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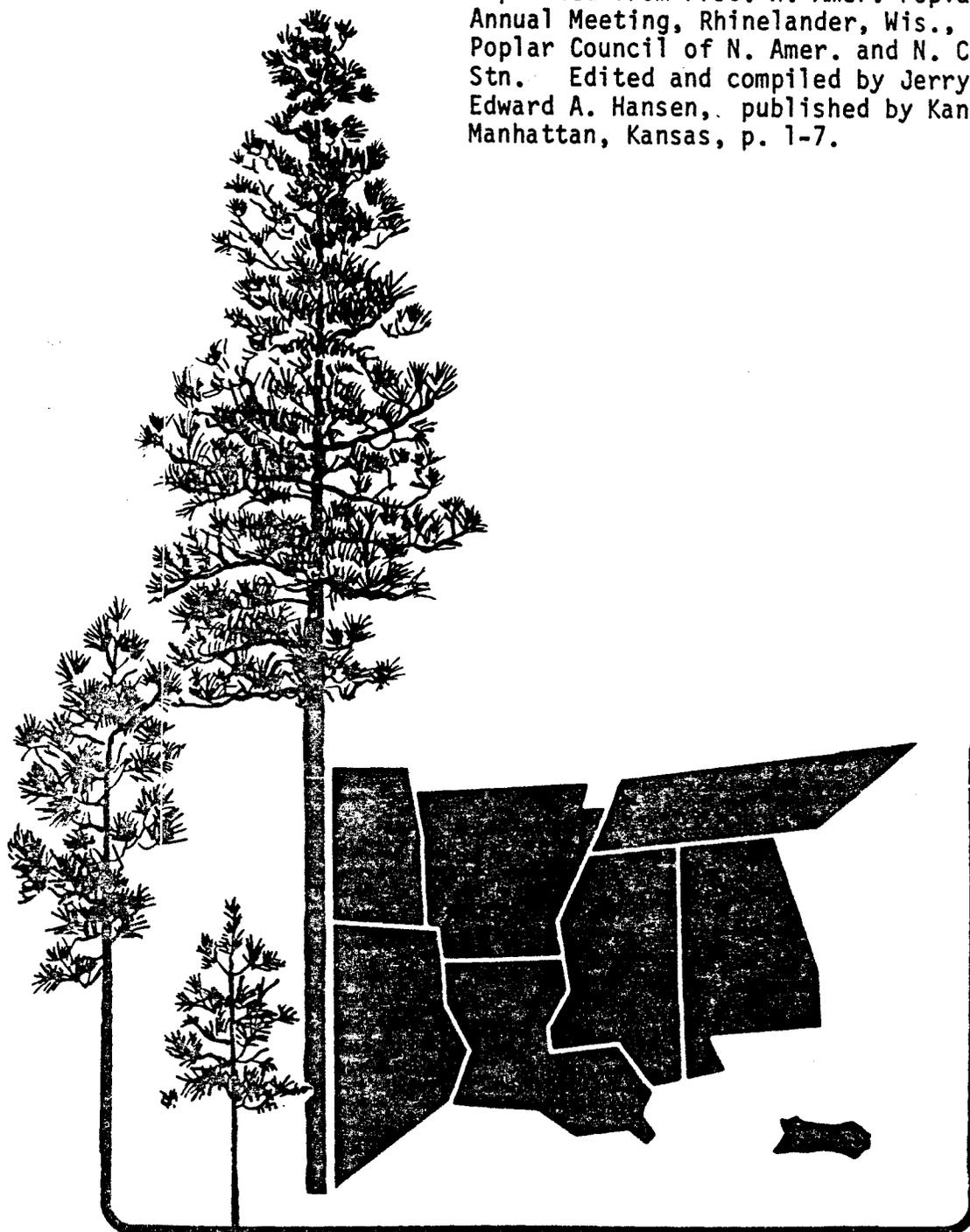
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FALLOWING FOR COTTONWOOD PLANTATIONS: BENEFITS CARRY TO ROTATION'S END

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FALLOWING FOR COTTONWOOD PLANTATIONS: BENEFITS CARRY TO ROTATION'S END

John K. Francis^{1/}

Abstract.--Johnson grass and other weeds are so prolific in old fields on the Mississippi Delta that frequent cultivation is necessary during the first season to obtain acceptable survival of planted cottonwood. A number of site preparation treatments were tested as a means of increasing early survival and growth. Fallowing, essentially five diskings the summer before planting, was the most successful treatment. Fallowing resulted in 18% better first-year survival than sites not fallowed before planting. By rotation's end (11 years), fallowed plots yielded over 50% more than nonfallowed plots, primarily due to better survival. Diameters were also significantly greater. Thinning at 5 years reduced total yield by 19% compared to unthinned, fallowed plots, but increased mean diameter by about 7%. Thinning at 8 years resulted in yields and diameters similar to unthinned plots. Second-year cultivation was tested; no benefit was detected.

Additional keywords: Populus deltoides Bartr. ex Marsh., plantations, cultivation, thinning.

It is sometimes more convenient and environmentally acceptable to establish cottonwood (Populus deltoides Bartr. ex Marsh.) plantations on old fields than to clear forested land. Soils of old fields on the Mississippi Delta, however, are often compacted, depleted of nitrogen, and covered with weeds. There is usually poor survival and growth of cottonwood on minimally prepared old fields (Maisenhelder 1960). This study was established to test several soil management alternatives for abandoned fields. Additional tests of second-year cultivation and thinnings at 5 and 8 years were superimposed on the original study plots during the course of the experiment. Results of these treatments were recorded through a pulpwood rotation of 11 years.

METHODS

Plots 30 X 800 ft (9 X 244 m) covered most of a 40-acre (16-ha) field in Issaquena County, Mississippi. The field had been previously cropped, pastured, and used as an airstrip. The soil was a Commerce silty clay loam (fine-silty, mixed, nonacid, thermic Aeric Fluvaquents). The original 16 soil management treatments tested consisted of all possible combinations of 1 through 4 below and number 5, a control.

1. Cover cropping. Winter rye and vetch were seeded (25 lbs/acre or 28 kg/ha of each) on disked plots in September 1970. The cover crop was incorporated into the soil by disking in January 1971.

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2. Deep plowing. Soil was turned to a 16-in (41-cm) depth in September 1970.
3. Fertilization. Ammonium nitrate at the rate of 200 lbs N per acre (224 kg/ha) was broadcast and incorporated by disking in April 1972 (the start of the second growing season).
4. Fallowing plus herbicide. Plots were disked four times at 3-week intervals between June and August 1970. Then 1 lb of active trifluralin/acre (1.1 kg/ha) was incorporated into the soil by disking in September 1970.
5. Control. No treatment.

Treatments were replicated three times in a randomized complete block design. All plots were disked in January before planting. Nursery-run, 20-in (51-cm) cottonwood cuttings were planted with a 10 X 10-ft (3 X 3-m) spacing in February 1971 and cultivated periodically during the first growing season. During the second growing season, a test of second-year cultivation was imposed on the study. Each plot was split and a randomly chosen half was cultivated three times to control weeds.

After year 5, all treatments were "pooled" into three groups: (1) control plots, (2) fallowed plots (fallowing in the treatment combination), and (3) nonfallowed plots (treatment combinations without fallowing). Then thinning treatments, thin at year 5, thin at year 8, and no thinning were applied. Thinning was done by removing every other row. Heights and diameters were measured and survival tallied after growing seasons 1, 2, 3, 4, 5, 8, and 11.

Volumes (outside bark) were estimated by the relationship^{2/}: $\text{Volume} = 0.082395 + 0.002264 (\text{d.b.h.})^2 (\text{Height})$. To obtain plot merchantable volume per acre, the volumes of individual trees larger than 5.0 in d.b.h. (12.7 cm) were calculated, summed, and multiplied by a factor for the number of surviving trees per acre. One cubic foot (0.028 m³) per tree was subtracted to approximate the unmerchantable 3-in (7.6-cm) top. Diameter, height, survival, and volume means were evaluated by analysis of variance and Duncan's New Multiple Range test ($\alpha = 0.05$).

RESULTS AND DISCUSSION

First- and second-year weed competition on plots not fallowed came primarily from Johnson grass (*Sorghum halepense* (L.) Pers.) with heavy growth between first-year cultivations. In contrast, little Johnson grass survived in plots that had been summer fallowed and so did not offer much competition during the first growing season. The principal benefit of fallowing appears to be weed control. A companion exploratory study by Baker and Blackmon

^{2/} Formula for cottonwood volumes developed by Roger M. Krinard, Mensurationist at Southern Hardwoods Laboratory, Stoneville, Mississippi. Development procedure is on file at the Laboratory.

(1973) in which fallowing was applied without herbicide showed similar height-growth benefits to those observed in this study where trifluralin was applied. The conclusion was made that application of trifluralin contributed little to the effectiveness of the fallowing treatment in weed control.

Second-year cultivation (across all treatments) promoted greater diameter growth in years 2, 3, and 4 (Baker and Blackmon 1978), but mean diameters were not significantly different at the end of the rotation. Survival of trees on cultivated plots was significantly lower than on uncultivated plots, possibly as a result of mechanical damage to the trees. Cultivated plots averaged 10.45 in (26.54 cm) d.b.h. with 61.7% survival; uncultivated plots averaged 10.27 in (26.09 cm) d.b.h. with 66.6% survival. This would indicate little justification for second-year cultivation.

At 5 years, diameters, heights, volumes, and survival of the original 16 treatments were compared. It was shown that treatment combinations containing fallowing treatments were superior in all measured variables to plots which received no fallowing (Baker and Blackmon 1978). Since no differences were found within the fallowed treatment combinations or within the nonfallowed combinations, and latent effects were not expected, the treatments were "pooled" for the duration of the experiment.

Diameters at 11 years were influenced by both fallowing and thinning, as indicated by the treatment means in table 1. The significant relationships were complex. Ranked, mean diameters by thinning treatment were in the order of thinned at 5 years, thinned at 8 years, and not thinned--just as would be expected. Within the same thinning regime, mean diameter of trees on fallowed plots was greater than means on nonfallowed plots. Significantly smaller than all others were means on the control plots. Heights were not significantly affected by treatment, but survival was. Treatments receiving a fallow had about 19% better survival than those that did not. Rotation yield (11-year volume + thinnings) of all the fallowed plots was greater than on the plots not fallowed. The 5-year thinned treatment of each group generally yielded less than the rest of the group.

Components of total yield (including volume in standing dead trees) are illustrated in figure 1. Plots thinned at 5 years have fallen behind plots thinned at age 8 due to loss of half their productivity-base 3 years earlier. Unthinned plots had not gained an advantage over plots thinned at age 8 either; they had greater mortality and may have suffered a degree of stagnation between years 8 and 11.

Volume per area is a function of diameter, height, and stocking. Diameter is a powerful effect because volume is increased by the square of the diameter. However, diameter differences due to fallowing and even thinnings were relatively small, so that their effect on volumes was moderate. Stocking levels are usually compared as rates of survival. Differences in survival exert a more than additive effect on yield. For example, a 16% increase in survival (53% vs. 69%) would cause a 30% increase in volume, given equal tree size. Although greater diameters, heights, and survival all contributed to greater volumes in fallowed plots, survival exerted the overriding influence.

Table 1.--Mean diameters, heights, survival, and yields of plots
in an 11-year-old cottonwood plantation receiving various
soil management treatments and thinnings

Treatment	d.b.h.	Height	Survival	Yield ^{1/}
	<u>inches</u>	<u>feet</u>	<u>percent</u>	<u>feet³/acre</u>
Fallowed, not thinned	10.3 bc ^{2/}	78 ^{3/}	69 a	4196 a
Fallowed, thinned age 5	11.0 a	73	73 a	3377 b
Fallowed, thinned age 8	10.6 ab	76	73 a	4207 a
Not fallowed, not thinned	9.7 c	71	53 b	2747 c
Not fallowed, thinned age 5	10.5 ab	73	51 b	2036 d
Not fallowed; thinned age 8	10.2 bc	72	55 b	2635 cd
Control	8.7 d	73	55 b	2288 cd

^{1/} Stancing live volume at age 11 plus volume removed during thinning.

^{2/} Means in a column followed by the same letter are not significantly different by Duncan's New Multiple Range test ($\alpha = 0.05$).

^{3/} F-test was not significant.

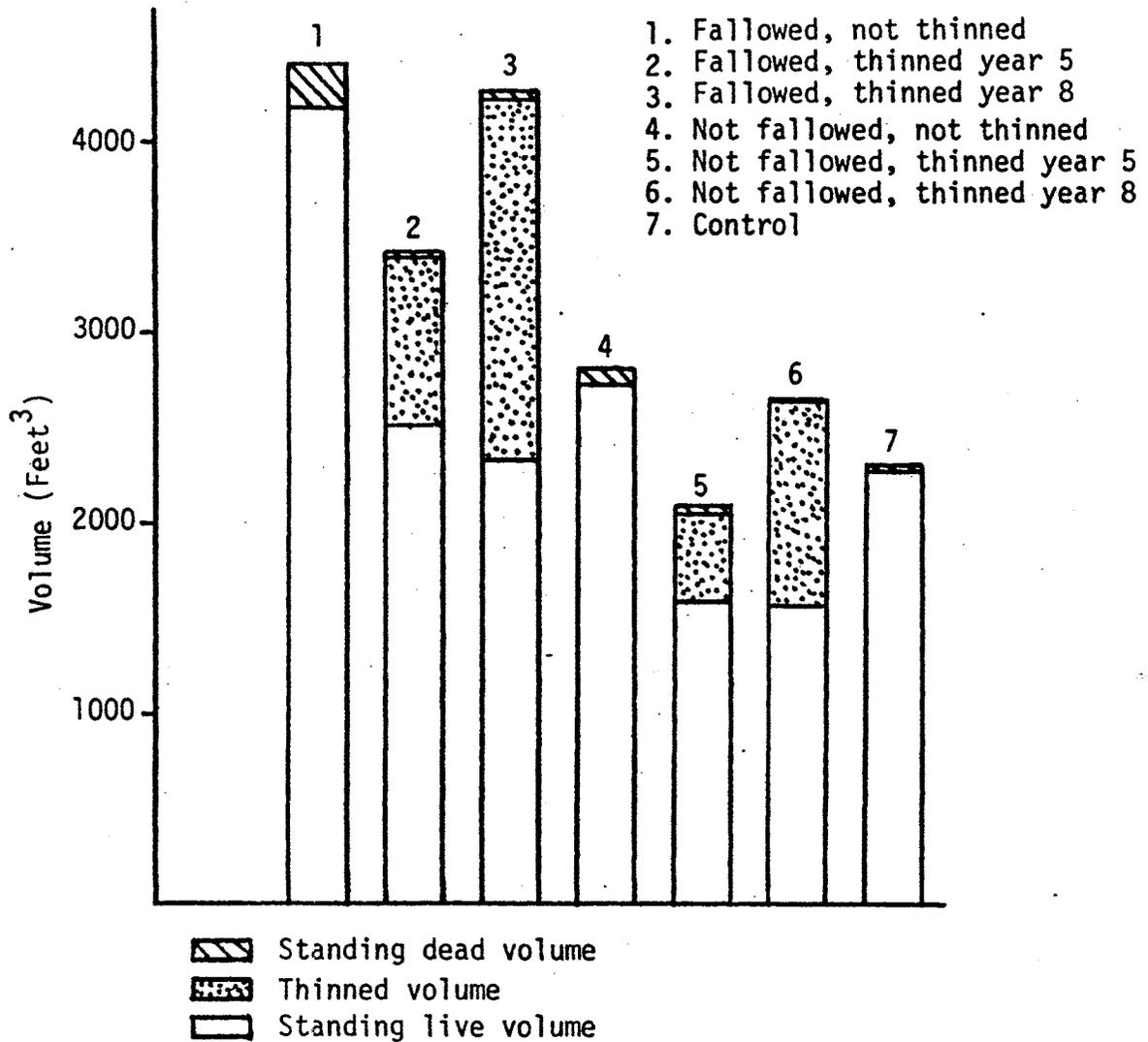


Figure 1.--Total yield at the end of an 11-year rotation of cottonwood on plots receiving site preparation and thinning treatments.

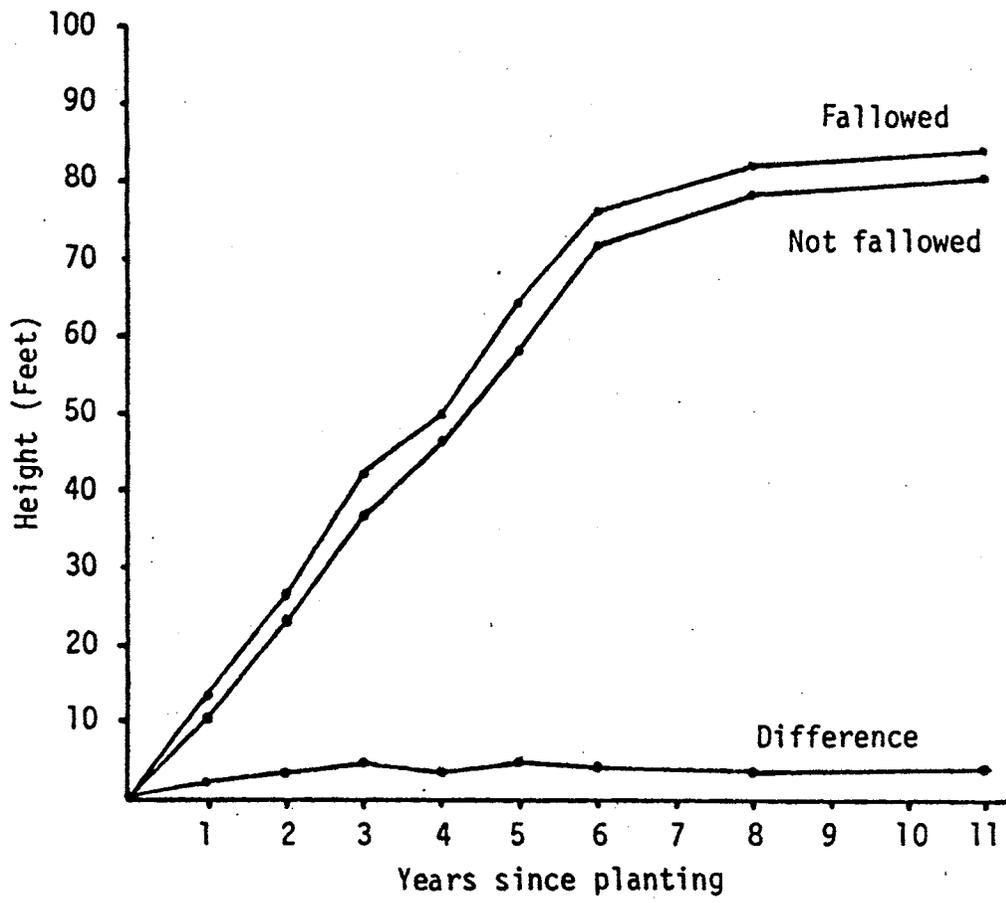


Figure 2.--Mean height of three tallest trees per plot on fallowed and unfallowed treatments. Differences between treatments are shown in lower line.

To determine if the site was lastingly improved (beyond a year or so through weed control) by the fallowing treatment, the average height of the three tallest measured trees per plot was used as an approximation of mean dominant-codominant height, since this measurement is usually considered to be independent of stocking and thus should not be confounded by differences in survival. At 11 years, there was a significant difference between fallowed plots (84 ft, or 25.6 m) and plots not fallowed (80 feet, or 24.4 m). Figure 2 illustrates that the majority of the difference originated in the first and second years. Differences in d.b.h. arose during the first 3 years (Baker and Blackmon 1978). Differences in survival due to fallowing were already in place by the first-year tally. Fallowed plots averaged 85% survival compared to 71% for unfallowed plots. By year 11, the survival rates were 71% and 54% respectively.

CONCLUSIONS

Fallowing has been shown to be a practical and effective procedure for establishing and growing cottonwood on old fields. Increased yield was realized mainly through better overall survival, probably as a result of better first-year weed control. Second-year cultivation was not beneficial. On an 11-year rotation, plots thinned at 5 years yielded considerably less than plots thinned at 8 years or those left unthinned.

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