EVALUATION OF PONDEROSA PINE SEED SOURCES FOR THE EASTERN GREAT PLAINS[1]

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Abstract. Ponderosa pine (*Pinus ponderosa*) were planted in north central Kansas in 1968 as part of a program to identify suitable seed sources for the Eastern Great Plains. Fifteen-year survival and height were obtained and evaluated during 1983. Foliage color and retention data were obtained during 1986. Sources from north central Nebraska and southern South Dakota were best suited to the eastern Great Plains because of their superior height growth, foliage characteristics, and above average survival. The opportunity now exists to select seed from native stands to improve upon the poor performance often exhibited by plantings of ponderosa pine in the region.

Key words: Pinus ponderosa, seed sources, tree selection, Great Plains.

Résumé. Des pins ponderosa, *Pinus ponderosa*, furent plantés au centre-nord du Kansas en 1968 dans le cadre d'un programme pour identifier des sources adéquates de graines pour la région des grandes plaines de l'Est. Un taux de survie et la hauteur aprè 15 ans furent obtenus et évalués en 1983. Des données sur la couleur du feuillage et sur son maintien furent obtenues en 1986. Les sources de graines provenant du centre-nord du Nebraska et du sud du Dakota étaient plus adéquates pour la région des grandes plaines de l'Est à cause de leur meilleur taux de croissance, leurs caractéristiques du feuillage et leur taux de survie au-dessus de la moyenne. L'opportunité existe maintenant de sélectionner des graines provenant de sites naturels pour améliorer la performance mediocre souvent exhibée par les plantations de pins ponderosa dans la région.

Ponderosa pine (*Pinus ponderosa*) is indigenous to every state west of the Great Plains of the United States where it is highly valued as a timber species (5). Its drought tolerance, dense crown form, and tall growth habit make ponderosa pine excellent for windbreaks, sight barriers, and ornamental plantings (4). This species was extensively planted in shelterbelts from North Dakota to northern Texas during the mid-1930s as part of the Prairie States Forestry Project (8). Inconsistent performance of these plantings in Kansas was attributed to use of seedlings not properly adapted to the environment (11). Distribution of ponderosa pine in the Kansas Conservation Tree Planting Program was discontinued in 1975 because of widespread damage by western pine tip moth (*Rhyacionia bushnelli*).

Outstanding performance of some individual trees found in Plains plantations suggested that proper selection could improve average tree quality. Survival, height growth, foliar characteristics, crown form, drought tolerance, and resistance to pests should be considered when evaluating sources for planting in windbreaks or as ornamentals (1).

In the late 1960s, numerous organizations established geographic source tests at 28 sites throughout the midwest which included seedlings from 79 locations; most of the trees were *P. ponderosa* var. *scopulorum* but some were *P. ponderosa* var. *ponderosa*. A major goal of these tests was identification of locations which would provide seed best adapted to the Eastern Great Plains (2). Kansas State University cooperated in this effort by establishing a plantation in Kansas composed of trees from 77 of the 79 geographic sources. Specific objectives of the current study included evaluation of seed sources with respect to survival, height growth, and foliar characteristics, and estimation of the youngest age at which reliable selections can be made based on height growth at the Kansas site.

Methods

Ponderosa pine seedlings were grown for two years in a nursery bed and one year in a transplant bed at the U.S.D.A. Forest Service Bessy Nursery in Halsy, Nebraska, then planted on a sandy loam soil in spring 1968 at a spacing of 8 by 12 feet. The site is near Junction City, Kansas, approximately 125 miles west of Kansas City, Kansas. Seventy-seven geographic sources were represented, including 1 from Arizona, 11 from Colorado, 1 from Idaho, 20 from Montana, 13 from South Dakota, 1 from Washington, and 14 from Wyoming. The plantation was established as a randomized complete block design with every

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source represented by a four-tree linear plot in each of 15 blocks. Weeds were controlled by Simazine application and mowing as necessary, with frequency of control decreasing as trees began to shade weeds.

Survival and height were recorded for every tree in May 1983, 15 years after establishment. Chi-square contingency analysis was employed to determine if seed sources differed with respect to survival. Analysis of variance was employed to determine if heights differed among seed sources. Mean heights at age 15 were correlated with those at ages 5 and 10 to estimate the youngest age at which reliable selections are possible.

Foliage color and retention were evaluated in June, 1986. Needles on 1984 and 1985 branch nodes were rated by the following system:

1 = nearly all needles were green over their entire length and more than one third of the node supported foliage;
2 = 50% or more of the needles were green for greater than half their length and more than one third of the node supported foliage;
3 = fewer than 50% of the needles were green for greater than half their length and more than one third of the node supported foliage;
4 = less than one third of the node supported foliage.

Current year's growth was not included in the analysis because it was healthy on every tree examined. Three branches were sampled from the lower third of the crown on the southern half of trees from three blocks. Two nodes per branch were sampled and their scores were combined to yield branch totals. These were averaged to obtain an overall tree score; the potential range in tree scores was 2.00 (best) to 8.00 (poorest). Analysis of variance was employed to determine if differences in foliar characteristics existed among sources. A Spearman's rank correlation test was used to determine if height and foliar characteristics were correlated.

Results

The mean survival percentage by sources at age 15 was 77.5% with a range of 33.3% to 91.6% (Table 1); differences were statistically significant (P=0.005). Sources from Montana, Nebraska, South Dakota, and Wyoming survived the best; those from south of Kansas or west of the continental divide survived the poorest.

Height was significantly different (P=0.0001) among seed sources. Means ranged from 5.8 feet to 16.0 feet (Table 1). Eight sources exceeded the mean plantation height (8.8 feet) by at least one standard deviation (1.9 feet); these were from Montana, Nebraska, and South Dakota (Figure 1). Those from south of Kansas or west of the continental divide generally were shortest. Six sources (720, 721, 754, 757, 825, and 853) were at least one standard deviation taller than the plantation mean and had a survival rate as high or higher than the plantation mean (Figure 2). The correlation between height at age 5 and at age 15 was moderate (r^2 = 0.51), however, heights at age 10 and at age 15 were highly correlated (r^2 = 0.95). Damage by western pine tip moth was severe on many sources.

Foliar characteristic scores were significantly different (P=0.0001) among seed sources, ranging from 2.74 to 7.94 (Table 1). Spearman's rank correlation test suggested a close relationship between foliar characteristics and height growth (Spearman's rank correlation coefficient = 0.49; P = 0.0001). Six sources (720, 721, 754, 757, 825, and 855) were ranked among the top ten with respect to height and foliar characteristics; five of these had survival percentages above the mean.

Discussion

Ponderosa pine from north-central Nebraska (sources 720, 721, 853, and 855), south-central South Dakota (sources 757 and 854) and several locations in Montana (sources 754, 822, and 825) are better suited to the eastern Great Plains because of superior survival, height growth, and foliar characteristics compared with those from south of Kansas or west of the continental divide. Those from Colorado and southern Wyoming are intermediate. The tallest sources in this study, particularly those from north-central Nebraska, also generally performed better than average at other sites throughout the midwest (11). He suggested that sources that performed well at most midwestern locations have intermediate genetic constitutions which enables the high degree of adapatability necessary to survive in non-native environments such as the eastern Great Plains.

Relative height ranking among sources in this

Table 1. Mean survival (%), tree height (feet), and foliar characteristic score for ponderosa pines grown near Junction City, Kansas, with corresponding ranks.

Seed source number	*Location*	*Survival (%)*	*Height (feet)*	*Height rank*	*Foliar score*	*Foliar rank*
701	ND	80.0	8.9	32	3.16	8
702	ND	86.6	8.1	48	4.16	20
703	SD	85.0	8.4	41	4.20	22
704	SD	90.0	8.8	33	5.28	52
720	NE	81.6	16.0	1	2.95	4
721	NE	80.0	14.3	2	2.99	6
722	NE	81.6	9.7	17	4.31	27
723	NE	88.3	9.5	21	6.41	68
724	CO	76.6	8.1	49	3.99	18
727	MT	78.3	8.0	51	4.25	25
754	MT	90.0	11.0	5	2.85	2
757	SD	85.0	13.8	3	2.93	3
758	NE	83.3	8.3	44	6.36	66
759	NE	80.0	9.5	19	4.45	31
760	CO	86.6	6.0	76	6.69	73
761	CO	83.3	6.3	74	4.57	34
762	CO	73.3	7.3	64	4.42	29
763	CO	76.6	7.5	60	5.47	56
764	CO	86.6	9.0	29	4.92	45
765	CO	88.3	9.5	22	5.92	62
766	NM	38.3	6.7	71	5.75	61
767	NM	58.3	7.1	66	6.55	71
768	NM	63.3	8.6	38	7.57	76
811	MT	88.3	9.7	16	6.40	67
812	MT	86.6	9.5	20	3.71	13
813	MT	83.3	8.2	45	4.08	19
814	MT	78.3	9.0	30	4.88	41
815	MT	86.6	7.3	63	5.53	57
816	MT	88.3	9.9	13	5.19	49
817	MT	36.6	9.3	27	4.88	39
818	MT	33.3	5.8	77	7.94	77
819	MT	58.3	6.8	69	6.68	72
820	MT	55.0	8.3	42	6.82	74
821	MT	90.0	9.4	24	3.03	7
822	MT	90.0	10.7	9	3.83	14
823	MT	88.3	10.2	11	3.95	17
824	MT	81.6	9.5	23	3.91	15
825	MT	90.0	10.8	8	3.17	9
826	MT	70.0	8.7	37	6.17	64
827	MT	91.6	9.6	18	4.43	30
828	MT	86.6	9.8	14	4.53	32
829	WY	85.0	8.2	46	4.28	26
830	WY	83.3	7.0	68	6.10	63
831	WY	78.3	8.0	52	5.20	50
832	WY	80.0	10.0	12	3.20	10
833	WY	90.0	8.8	35	4.90	44

Seed source number	*Location*	*Survival (%)*	*Height (feet)*	*Height rank*	*Foliar score*	*Foliar rank*
834	WY	83.3	8.3	43	5.39	53
835	WY	83.3	8.5	40	3.44	11
836	WY	76.6	7.7	58	2.74	1
837	SD	83.3	9.1	28	5.63	59
838	SD	75.0	8.6	39	4.23	23
839	SD	80.0	7.9	53	4.57	33
840	SD	68.3	9.4	25	4.33	28
844	NE	71.6	7.1	67	5.61	38
845	NE	83.3	7.4	62	4.16	21
846	WY	86.6	9.3	26	4.81	38
847	WY	63.3	6.6	72	5.23	51
848	WY	81.6	6.4	73	5.44	54
849	WY	81.6	7.5	61	6.54	70
850	WY	83.3	8.9	31	4.57	35
851	NE	90.0	8.8	34	4.23	24
852	NE	86.6	9.8	15	5.45	55
853	NE	90.0	11.0	6	4.71	37
854	SD	71.6	10.5	10	3.55	12
855	NE	71.6	11.6	4	3.98	5
856	NE	51.6	10.8	7	5.09	46
857	WY	86.6	36.8	70	3.92	16
858	CO	81.6	7.8	55	5.64	60
859	CO	61.6	7.2	65	5.10	47
860	CO	66.6	7.7	57	4.88	43
861	CO	83.3	7.8	54	4.88	42
862	NM	80.0	7.8	56	4.88	40
863	NM	76.6	8.2	47	5.15	48
864	NM	75.0	8.7	36	4.59	36
866	WA	73.3	8.0	50	6.50	69
867	ID	43.3	6.1	75	7.06	75
869	AZ	56.6	7.6	59	6.18	65
	Mean	77.5%	8.8 feet		4.88	
	Std. Dev.	13.2%	1.9 feet		1.18	

plantation has stabilized, so reliable seed source recommendations are now possible. Wakeley (13) and Read (9) suggested that selection of southern pines and ponderosa pine, respectively, for height growth should not be made until age 15 because height growth performance of young trees is imperfectly related to that at maturity. Age-age correlations in this study suggest the fastest growing seed sources probably could have been identified when the plantation was 10 years old, but not before. Van Haverbeke (11) and Lambeth (6) suggested selection between ages 5 and 10 is practical for ponderosa pine.

Western pine tip moths have frequently limited screening efficiency and ornamental value of ponderosa pine plantings, and they severely damaged some seed sources in this study. However Dix and Jennings (3) reported that trees from seed sources 720 and 757 were able to outgrow tip moth infestation or were less desirable hosts in a central Nebraska plantation; other fast growing individuals may interact similar-

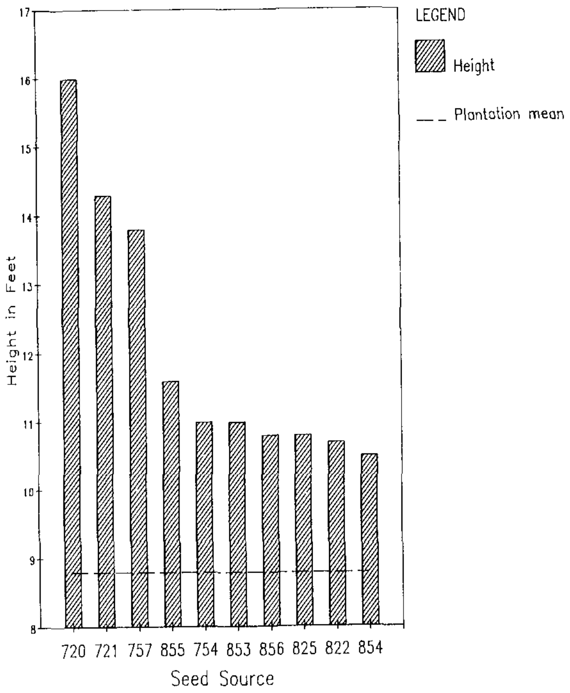

Figure 1. Mean heights of the ten tallest ponderosa pine sources at age 15.

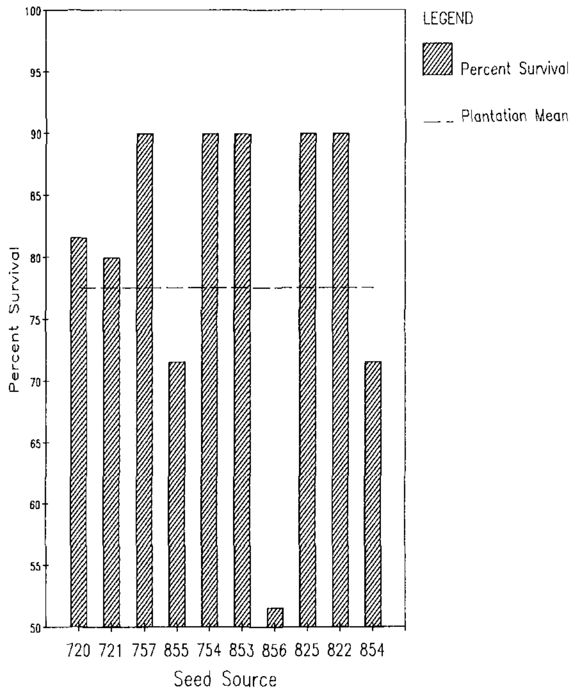

Figure 2. Mean survival of the ten tallest ponderosa pine sources.

ly with tip moths. Van Haverbeke *et al.* (12) indicated application of systemic insecticides can effectively protect young ponderosa pine from tip moth damage, but insecticides may not be necessary if proper seed sources are used.

This study and others have shown that selection for foliar characteristics among ponderosa pines is possible. Taller sources generally have foliar characteristics that are more desirable than shorter ones for ornamental and screening purposes because they retain a high percentage of green needles for up to three years. Peterson (7) found differences among seed sources with respect to resistance to Dothistroma needlecast; trees from taller sources generally were above average in resistance. Read and Sprackling (10) suggested that differences among seed sources with respect to susceptibility to hail damage were attributable to differences in needle characteristics. Collectively, these results suggest selection for foliar characteristics could lead to improved aesthetics and windbreak efficiency of future ponderosa pine plantings.

Conclusions

Hardiness and site adaptability are among the most important criteria that horticulturists and arborists use in making tree selections. Sources of ponderosa pine from north-central Nebraska and south-central South Dakota demonstrate a high level of hardiness as evidenced by their superior survival, height growth, and foliage characteristics. Individuals from some areas in Montana and Wyoming also perform well in the eastern Great Plains. Foliage characteristics vary among seed sources; trees from taller seed sources generally have foliar characteristics that are more favorable for ornamental and screening purposes than short ones. Age-age correlations indicate selection for height may begin as early as age ten.

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Abstract

Funk, R. C. 1986. **The politics and perception of pesticides.** Arbor Age 6 (60): 12-14.

Much of the current concern about pesticides is based on the myth that "natural is good" and what psychologists call "fear of the unknown." There is no separation between *natural* and *chemical.* Everything in our world is made of chemicals. The air we breathe, the water we drink, the foods that we eat, all consist of chemicals. Even organically grown foods contain combinations of complex chemicals, many of which are highly toxic if taken alone in sufficient quantity. The toxicity of a chemical is dependent upon its chemical structure and not on whether it is naural or man made. The best definition of a poison is "too much" of anything. Plants produce toxic chemicals in large amounts, apparently as a primary defense against the hordes of bacterial, fungal, insect, and animal predators. The variety of toxic chemicals that occur in nature is so great that *organic* chemists have been characterizing them for over 100 years—and new plant chemicals are still being discovered. Uncertainty over the long-range effects of pesticides is perhaps the major fear of those opposed to their use. Can the most minute trace of certain chemicals cause cancer or other problems long after the exposure has taken place. Many scientists believe that the body's natural defense mechanisms protect against cell damage from these chemicals, even though high levels used in laboratory tests may indeed overwhelm the system.