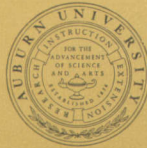


The NECESSITY for
INTENSIVE CULTURAL TREATMENT
in COTTONWOOD PLANTATIONS



AGRICULTURAL EXPERIMENT STATION
AUBURN UNIVERSITY

E. V. Smith, *Director*

Auburn, Alabama

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The Necessity For Intensive Cultural Treatment in Cottonwood Plantations

MASON C. CARTER and E. H. WHITE¹

FAILURE TO APPLY intensive cultural treatments in cottonwood (*Populus deltoides* Bartr.) plantations usually results in complete failure of the planting. McKnight and Biesterfeldt (11) have recently reviewed the cultural practices in general use in cottonwood production but placed little emphasis on mineral nutrition and chemical weed control. These subjects will be emphasized in the following discussion.

FERTILIZATION

A suitable² site for cottonwood may need no fertilizer, but for an unsuitable site, the amount needed is undetermined. Cottonwood removes 2 to 5 times as much soil nutrients as loblolly pine per pound of dry matter, Table 1. But soils suitable for cottonwood usually contain much higher levels of available nutrients than soils from pine lands of the Coastal Plain, Table 2.

In greenhouse studies, Blackmon and Broadfoot (4) found that lime and NPK improved growth of cottonwood on a Bibb soil of Coastal Plain origin, but growth was well below that on unfertilized Delta soils. Similar results were observed in the field.

Cottonwood was planted on a moist stream-bottom site with local alluvium derived mainly from a Norfolk sandy loam. The site was well prepared and fertilizer and weed control treatments carefully applied. Trees responded to these treatments and at the end of the first growing season, tree height averaged 8.3 feet on fertilized and cultivated plots compared to 3.3 feet on the control

¹ Alumni Associate Professor, Department of Forestry, Auburn University and Assistant Professor, Department of Forestry, University of Kentucky, respectively.

² Soil suitability for cottonwood is described by Broadfoot (5).

TABLE 1. TYPICAL NUTRIENT CONTENTS OF ABOVE GROUND PARTS OF A COTTONWOOD AND A LOBLOLLY PINE WEIGHING APPROXIMATELY 200 POUNDS¹

	Cottonwood	Loblolly Pine	Ratio C/Lob
	<i>Lb./tree</i>	<i>Lb./tree</i>	
N.....	0.57	0.25	2.3
P.....	0.13	0.03	4.3
K.....	0.46	0.18	2.6
Ca.....	1.03	0.20	5.2
Mg.....	0.11	0.06	1.8

¹ Cottonwood data from White (16); loblolly pine data from Metz and Wells (13).

area. Foliar concentrations of N, P, and K were increased significantly by treatment, Table 3. However, calcium levels were not increased even where 2,500 pounds per acre limestone was disked into the soil prior to planting. The calcium levels were well below the average for good cottonwood sites, Table 4, and this could have been the critical factor. Trees on the best plots averaged only 2 feet of growth during the next 2 years. Unless fertilization and cultivation are continued, the plantation will not reach merchantable size. Several other cottonwood plantings established on small stream bottoms in the Coastal Plain were observed. With cultivation, growth was usually good the first year but after 3 to 4 years the cottonwood had all but disappeared.

Soils strongly acid (below pH 5.0) and/or low in exchangeable calcium (less than 1,000 p.p.m.) should not be planted to cottonwood unless heavy applications of lime are applied.

Fertilization is not widely used in cottonwood plantations on suitable sites but it may be a profitable practice. Merritt and Bramble (12) reported increased growth following fertilization and Bhagwat (3) found that fertilization, particularly with nitrogen, increased specific gravity, fiber length and double-wall thickness in cottonwood.

White, (16) studied five natural stands and three plantations

TABLE 2. COMPARISON OF AVAILABLE NUTRIENTS IN THE 0-6" LAYER FOR A COASTAL PLAIN AND A DELTA SOIL¹

	Sharkey clay	Ruston sandy loam	Ratio S/R
pH.....	6.0	5.2	---
O.M.....	5.6%	0.8%	7
P.....	31 p.p.m.	2 p.p.m.	15
K.....	312 p.p.m.	43 p.p.m.	7
Ca.....	5,640 p.p.m.	200 p.p.m.	28
Mg.....	156 p.p.m.	36 p.p.m.	4

¹ Data taken from Anonymous (1).

TABLE 3. EFFECT OF CULTIVATION AND FERTILIZATION ON FOLIAR NUTRIENT CONCENTRATION AND HEIGHT GROWTH OF COTTONWOOD PLANTED ON AN ALLUVIAL COASTAL PLAIN SOIL. FOLIAGE SAMPLED AFTER FIRST GROWING SEASON

	N	P	K	Ca	Mg	Height	
						1 yr.	3 yr.
	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Ft.</i>	<i>Ft.</i>
Not cultivated							
not fertilized.....	1.37	0.34	1.24	0.84	0.26	3.3	4.3
Fertilized ¹	2.23	0.41	1.22	1.01	0.36	6.2	8.3
Cultivated ²	2.43	0.52	2.20	0.79	0.27	5.0	5.2
Cultivated ¹ and fertilized ²	2.94	0.62	1.90	0.97	0.35	8.3	10.4

¹ 2,500 lb./A. agricultural grade dolomitic limestone, 700 lb./A. 0-14-14, 300 lb./A. ammonium nitrate.

² Herbicide application in bands, disking between rows.

along the lower Alabama and Tombigbee rivers and found the average height at age 6 years varied from 32 to 66 feet. When soil physical and chemical properties were related to tree growth, soil potassium levels were found to be positively correlated with tree growth. Foliage concentrations of potassium and calcium were also positively correlated with growth while phosphorus levels were negatively correlated. The range of foliage concentrations observed by White (16) and critical levels are shown in Tables 4 and 5. These data were derived from a small number of plots over a restricted part of the range of cottonwood and they must be tested over a wide range of soil and climatic conditions before their reliability can be assessed. However, the data suggest that fertilization may be beneficial even on good cottonwood sites. Unfortunately, fertilization, particularly with nitrogen, will stimulate the competition and increase the problem of weed control. If nitrogen applications could be delayed until the second growing season or later, the problem of stimulating competition might be avoided.

On polder soils in Holland, the water table is maintained at 36 inches and levels of all nutrients except nitrogen are adequate

TABLE 4. RANGE OF NUTRIENT LEVELS IN COTTONWOOD STANDS GROWING ON ALABAMA AND TOMBIGBEE RIVER FLOOD PLAIN¹

	N	P	K	Ca	Mg
	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>
Upper crown	1.64-2.44	.17-.22	1.05-1.60	1.56-2.30	.18-.32
Lower crown	1.46-2.32	.17-.22	0.89-1.34	1.83-3.45	.21-.40

¹ Figures represent averages for stand. A total of eight stands sampled. White (16).

TABLE 5. SUGGESTED CRITICAL LEVELS OF FOLIAR NUTRIENTS FOR COTTONWOOD IN ALABAMA¹

Element	Concentration	Position
	<i>Pct.</i>	
N.....	2.00	Lower crown
P.....	0.17	Lower crown
K.....	1.30	Lower crown
Ca.....	2.20	Upper crown
Mg.....	0.18	Upper crown

¹ Based on White (16).

for the production of hybrid poplar, van der Meiden (15). However, if nitrogen fertilizer is applied, the poplars suffer from competition. Therefore, alder (*Alnus* sp.), a nitrogen fixing plant, is planted between the rows of poplar. The poplars obtain the nitrogen they need from the alder without suffering from competition. It is questionable that such success could be obtained on sites where the water table is not regulated and alder and poplar competed for moisture.

WEED CONTROL

Weeds compete with cottonwood not only for light and moisture, but for nutrients as well. In Table 3 it is shown that cultivation increased foliage nutrient levels as much as fertilization. Cottonwood is very intolerant of such competition and intensive cultivation is required for successful plantation establishment. Mechanical weed control is practiced on most commercial plantings, but, on some sites, chemical weed control may be applied successfully with a cost savings over mechanical methods.

Cottonwood is tolerant of a number of effective herbicides, Martin and Carter (10) but chemical weed control has not proven effective in some instances, Krinard (9). Clay soils and/or the presence of johnsongrass (*Sorghum halepense* L.) were the primary causes of the poor performance of herbicides in several trials.

Preemergence herbicides are designed to function on or very near the soil surface. Johnsongrass propagates by seed and rhizome sprouting. The seedlings are controlled effectively by any one of several herbicides. But shoots originating from rhizomes are highly resistant to preemergence herbicides. Rhizome johnsongrass should be eliminated prior to planting by repeated plowing during late summer and fall. Seedling johnsongrass may then be controlled by the application of preemergence herbicide.

Clay soils such as Sharkey and Alligator greatly complicate chemical weed control. Clays bind most herbicides and necessitate the use of higher rates than those used on lighter soils. Also, clay soils shrink and crack as they dry. These soils are usually wet in the late winter or spring when herbicides are normally applied. As the soil dries and cracks, untreated soil is exposed and weed seed germinate and grow from the fissures.

Unfortunately, clay soils infested with johnsongrass are common throughout much of the Delta. On such sites, mechanical weed control may be the only satisfactory method, and the improvement in physical properties resulting from cultivation may be nearly as important as weed control. But on medium to light textured soils where annual weeds and grasses are the primary competitors, herbicides may be quite useful.

The most effective compounds tested by Auburn's researchers are simazine (2-chloro-4,6-bis-(ethylamino)-s-triazine) and prometryne (2,4-bis(isopropylamino)-6(methylthio)-s-triazine). Rates may vary from 2 pounds per acre on light soils to 6 pounds per acre on heavy clays and the sprays may be applied directly over dormant cuttings.

Preemergence herbicides should be applied to bare soil. Many failures of herbicides in forest plantings result from weeds present at time of treatment. When weeds are barely visible, they have already passed their most sensitive stage. Unless the planted site has been cultivated within a few days of treatment a contact herbicide should be applied along with the preemergence compound. Paraquat (1,1'-dimethyl-4,4'-bipyridinium ion), MSMA (monosodium methanearsonate), and amitrole (3-amino-s-triazole) are all effective when used as directed. Amizine, a mixture of simazine and amitrole has been used quite effectively in cottonwood plantings, Merritt and Bramble (12). Contact herbicides should not be applied to foliage or buds of cottonwood since they may injure the plant. They may be applied from the side as a directed spray or over the row using shields to protect the cottonwood.

Once the preemergence herbicide is applied, the soil should not be disturbed. Another common cause of herbicide failure has been the covering or turning under of the thin layer of herbicide treated soil.

Broadcast herbicide treatments have not been tested by the Agricultural Experiment Station, but banded herbicide plus disking the untreated soil between the rows results in better growth

than band treatment alone. Disking not only controls weeds but also improves physical properties of the soil.

Time of application will influence persistence of the herbicide and effectiveness of weed control. Preemergence herbicides applied at planting in mid-winter are subjected to several weeks of leaching and degradation before weed species begin rapid growth. Best results have been obtained with amizine, a contact plus a preemergence herbicide, applied in 4- to 5-foot bands when weeds are 2 to 3 inches tall using shields to protect cottonwood foliage. Amizine at 10 pounds per acre (4.5 pounds per acre simazine) has given satisfactory weed control throughout the first growing season on Alabama sites. On more fertile Delta soils, it may be necessary to repeat the treatment in mid-summer.

The list of herbicides registered for use in forest operations is subject to frequent revision and careful reading of the label should precede the use of any of the materials mentioned in the preceding discussion.

ANIMAL DEPREDATION

A recent study, Anthony (2) revealed that *Populus tremuloides* Michx. chipped into silage was 40 per cent digestible by cattle. This is an unusually high digestibility for a tree species. However, deer and cattle were already aware of the palatability of *Populus deltoides* Bartr.

In areas where cattle are present, cottonwood plantations must be well fenced to exclude cattle. Cattle completely destroyed 100 acres of planted cottonwood which were not exposed to the cattle until the end of the first growing season when the tree height averaged 6 feet.

Deer browse is generally more difficult to cope with than cattle browse. Repellants have not proven effective except in a few areas with relatively low deer populations. Costs of wire or electrified fences are prohibitive. McKnight and Biesterfeldt (11) report that brush fences built with debris produced during site preparation are effective and can be constructed at a reasonable cost.

Beavers sometimes damage young cottonwood plantings. Felling young trees or stripping the bark may not be extensive enough to justify control measures. But flooding caused by dam construction is another matter and control measures are necessary when extensive flooding occurs. Trapping is the most effective

tive method of beaver control available and wildlife research personnel at Auburn University have discovered an attractant which they hope will increase the efficiency of trapping operations.

INSECT AND DISEASE PESTS

Experience indicates that insect and disease problems are inversely related to tree vigor. On poor sites or where competition is intense, cottonwood will be severely damaged by insects and disease. But on good sites with vigorous trees only twig borers (*Gypsonoma hainbachiana* Kearfott) and cottonwood leaf beetles (*Chrysomela scripta* F.) generally cause damage. At present there are no insecticides registered for use on cottonwood but research on some of the newer bio-degradable compounds is in progress and, hopefully, there will be some recommended materials available in the near future.

INTERMEDIATE TREATMENTS

After the first growing season, little cultural treatment is needed on good sites. On poor sites cultivation may be required during the second growing season and repeated fertilization may be necessary.

On short rotations, 10 years or less, thinning may not be necessary if proper spacings are used. For longer rotations, thinning is advisable to maintain the stand in a vigorously growing condition. McKnight and Biesterfeldt (11) recommend thinning when basal area reaches 80 square feet per acre with 50 to 60 square feet per acre being left as growing stock. These values will no doubt vary with site quality in a manner similar to pine and other tree species. Good sites can carry a higher stocking than poor sites and maintain the same rate of return.

TREE IMPROVEMENT

An intensive tree improvement program is needed for cottonwood. The flowering characteristics of cottonwood lend themselves to genetic improvement research and the species propagates easily from stem cuttings, Farmer (6). Farmer and Wilcox (7) found that the specific gravity of cottonwood in the lower Mississippi Valley ranged from 0.32 to 0.46 and averaged 0.38. Thus, a considerable increase in specific gravity may be possible through selection and vegetative propagation alone.

Jones and Curlin (8) found considerable variation in response to nitrogen fertilization among clones. Thus, it may be possible to develop clones that are highly responsive to fertilizer.

While extensive natural stands of cottonwood are rare outside the major river flood plains, occasional trees can be found growing well on dry or infertile soils. It may be possible to develop clones adapted to soils of low fertility or low soil calcium and thus extend the intensive production of the species to less fertile sites. Randall and Mohn (14) have reported that clone site interactions do occur.

Breeding for resistance to insects and disease is possible. Farmer (6) reported that he found clones highly resistant to melamsora rust. It would be a considerable advance if cottonwood distasteful to deer could be developed.

Wild populations of cottonwood on good sites will equal the growth of the hybrid poplars in Europe where they have been selecting and breeding poplars for more than 40 years. Thus a well conducted tree improvement program may produce cottonwood clones with an astonishing growth rate. The Forest Service recently announced³ development of a new strain of cottonwood clones which have shown a superior performance in test plantings. Limited supplies of cuttings should be available for commercial planting by 1972.

SUMMARY

Intensive culture of cottonwood is still in its infancy and confined to a relatively small portion of the forest in the South. The exploding population and shrinking forest acreage will increase the need for a timber species capable of high production under intensive culture. As knowledge and techniques of propagation and cultivation improve, and more is learned about moisture and nutrient requirements, as improved clones or varieties become available, it is believed that there will be more intensive and extensive production of cottonwood.

Unless cottonwood is maintained at a vigorous rate of growth, competition and predators will not just retard but completely eliminate it. There can be no halfway measures. Intensive culture is necessary for satisfactory production.

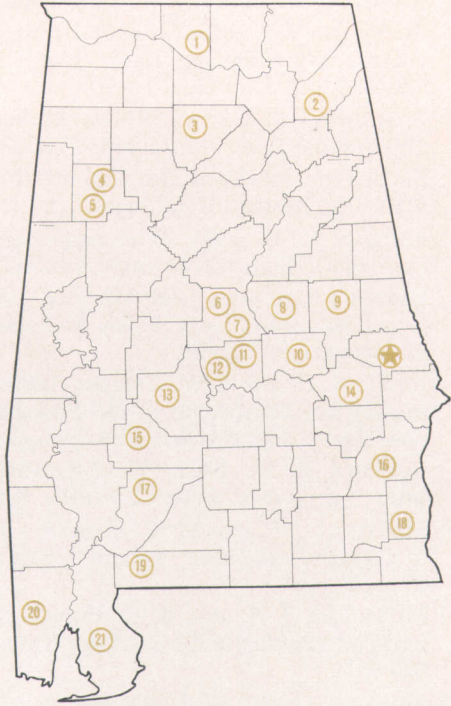
³ See cover story, *J. of Forestry*, March, 1970.

LITERATURE CITED

- (1) ANONYMOUS 1959. Certain Properties of Selected Southeastern United States Soils. Southern Regional Bulletin 61. Va. Agr. Exp. Sta.
- (2) ANTHONY, W. B. 1970. Private Communication.
- (3) BHAGWAT, S. G. 1967. A Study of the Effects of Nitrogen, Phosphorus, and Mulching on the Wood Anatomy of *Populus Deltoides*. March. Ph.D. Diss. S.I.U.
- (4) BLACKMON, B. G. AND W. M. BROADFOOT. 1969. Lime, Fertilizer Cottonwood Tests. Mississippi Farm Research. 32(7):6, 8.
- (5) BROADFOOT, W. M. 1964. Soil Suitability for Hardwoods in the Mid-south. USFS Res. Note So-10. 10 pp.
- (6) FARMER, R. E. 1965. Tree Improvement in Cottonwood. Southern Conference Forest Tree Improvement. pp. 49-51.
- (7) FARMER, R. E. AND J. R. WILCOX. 1965. Specific Gravity Variation in a Lower Mississippi Valley Cottonwood Population. Third Forest Biology Conf., TAPPI.
- (8) JONES, H. C. AND J. W. CURLIN. 1968. The Role of Fertilizers in Improving the Hardwoods of the Tennessee Valley. In Forest Fertilization-Theory and Practice TVA Symposium. pp. 185-190.
- (9) KRINARD, R. M. 1964. Weed Control Trials in Cottonwood Plantations. Information Sheet 854. Miss. State Univ. Agr. Exp. Sta.
- (10) MARTIN, J. W. AND M. C. CARTER. 1966. Tolerance of Cottonwood to Certain Herbicides. Auburn University (Ala.) Agr. Exp. Sta. Bull. 372. 20 pp.
- (11) MCKNIGHT, J. S. AND R. C. BIESTERFELDT. 1968. Commercial Cottonwood Planting in the Southern United States. J. of Forestry. 66(9): 670-675.
- (12) MERRITT, C. AND W. C. BRAMBLE. 1966. Poplar Plantation Research in Indiana—A Five-Year Report. Purdue University Agr. Exp. Sta. Res. Bull. 818. 15 pp.
- (13) METZ, L. J. AND C. G. WELLS. 1965. Weight and Nutrient Content of the Above Ground Parts of Some Loblolly Pines. USFS Res. Paper SE-17. 20 pp.
- (14) RANDALL, W. K. AND C. A. MOHN. 1969. Clone-site Interactions of Eastern Cottonwood. Proc. Tenth So. Conf. For. Tree Imp. pp. 89-91.
- (15) VAN DER MEIDEN, H. A. 1967. Private Communication.
- (16) WHITE, E. H. 1969. Nutrient and Dry Matter Relations in Young Stands of *Populus Deltoides* Bartr. Ph.D. Diss. Auburn University. 101 pp.

AGRICULTURAL EXPERIMENT STATION SYSTEM OF ALABAMA'S LAND-GRANT UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



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★ Main Agricultural Experiment Station, Auburn

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.