descending order of "Average annual height growth," since height is the most heritable indicator of vigor. Diameter is more strongly influenced by environmental factors, but in this study annual diameter growth fell into almost exactly the same order as annual height growth. The three collections with the best height and diameter growth rates are all from eastern Montana, as was the case in the survival results.

Branch habit. — A significant factor in Plains plantings is branch habit because heavy

branches indicate good resistance to wind, ice, and snow damage. As the table indicates, this factor varies by collection with no particular relationship to other traits such as general vigor or height growth. Collections I and II — both from eastern Montana — had the largest percentages of coarse branches.

Foliage density. — Resistance to winter desiccation damage, length of needles, shade tolerance, and other factors that influence needle retention all contribute to foliage density. The collections having the highest percentage of trees with dense foliage (Collections I and VI) are from the two Montana divisions of the Custer National Forest. The parent stands are about 100 miles apart and at about the same elevation. It is interesting

TABLE 1. — *Survival and growth characteristics of eight seed sources of ponderosa pine growing in the Denbigh Experimental Forest, North Dakota*¹

Seed source no. and collection location ²	Pct. survival since 1941, calculated in 1959-60	Growth Characteristics								No. trees sampled
		Avg. annual height growth (ft.)	Avg. annual diameter increase (in.)	Branch habit (pct.)			Foliage density (pct.)			
				Coarse	Medium	Fine	Dense	Medium	Light	
I Long Pines Div., Custer National Forest, Montana	100	0.69	0.176	50	33	17	78	15	7	210
II Jordan, Mont. (8 to 15 miles north)	72	0.65	0.169	58	22	20	4	55	41	84
III Glendive, Mont. (5 to 8 miles south)	86	0.65	0.146	38	32	30	5	60	35	127
IV Western Nebraska	55	0.59	0.142	47	40	13	6	51	43	67
V Bitterroot National Forest, western Montana	73	0.58	0.143	35	33	31	24	41	35	132
VI Custer National Forest, Montana ³	100	0.58	0.136	25	33	42	45	42	13	53
VII Southern half of Black Hills National Forest, South Dakota ⁴	94	0.53	0.115	30	45	25	30	38	32	366
VIII Black Hills National Forest, South Dakota	58	.46	.116	38	39	23	5	46	49	67

¹ Tree age from seed varied from 25 through 30 years and average total height varied from 11.5 through 18.6 feet.

² Seed source locations and their relative distances from the Denbigh Experimental Forest can be seen on figure 1.

³ Presumably from the Ashland Division.

⁴ Designated as the Harney National Forest at the time of collection.

to note that Collections II and III have a very low percentage of dense trees, although the parent stands are only about 150 miles north of the sources of Collections I and VI. Perhaps differences in elevation are responsible, since the northern stands are approximately 1000 feet lower than the two Custer National Forest sources.

Other performance-related factors. — Resistance to winter desiccation was not recorded because evaluations were made in midsummer when injury was generally not evident. However, Stoeckeler and Rudolf¹ reported that trees from the Black Hills in South Dakota and from western Nebraska suffered 7.0- and 16.3-percent average defoliation in comparison with 4.1- and 4.8-percent average defoliation on trees from the Glendive, Mont., source and from Medora, N. Dak. (In the

table, Collections IV and VIII show low percentages of dense trees, which may be related to a high incidence of winter desiccation.)

The possible effects of altitude on seed sources are indicated in the marked differences in responses between Collections VII and VIII. Geographically these two seed sources are located very close to one another, but there may be two or three thousand feet difference in elevation between their sites. Unfortunately, precise elevation data are lacking for these two collections.

It is also significant that Collection V from the Bitterroot National Forest seemingly is quite well adapted, in spite of the fact that the collection area is some 800 miles west of the planting site and a minimum of 2000 feet higher in elevation. It is, however, within 2° of the same latitude as the planting site.

Summary

Although the data are by no means conclusive, this comparison strongly suggests that different geographic races of ponderosa

¹ Stoeckeler, J. H., and Rudolf, Paul O. *Winter injury and recovery of conifers in the upper midwest. U.S. Forest Serv., Lake States Forest Expt. Sta., Sta. Paper 18, 20 pp., illus. 1949.*

pine do exist in the eastern outliers of the species and that these races respond differently when planted in a Plains environment. Until more positive results of current research concerning the adaptability of ponder-

osa pine seed sources to the Great Plains region are available, Great Plains nurserymen should probably collect their ponderosa pine seed from eastern Montana sources for North Dakota plantings.

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