

Growth and Yield of a 24-Year-Old Black Cottonwood Plantation in Western Washington

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A 24-year-old black cottonwood plantation in western Washington has total stem volume of 7,242 cubic feet per acre. Heights of dominant trees are 115 to 122 feet. This plantation illustrates the productivity of the species on a deep alluvial soil.

In the forests of the Pacific Northwest, no other tree species can match the early growth of black cottonwood (*Populus trichocarpa* Torr. & Gray) on a favorable site. Juvenile height growth of 6.3 feet per year (4) and diameter growth of more than 1 inch per year (1) have been reported. The species is less commonly distributed than most of its tree associates, however, because it has a distinct preference for abundant soil moisture combined with adequate aeration, a good nutrient supply, and soil pH values close to neutral (1).

Some of the earliest known reforestation work in the Western United States involved planting black cottonwood during the 1890's along the Willamette River in Oregon (7). Plantings of black cottonwood were also made in British Columbia in the 1950's and 1960's (9, 10). More recently, black cottonwood has been considered a candidate for biomass farming and has been planted and coppiced under various experimental regimes (2, 3, 5). Currently, however, the species is not commonly planted or managed. Aside from the British Columbia work, there is little information on its growth in plantations. This

report presents 24-year growth and yield information from one of the very few older cottonwood plantations in the Pacific Northwest.

Plantation History

In the mid-1950's, Mayr Brothers Logging Co., Inc., purchased a small farm for reforestation. The farm, located on old river terraces along the North River in Grays Harbor County, Wash., had areas that were considered suitable for planting black cottonwood. At that time, there was considerable interest in black cottonwood as a possible raw material for the local plywood industry.

The soil series, Grande Ronde, is a very fine, mixed, mesic Aquic Dystrachrept. Developed from sandstone and shale, it is a deep alluvial soil, typically found on river benches or terraces. Texture ranges from a silty clay loam in the surface horizons to clay loam in the subsoil. Water movement is generally slow, but tree roots penetrate easily. The water table is usually about 3 feet from the surface during the growing season; however, the area is subject to flooding during peak flows.

In early 1958, 6 acres were prepared for planting by plowing, disking, and applying a layer of crushed oyster shells to serve as a source of limestone. In the spring, the area was planted at an 11.5- by 11.5-foot spacing with 6- to 8-foot unrooted, terminal cuttings collected from young native trees growing along the North River and the

lower Wynoochee River. In the first few years after planting, circles 2 feet in radius were occasionally hoed around each tree. Later, horses were grazed in the plantation to help keep the grass down. During the dry summer of 1960, the trees were irrigated with water from the river. Beaver were sporadically troublesome and cut some of the trees close to the water. The beavers were later eliminated by trapping. Once the plantation was considered well established, no additional cultural treatments were applied.

Growth and Yield

In fall 1981, two plots totaling 1/2 acre were established in areas with minimal signs of past disturbance. All trees in the plots were measured for diameter. Thirty trees in the plantation were measured for height; these spanned the range of heights and were selected so that two-thirds of them had diameters equal to or greater than the average stand diameter. Volumes (total stem inside bark) by diameter class were taken from a volume-diameter curve calculated using a diameter-squared-times-height equation (12).

This plantation has grown extremely well (table 1) and looks impressive (fig. 1). Mortality over 24 years has been minor, with 291 stems per acre remaining from the original stocking level of 329. Dominant trees are now 115 to 122 feet tall and 13 to 16 inches in diameter. Basal area is 169 square feet per

Table 1.—Stand characteristics of the North River black cottonwood plantation 24 years after planting

Diameter class	Number of trees	Height	Total stem volume
<i>Inches</i>		<i>Ft</i>	<i>FP</i>
4	6	55	11
5	4	69	14
6	25	84	160
7	23	93	221
8	23	98	304
9	35	103	612
10	41	106	910
11	56	109	1,646
12	27	112	977
13	25	115	1,048
14	16	118	773
15	8	120	440
16	2	122	125
Total	291		7,242



Figure 1.—North River cottonwood plantation 24 years after planting.

acre; the tree of mean basal area is 10.3 inches in diameter. Total stem cubic volume in live trees was calculated to be 7,242 cubic feet per acre or an average of 302 cubic feet of growth per acre per year. This would be roughly equivalent to 3.4 oven-dry tons of growth per acre per year (assuming 22.5 pounds per cubic foot of oven-dry material).

Discussion

We have not been able to find any reports in the literature where black cottonwood equaled or exceeded the 24-year height and volume growth of this stand (6, 8, 11). Higher annual yields have been reported for older stands (9) and those under intensive culture (2, 3, 5), but not for plantations or natural stands of similar age.

The plantation is now too dense, and some of the trees with small narrow crowns have recently suffered top damage and stem breakage following heavy wet snows. Some areas of the plantation have lower stocking than the measurement plots both as a result of early mortality and some recent cutting. In these areas of lower stocking, damage has generally been less and average diameter is greater, with 10 to 15 stems per acre exceeding 17.0 inches. The largest trees in the plantation (excluding border rows) are 18.5 to 18.7 inches in diameter and 128 to 129 feet tall. As a result, we believe if the stand had been thinned early, diameter growth could have been accelerated,

damage reduced, and future mortality forestalled.

Black cottonwood can be used to produce pulp, paper, lumber, veneer, and energy. Past cutting has reduced available inventories; consequently, current markets are fairly localized. Markets may expand in the future, however, if more wood becomes available or technological changes allow greater substitution of black cottonwood for other species to produce some end products.

Forest management practices are becoming increasingly oriented to producing maximum yield. This plantation provides an example of the potential productivity of black cottonwood. On appropriate sites, particularly on river benches or terraces, we believe the species warrants greater consideration.

Literature Cited

1. Fowells, H. A., comp. Silvics of forest trees of the United States. Agric. Handb. 271. Washington, DC: U. S. Department of Agriculture; 1965. 762 p.
2. Harrington, Constance A.; DeBell, Dean S.; Strand, Robert F. An experiment in biomass production: Results from three consecutive harvests of cottonwood and alder. In: Proceedings Solar'79 Northwest; 1979 August 10-12; Seattle, WA. [Place of publication unknown.] U.S. Department of Energy; 1979: 363-366.
3. Heilman, P. E.; Peabody, D. V., Jr.; DeBell, D. S.; Strand, R. F. A test of close-spaced, short-rotation culture of black cottonwood. Can. J. For. Res. 2: 456-459; 1972.
4. Heilman, Paul E.; Ekuan, Gordon. Effect of planting stock length and spacing on growth of black cottonwood. For. Sci. 25(3): 439-443; 1979.
5. Heilman, Paul E.; Peabody, D. V., Jr. Effect of harvest cycle and spacing on 8-year yield of black cottonwood in intensive culture. Can. J. For. Res. 11: 118-123; 1981.
6. Mahon, J. E. Empirical yields from stands of black cottonwood in the lower Fraser Valley. Vancouver: University of British Columbia; 1966. 59 p. Thesis.
7. Priaulx, Arthur W. Oregon's planted cottonwoods. Am. For. 58(10): 10-11, 66-68, 70; 1952.
8. Smith, J. H. G. Growth and yield of poplar in British Columbia. In: Proceedings second annual meeting of the Poplar Council of Canada, 1980 August 19-22; Richmond, BC. 1980.
9. Smith, J. H. G.; Blom, G. Decade of intensive cultivation of poplars in British Columbia shows need for long-term research to reduce risks. For. Chron. 42(2): 359-376; 1966.
10. Smith, J. H. G.; Blom, G. Poplar spacing trials show way to gains in wood yield. Can. For. Ind. 1970 July: 40-41.
11. Smith, J. Harry G. Some factors indicative of site quality for black cottonwood (*Populus trichocarpa* Torr. & Gray). J. For. 55(8): 578-580; 1957.
12. Smith, J. Harry G.; Breadon, Robert E. Combined variable equations and volume-basal area ratios for total cubic foot volumes of the commercial trees of BC. For. Chron. 40(6): 258-261; 1964.