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The Decline and Mortality of Cottonwood Clone Stoneville 124 on a Clay Soil

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SUMMARY

A decline sequence involving multiple factors was proposed as the cause of death and diminished crowns of **12-year-old** cottonwood planted on a clay site. Stoneville clone 124, of which the plantation was formed, has proved to be poorly adapted to clay soils. Rates of death and weakened crowns were shown to be related to minor elevation differences within the plantation, the higher, drier areas being the most affected. Finally, several weak pathogens, including ***Phomopsis macrospora***, apparently participated in weakening and ultimately killing the trees.

Additional keywords: ***Populus deltoides, Phomopsis*** *macrospora,* twig canker.

INTRODUCTION

Cottonwood (***Populus deltoides*** Bartr. ex Marsh.) grows naturally on clay soils in the South when disturbances allow its establishment. Those few cottonwood trees that survive early competition can **outpace** other local species and often attain heights of 100 feet or more. Stoneville select clone 124 (ST-l **24),** observed in this study, had received favorable review, its growth being similar to 13 other superior clones on Sharkey clay at 5 years old (Mohn and others 1970). However, Krinard and Kennedy (1983) found ST-1 24 inferior to ST-66 and ST-67 in both growth and survival at 10 years and on the same soil type. This paper features observations of tree growth and decline of a cottonwood plantation of clone ST-124 on a clay site-the same Sharkey **series—** through age 12. Also reported here are the principal biological and edaphic factors which we believe contributed to the decline.

THE PLANTATION

In January 1973, a **15-acre** area on the Delta Experimental Forest, Stoneville, Mississippi, was planted with **20-inch** cuttings of cottonwood select clone Stoneville 124. The site had been cleared of an **elm-ash-**sugarberry stand (SAF type **93),** and the slash was piled and burned. The site was **disked** prior to planting and disk cultivated three times during the first growing, season to control weeds. The soil was a Sharkey clay, a member of the montmorillonitic, thermic family of the Vertic Haplaquepts. The initial spacing was 10 by 10 feet. At the end of the third growing season, every other row was removed, increasing the spacing to 10 by 20 feet. A selective thinning after the 8th growing season removed weak or dying trees and reduced the stand to 128 trees per acre.

A **4.4-acre** portion of the plantation was chosen for study. Measurements of diameter (dbh) and height were made after 1, 2, 3, 4, 8, and 12 growing seasons. The progression of average heights and diameters is illustrated in figure 1. Cottonwood of ST-1 24 growing on Sharkey clay in a clonal trial’ averaged 44 feet high and 6.1 inches dbh at 14 years old. On Commerce soil (silty clay loam texture) a few miles away, it averaged 96 feet and 15.5 inches dbh at the same age. The cottonwood in the study reported in this paper grew rapidly for the first 4 years, then grew much slower, especially in height. During the latter part of the 12th growing season, it was recognized that the plantation was in serious trouble; more than 40 percent of the trees were dead, dying,

[1] **Unpublished** data on file at the Southern Hardwoods Laboratory, Southern Forest Experiment Station, Stoneville, Mississippi.

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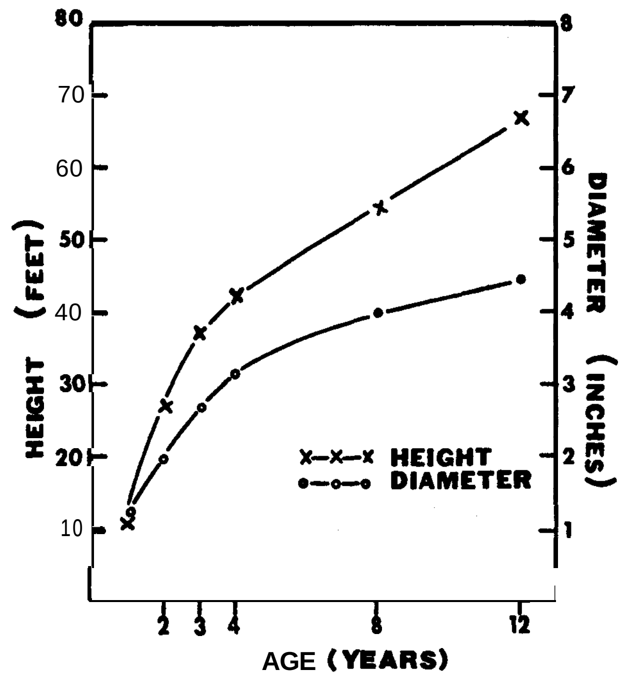

Figure 1 .-*Average diameter and height of a cottonwood plantation of* clone Stoneville 124 at ages *1* through 12.

or seriously weakened. Each tree was rated as healthy, thin crown (many twigs and limbs dead), top dead (at least the upper 3 feet), or standing dead.

The first symptoms of decline were decreased crown vigor and size. Closer inspection revealed numerous twig cankers that resulted in twig dieback. The dieback progressed to involve larger limbs. The entire top sometimes died and broke off. Stem and branch cross sections showed dark stained zones of wood associated with cankers. Epicormic branches sometimes developed on the lower bole and died in turn.

Because weak and dying trees seemed less common in the lower-lying areas of the plantation, the area was surveyed and the health groups compared to elevation. Elevations are relative to a benchmark at the southwest corner of the plantation and varied about 6 feet from the high to low areas. The effect of elevation is illustrated in table 1 where the trees are separated by health categories and divided into four convenient elevation groups. Note how the proportion of weakened and dead trees drops off as elevation decreases. Percent of the trees that were healthy at each elevation (.5-foot interval) was regressed on change in elevation below the benchmark. The following model was used:

$$Y = a + b_1X + b_2X^{.5}$$

where

Y = % in health class, Arcsin-transformed and
X = feet elevation relative to benchmark.

Elevation significantly (α = .05) predicted the proportion of healthy trees. The coefficient of multiple determination for percent in the "healthy" class was .82 with a coefficient of variation (CV) of 14.47%.

Soil cores were collected from a high elevation, high mortality area and a low elevation, mostly healthy area. There was no discernible difference between the two profiles in color, mottling, structure or texture (feel method). The same pH (5.9) was found at 6 inches and almost the same pH at 18 inches depth (high = 6.3; low = 6.1) in both profiles.

Pieces of tissue, about 0.1 cubic inch, were removed aseptically from root, stem, and branch samples of affected trees in a high elevation area of the plantation and cultured in the laboratory at room temperature on potato dextrose agar. Cultures were examined microscopically and identified. ***Phomopsis macrospora*** Kobayshi & Chiba was isolated from all the twig cankers sampled. ***Fusarium solani*** (Mart) Snyder and Hans. and a ***Penicillium*** sp. were also isolated from twig samples, but they occurred less frequently (5-20%) than *Phomopsis*. ***Botryodiplodia theobromae*** Pat. was recovered from root and stem tissues. An unidentified basidiomycete and *Bacillus* sp. were isolated from root tissues showing necrosis and decay. All cottonwood trees in the area are slightly to moderately affected annually by one or more common leaf diseases caused by ***Melampsora*** *medusae* Thum, ***Septoria musiva*** Peck, and ***Phyllosticta*** sp.

Table 1.—*Numbers of 12-year-old cottonwood trees per acre in four health categories across an elevational gradient on a 4.4-acre tract*

Health category	Feet drop below benchmark				
	Cl.0	1.0	1.5–2.0	>2.0	Total
	number of trees per acre				
Healthy	15.7	16.8	15.7	17.5	65.7
Thin crown	7.3	7.0	8.4	2.7	25.4
Top dead	6.4	3.0	.9	.9	11.2
Standing dead	4.8	2.5	2.0	.7	10.0

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DISCUSSION AND CONCLUSIONS

The only substantial environmental difference, identified across the gradient from the healthy to poor areas was elevation. Elevation is the determinant of flooding depth after winter and spring rains and presumably determines water table depth during the early to mid-growing season. Clay soils can hold a large percentage of water, but they hold it tightly and release it slowly. Root absorption of moisture is especially difficult in the subsoil where roots only penetrate between the large soil peds. A few extra days of root contact with free water-rather than having to draw water from the large subsoil peds- may give a slight advantage in growth to the lower elevation trees.

Mortality was first noticed in year 8. Although casual organisms were not diagnosed at that time, twig cankers were present and *P. macrospora* was later isolated from similar cankers, When the plantation was thinned after growing season 8, all dead and most seriously weakened trees were removed. The current standing dead trees have died since thinning. Because some of these trees appeared to be in their second year after mortality, it would seem that trees can progress from relatively good health to death in 2 years or less.

Studies by Filer (1967) show that *P. macrospora, F. solani,* and other fungi can infect cottonwood trees and cause cankers and mortality. However, the size of the cankers and mortality depend upon the quality of the site on which the tree is growing and upon environmental conditions during the attack. Above normal temperature and rainfall during the fall were believed to encourage disease development on poor sites.

A single cause could not be established for the decline and mortality of ST-124 on the clay site in this report. Numerous theories for tree declines have been proposed; however, the decline syndrome (Manion 1981), which involves several factors acting together, appears to be the most appropriate approach to an understanding of the decline and mortality of cottonwood on these sites.

A combination of factors is believed to account for this example of decline and mortality of ST-124 on a clay site. The principal factors appear to be the unsuitability of this cottonwood clone to the clay soil site; the unavailability of water for a part of each year related to minor differences in elevation on the site, stress each year from leaf disease and insects, a drought during the summers of 1980 and 1982, and attack by one or more canker fungi. The results of this planting suggest that ST-1 24 is at risk to develop decline symptoms and high mortality when these clones are planted on clay soils, especially better drained ridges. No doubt many other clones would also fail for the same reasons if planted on clay. One assurance of acceptable growth and survival on clay soils might be obtained by testing clones through the chosen rotation age.

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