Sprouting Characteristics and Cutting Practices Evaluated for Cottonwood

Dean S. DeBell and Lee T. Alford 1

Management of hardwood coppice stands on short (2-to-5 year) rotations results in high yields of cellulose fiber .[2] In a cooperative study between Washington State University and Crown Zellerbach Corporation, it was found that yields of dense coppice stands of black cottonwood may exceed 500 cubic feet per acre per year (3). However, before coppice plantations can be widely established, data are needed on factors affecting sprout production of the species. This article reports on sprouting characteristics of black cottonwood and discusses effects of cutting practices on sprout production of eastern cottonwood.

Sprouting Characteristics of Black Cottonwood

Information on sprouting characteristics of black cottonwood *(Populus trichocarpa,* Torr. & Gray) was obtained from a 4-year-old coppice plantation near Mt. Vernon, Wash. The plantation was established using 24-inch cuttings planted 12 inches deep in February 1967. An initial harvest cut was made in February 1969, leaving stumps 12 inches high for sprout production. After two growing seasons, sprouts were abundant.

Five stumps were dug in December 1970, and soil was washed from the roots. The following data were collected for all sprouts on each stump:

1. height above ground at which each sprout originated, and
2. diameter of each sprout at 1 in. above its origin. Stumps were cut into cross-sections ½ inch thick. Development of vascular tissue in several sprouts was traced in these sections. In addition, bark was peeled from parent stumps and 2-year-old sprouts to determine the number and arrangement of suppressed buds.

A second crop was harvested in January 1971, leaving stumps 6 inches high for sprout production. Examination of the plantation during the subsequent growing season revealed that sprout development was slower than after the first cut. Sprouts on some stumps appeared to arise from wound callus. Therefore, five such stumps were dug and their bud and sprout patterns were studied.

Origin

For stumps examined after the first harvest, all black cottonwood sprouts originated from suppressed buds (i.e., vascular tissue of sprout was continuous with pith of parent stump) rather than forming adventitiously in wound tissue. Suppressed buds (also referred to as dormant buds) are formed in the axils of leaves on new shoots, and continue to elongate just enough to remain outside the most recent annual ring (1). These buds often branch, thereby giving rise to additional buds (1). A clustered arrangement of buds was noted on parent stumps, presumably, the result of such branching. Suppressed buds develop into sprouts and/or epicoromic branches when the tree encounters some type of physiological "shock," such as severe

1Research foresters, Crown Zellerbach Corporation, Camas, Wash. and Bogalusa, La., respectively.

[2]McAlpine and associates have suggested that yields of "silage sycamore" will nearly double yields produced from conventional rotations of southern pines (2)

TABLE 1.—*Occurrence and size of black cottonwood sprouts as related to height of origin on stump*

Stump number	Number of sprouts	Range in heights of sprout origin above ground	Height of origin of 3 largest sprouts per stump
		Inches	*Inches*
1	8	6.7 to 10.6	7.1, 9.0, 10.2
2	6	9.0 to 11.4	10.2, 11.0, 11.0
3	14	6.7 to 10.2	7.1, 9.4, 10.2
4	11	4.7 to 10.2	6.7, 9.8, 9.8
5	13	5.5 to 11.4	7.9, 10.2, 11.0

thinning, disease attacks, or cutting (1).

Most sprouts produced in the first growing season after the second harvest also originated from suppressed buds. However, several stumps were suspected to have adventitious sprouts. Detailed examination of five such stumps revealed that more than 90 percent of the sprouts were of adventitious origin. Suppressed buds were present on the stumps, but they did not develop rapidly into dominant sprouts.

Occurrence

Most sprouts originated between 6 and 12 inches above ground (table 1) ; only 6 percent originated below 6 inches. Within the 6 to 12-inch range, however, there was no relationship between a sprout's size and its point of origin on the stump (table 1).

The peeling of parent stumps revealed that the relative absence of sprouts below 6 inches was not due to lack of buds in this region. Apparently the sprouting of buds above 6 inches exerted dominance over lower buds which remained in a suppressed state. Our study also showed that density of suppressed buds was greater in the lower 6 inches of parent stumps (5.3 buds per inch of height) than in the basal region of 2-year-old sprouts (2.8 buds per inch of height). The increased numbers of buds on parent stumps may be due to branching of original auxiliary buds.

The lack of relationship between bud density and height level on parent stumps probably results from the use of cuttings for plantation establishment. Therefore, the entire "stump" originally was shoot wood and should have auxiliary bud patterns similar to shoots. Had stumps come from trees started from seed, morphological development of the stump region and associated bud patterns may have been different.

The decision to cut stumps at 6 inches in the second harvest was based on the finding of abundant buds in the 0 to 6 inch region of stumps. Sprouting was slower in the spring after the second harvest, and some stumps produced sprouts of adventitious origin even though suppressed buds were abundant. These sprouts were smaller, susceptible to wind breakage, and may be more subject to decay than sprouts originating from suppressed buds. Reasons for differences in sprout development after the first and second harvests are not fully understood. However, it appears that suppressed buds on portions of stumps which had an opportunity to sprout after the first cutting did not sprout as vigorously as suppressed buds on younger sprout material. In the absence of rapid sprout development from suppressed buds, sprouts developed adventitiously from wound callus. If the same cutting height was used for each harvest, some younger growth should have been present on every stump and sprouting probably would have developed rapidly from suppressed buds.

Effects of Cutting Practices on Sprouting of Eastern Cottonwood

Studies were carried out in 5- to 7-year old plantations of eastern cottonwood *(Populus deltoides* Bartr. var. *deltoides)* in the Mississippi River floodplain to determine the relationship of sprouting to time of harvest, stump height, and angle of cut. Although these trees were older than ages envisioned for coppice rotations, the findings should be applicable. Likewise, information presented here as well as that in the preceding section on sprouting characteristics probably applies to both cottonwood species.

Time o f Harvest

Four rows of 25 trees per row were cut each month from April 1968 to March 1969, leaving 4- to 6-inch stumps, to determine the effect of time of harvest on number and growth of cottonwood sprouts. In January 1971, the sprouts were measured. Because effects of time of harvest on sprout size were confounded with age of sprouts, regression analysis was used to predict mean monthly growth with month of cut as a discrete independent variable. All growth data were adjusted to a 24-month base so that a valid comparison of sprout growth for different cutting dates could be made.

Sprouting was poorest for stumps cut in May and June (table 2), probably because food reserves were low after initiation of growth in April. Stumps cut during the first 5

months of the growing season (April through August) averaged less than three sprouts per stump, whereas stumps cut from September through March had more than five sprouts. Similar trends were evident with respect to diameter and height growth (table 2). Stumps cut from April through August produced sprouts which averaged 8.9 feet in height and 0.6 inches in diameter. Harvesting in other months led to sprouts averaging 15.4 feet high and 1.3 inches in diameter.

Stump Height and Angle o f Cut

Another study was established in February 1967 to test effects of horizontal and angular (45^0) cuts at three heights-4, 8, and 12 inches above the ground. Data collected and analyzed 4 years later indicated no significant differences due to height and/or angle of cutting in number of sprouts per stump, or diameter and height growth. These results are related to the finding that successful cottonwood sprouts originate primarily from suppressed buds rather than wound callus and the fact that plantations were established from cuttings.

Summary and Conclusions

Our data indicate that:

1. Cottonwood sprouts arise primarily from suppressed buds, but also can originate in wound callus.

2. Suppressed buds on portions of stumps which have had opportunity to sprout after previous harvests may not sprout as vigorously as buds on younger growth which has not been through a sprouting cycle.

3. For plantations established from cuttings, there is no relationship between bud density and height on the stump. Neither is there a relationship between sprout vigor and the height at which the sprout originated.

4. Cutting height and angle have no effect on initial sprouting of stumps established from cuttings.

5. Harvest during April through August reduces subsequent sprouting. Considerably better results are obtained when harvests are made from September through March, with best sprouting made from cuts during November through February.

Based on these findings, we recommend harvest at any convenient stump height (such as 4 to 6 inches) during the dormant season if maximum sprout growth is desired. Probably, stumps should be cut either at a consistent height or gradually higher in successive rotations for rapid sprout development from suppressed buds. Conversely, if the landowner wants to minimize sprouting, cuts should be made during the early growing season (preferably May or June).

Literature Cited

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TABLE 2.—Effect of time of harvest on sprout production of eastern cottonwood

Month	Sprouts per stump	Sprout height	Sprout diameter (b.h.)
	Number	*Feet*	*Inches*
January	6.3	15.8	1.4
February	7.9	15.8	1.2
March	5.6	14.1	1.2
April	3.4	7.9	0.7
May	1.3	8.5	0.6
June	2.7	6.8	0.3
July	3.1	9.6	0.5
August	3.5	11.8	0.8
September	4.2	13.6	1.0
October	3.9	15.8	1.2
November	4.1	15.8	1.4
December	5.1	17.2	1.4