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Summer Fallowing – A Simple Technique For Improving Old-Field Sites For Cottonwood

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Summary

Fallowing old fields during the summer before planting eastern cottonwood significantly increased survival and growth through age 5. Fallowed plots produced 1,700 ft^3 of merchantable wood per acre while untreated controls produced only 540 ft^3—a 215 percent increase. Little benefit was derived from second-year cultivation of fallowed plots, but on plots not fallowed before planting, second-year cultivation increased height and diameter growth by about 30 percent in the second and third years. Deep plowing, cover cropping, or fertilization did not influence growth or survival.

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Survival and growth of planted eastern cottonwood *(Populus deltoides* Bartr.) are often poor on abandoned fields in the Mississippi River floodplain. These fields usually have compacted, nutrient-depleted surface soils and abundant grasses and other herbaceous vegetation. To improve establishment and growth of cottonwood on these sites, intensive soil management appears essential. Earlier, we reported the effects of several soil management treatments on the initial survival and early growth of cottonwood planted on a deterlorated old-field site (Baker and Blackmon 1973). This paper reports the results of these soil treatments and extended cultivation on cottonwood growth and yield on this site through age 5.

Methods

The study area is an abandoned old field on Crown Zellerbach Corporation property in Issaquena County, Mississippi. It had been cropped for about 30 years and pastured for 8 years. Soil is a Commerce silty clay loam (Aeric Fluvaquent).

Soil treatments included:

1. Summer fallowing: Plots disked four times at about 3-week intervals between June and August 1970.
2. Cover cropping: Winter rye and vetch (25 lbs/acre of each) seeded on disked plots in September 1970. The cover crop was incorporated into the soil by disking in January 1971.
3. Deep plowing: Plowing to a 16-inch depth with a moldboard plow in September 1970.
4. Fertilization: Ammonium nitrate at the rate of 200 lbs of N per acre broadcast on the soil surface and incorporated by disking in April 1972.
5. Control: No treatment.

The first three treatments were applied before planting. Fertilizer was applied at the beginning of the second growing season. All plots, including the controls, were uniformly disked before planting.

Treatments were replicated three times in a randomized complete block design. Plots were 36 by 800 feet (0.66 acres) in size. Cottonwood cuttings were planted at 12- by 12-foot spacing in February 197 1.

All plots were cultivated at least three times during the first growing season. At the beginning of the second year, treatment plots were split, and one-half of each plot was cultivated at least three times during the second season.

Tree height measurements were made at the end of each year. Diameter (dbh) measurements were

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made at the end of the second through the fifth years. Survival counts were taken following the first and fifth years. Leaf samples were collected in August of the second and third years from randomly selected trees within each plot and analyzed for nitrogen (N), phosphorus (P), and potassium (K) concentrations. After analysis of variance (ANOV), differences in treatment means were evaluated by Duncan's new multiple range test (DNMRT). All statistical tests were performed at the 5 percent level of probability. In addition, fifth-year results were analyzed by a cottonwood growth simulator developed by Crown Zellerbach Corporation.1 The simulator predicted tree growth and yield over a 12-year rotation.

Results and Discussion

Tree Height and Diameter Growth

Summer fallowing significantly improved height and diameter growth of planted cottonwood through the fifth year (table 1). At age 5, trees on summer-fallowed plots averaged 58 feet in height and 7.8 inches in diameter, compared with 45 feet in height and 6.0 inches in diameter for control trees, a 29 and 30 percent increase as a result of fallowing.

Trees on plots that had been deep plowed, cover cropped, or fertilized, but not fallowed, averaged only 3 feet taller and 0.5 inch larger in diameter than controls at age 5. Blackmon and White (1972) and Blackmon (1977b) tested N fertilization on old-field soils similar to the one in this study and reported significant cottonwood growth response. However, they applied fertilizer at plantation ages 6 to 10, at which time competition among trees for nutrients was critical. Blackmon (1977a), having fertilized cottonwood on an old-field site at plantation ages 2, 3, and 4, measured a growth response only with the final application. He concluded that response to fertilization is not likely to occur in widely spaced plantations until the site becomes fully occupied and competition for nutrients established. The lack of response to fertilization probably resulted from the early (second-year) application of fertilizer.

The major response to fallowing came during the first 3 years (table 1). By age 4, the annual benefits of fallowing had diminished. However, the advantages incurred during the early years remained evident in total tree heights and diameters.

Tree Survival

Summer fallowing also resulted in significantly better survival than did other treatments. At the end of the first year, survival averaged 84 percent on fallowed plots but only 68 percent on unfallowed plots. By the fifth year, 79 percent of the trees on fallowed plots were alive, compared with 59 percent on unfallowed plots.

Volume Production

By the end of the fifth year, average tree volumes ranged from 3.2 ft^3 per tree on controls to 7.3 ft^3 per tree on fallowed plots, a 128 percent difference (table 2). The large increase in average tree volume, coupled with the significantly better survival from fallowing, resulted in even larger differences in total volume yield at age 5. Total yield ranged from 542 ft^3 per acre on controls to about 1,700 ft^3 per acre on fallowed plots, a 215 percent increase (128 percent due to better tree growth and 87 percent due to better survival).

The cottonwood growth simulator predicts that by age 12, trees on the summer-fallowed plots will produce 45 cords of merchantable wood per acre, as compared with only 21 cords per acre for the control plots (fig. 1).

'Crown Zellerbach Corp., Bogalusa, La. Unpublished data.

Table 1.—*Effect* of soil treatment on annual growth of *cottonwood*

Treatment	Growth									
	1st year	2nd year	3rd year		4th year		5th year		Total	
	Ht	Ht	Ht	DBH	Ht	DBH	Ht	DBH	Ht	DBH
	ft	*ft*	*ft*	*in*	*ft*	*in*	*ft*	*in*	*ft*	*in*
Control	5 b[1]	8 b	10 b	1.6 b	11a	1.5a	11a	1.2a	45 b	6.0 b
Cover crop	7 b	9ab	10 b	1.7 b	11a	1.5a	11a	1.3a	48 b	6.6 b
Deep plow	7 b	9ab	10 b	1.8 b	12a	1.6a	11a	1.0a	49 b	6.4 b
Fertilize	6 b	10ab	10 b	1.7 b	12a	1.2a	8a	1.2a	46 b	6.4 b
Summer fallow	10a	12a	14a	2.0a	10a	1.5a	12a	1.1a	58a	7.8a

[1] Means in the same column followed by the same letter are not significantly different (0.05 level).

Table *2.-Effect of soil treatment on average cottonwood volume and total yield at age 5*

Treatment	Average tree volume[1]	Trees per acre	Total volume per acre
	ft^3		ft^3
Control	*3.2* b[2]	*164* b	*542* b
Cover crop	*4.4* b	180 b	812 b
Deep plow	3.9 b	193 b	756 b
Fertilize	4.0 b	167 b	672 b
Summer fallow	7.3a	237a	1704a

[1] Merchantable volume outside bark to a 3% inch top. Calculated from equation by Mohn and Krinard (1971).

[2] Means in the same column followed by the same letter are not significantly different (0.05 level).

Summer fallowing is widely used in agriculture, especially in semiarid regions, both for weed control and for soil moisture conservation. These benefits are also attainable in cottonwood plantations.

On grass-infested old fields having compacted and nutrient-depleted surface soils, summer fallowing can temporarily improve soil structure, allowing for better water infiltration. Fallowing also incorporates organic matter and nutrients into the soil. Finally, by reducing competing vegetation, fallowing allows for maximum storage of soil moisture and eliminates any allelopathic effect that competing vegetation, particularly Johnson grass *(Sorghum halepense* (L.) Pers.), might have on cottonwood growth.

Influence of Second-Year Cultivation on Tree Growth

The major benefit of cultivating established plantations is probably competition control. However, like summer fallowing, it also improves soil structure, water infiltration and storage, organic matter, and availability of nutrients. Second-year cultivation had a significant influence on tree growth during the second and third growing seasons, and growth benefits were still evident in tree heights and diameters at the end of the fifth year (table 3).

Cultivation during the second growing season was most important on plots that had not been fallowed the summer before planting. By the end of the third growing season, trees that had been cultivated the second year but not fallowed averaged 5 feet taller and 0.8 inch larger in diameter than uncultivated and unfallowed trees. Most of this increase occured during the second growing season. In contrast, on plots that had been fallowed, extended cultivation resulted in only 2 feet

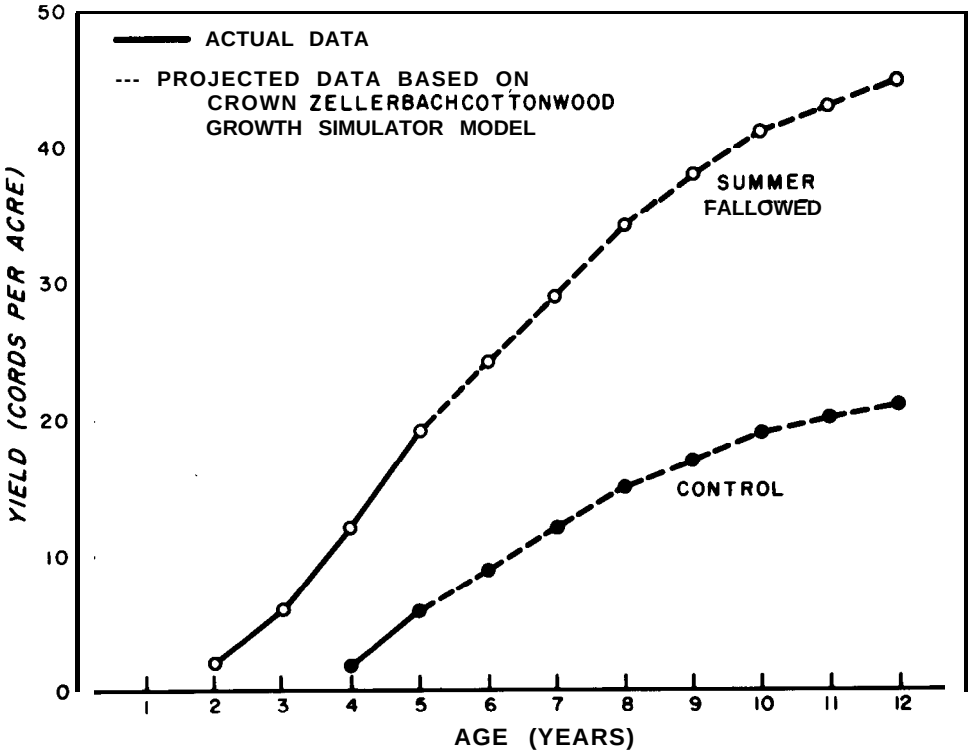

Figure *1.-Anticipated cottonwood yield over a 12-year rotation.*

Table 3.-*Effects of second-year cultivation on cottonwood growth*

Treatment	Tree growth by year								
	2nd year	3rd year		4th year		5th year		Total at 5 years	
	Ht	Ht	DBH	Ht	DBH	Ht	DBH	Ht	DBH
	ft	*ft*	*in*	*ft*	*in*	*ft*	*in*	*ft*	*in*
No second-year cultivation	8 b[1]	10 b	1.7 b	11a	1.5a	10a	1.2a	48 b	6.4 b
Second-year cultivation	11a	12a	1.9a	11a	1.3a	11a	1.1a	52a	6.9a

[1] Means in a column followed by the same letter are not significantly different (0.05 level).

more height growth and 0.3 inch more diameter growth by the third year. Since there was relatively little herbaceous vegetation on the fallowed plots at the beginning of the second season, little was gained by additional competition control. Besides promoting significantly better growth and survival throughout the first 3 years of plantation establishment, summer fallowing also appears to eliminate the need for second-year cultivation.

Influence of Treatments on Foliar Nutrient Levels

All treatments significantly increased foliar N concentrations during the second year (table 4). Second-year foliar N levels ranged from 1.96 percent for controls to 2.43 percent for summer-fallowed plots. Treatments had no effect on P and K levels during the second or third years, nor did they influence third-year N levels.

Second-year cultivation also affected foliar N levels during the second and third years. Nitrogen concentrations in the second year averaged 2.06 percent for trees on uncultivated plots and 2.51 percent for trees on cultivated plots. The following year, N concentrations on the uncultivated plots were 2.04 percent; concentrations on cultivated plots were still significantly elevated to 2.31 percent.

Cultivation increased N levels in cottonwood foliage almost as much as an application of 200 lbs per acre of N fertilizer. When fertilizer N was applied to plots which had not been cultivated in the second year, foliar N concentrations averaged I.97 percent. When the fertilizer was applied to plots which had received second-year cultivation, foliar N levels averaged 2.75 percent. By the third year, trees that were fertilized, or cultivated, or both, averaged about 2.34 percent foliar N. The high foliar N levels associated with cultivation probably resulted from periodic incorporation of green herbaceous matter (accompanied by its release of N during decomposition) and reduction of competition for the available soil N.

Table 4.-*Effect of treatment on second- and third-year foliar nutrient levels*

Treatment	Foliar nutrient concentration by years	
	2nd year N	3rd year N
	percent	
Control		
No cultivation	1.64	2.01
Cultivation	2.29	2.27
Mean	1.96 b[1]	2.14a
Summer fallow		
No cultivation	2.34	2.11
Cultivation	2.52	2.43
Mean	2.43a	2.27a
Fertilization		
No cultivation	1.97	1.92
Cultivation	2.75	2.36
Mean	2.36a	2.14a
Cover cropping		
No cultivation	2.17	2.05
Cultivation	2.45	2.10
Mean	2.31a	2.08a
Deep Plowing		
No cultivation	2.17	2.10
Cultivation	2.54	2.41
Mean	2.36a	2.26a
Mean		
No cultivation	2.06	2.04
Cultivation	2.51[2]	2.31[2]

[1] Means in the same column for each treatment followed by the same letter are not significantly different (0.05 level).

[2] Indicates a significant difference (0.05 level) between 2nd-year and no 2nd-year cultivation (averaged over treatments).

Conclusions

Summer fallowing (disking as often as necessary to control weeds during the summer before planting) is a simple, yet efficient way to improve both cottonwood plantation establishment and early growth on abandoned fields. Fallowing seems most beneficial to old fields with compacted and nutrient-depleted surface soils or on sites where herbaceous competition is severe.

Fallowing not only controls seedling and rhizome Johnson grass and other herbaceous species, but also improves the nutrient and moisture status of the soil. Summer fallowing may eliminate the need for second-year cultivation, a treatment that provides benefit to tree growth when competition from herbaceous vegetation is serious.

Literature Cited

Baker, James B., and B. G. Blackmon.
1973. Summer fallowing improves survival and growth of cottonwood on old fields. U.S. Dep. Agric. For. Serv. Res. Note SO-149, 3 p. South. For. Exp. Stn., New Orleans, La.

Blackmon, B. G.
1977a. Cottonwood response to nitrogen related to plantation age and site. U.S. Dep. Agric. For. Serv. Res. Note. SO-229, 3 p. South. For. Exp. Stn., New Orleans, La.

Blackmon, B. G.
1977b. Effects of fertilizer nitrogen on tree growth, foliar nitrogen, and herbage in eastern cottonwood plantations. Soil Sci. Soc. Am. J. 41(5): 992-995.

Blackmon, B. G., and E. H. White.
1972. Nitrogen fertilization increases cottonwood growth on old-field soil. U.S. Dep. Agric. For. Serv. Res. Note SO-143, 5 p. South. For. Exp. Stn., New Orleans, La.

Mohn, C. A., and R. M. Krinard.
1971. Volume tables for small cottonwoods in plantations. U.S. Dep. Agric. For. Serv. Res. Note SO-113, 4 p. South. For. Exp. Stn., New Orleans, La.

Baker, James B. and B. G. Blackmon.
1978. Summer fallowing-a simple technique for improving old-field sites for cottonwood. U. S. Dep. Agric. For. Serv. Res. Pap. SO-142, 5 p.

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