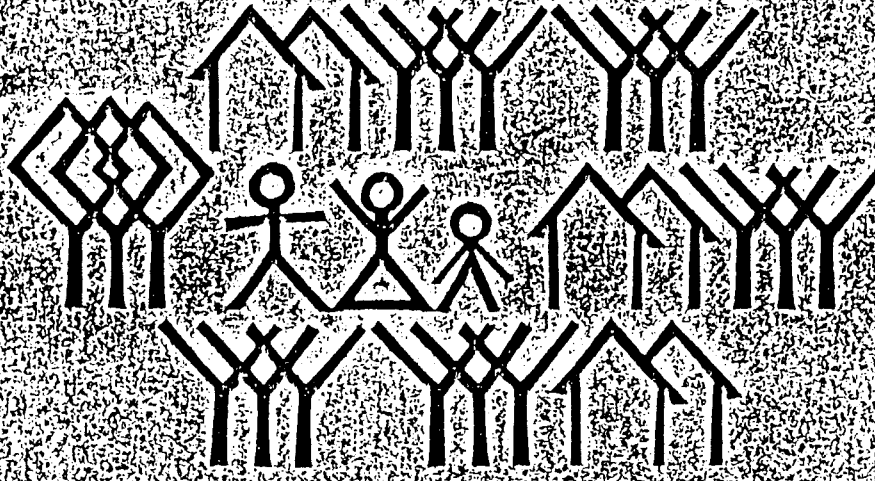
Trees and Forests for Human Settlements



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ANTIBIOTIC INJECTIONS CONTROL ELM PHLOEM NECROSIS IN THE URBAN ECOSYSTEM

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ABSTRACT

When nine American and cedar elms showing symptoms of elm phloem necrosis were given repeated injections of tetracycline antibiotics for several years, all treated trees recovered and appeared healthy by 1976. All but one of the untreated checks died. Of 10 severely infected American elms treated only during the summer of 1972, seven died and the other three showed severe symptoms by 1976, indicating that treatments must begin early and must be continued annually.

INTRODUCTION

Since 1947 researchers have reported that antibiotics control certain yellow diseases (Stoddard, 1947; KenKnight, 1955; Davis et al., 1968; Freitag and Smith, 1969). At first other workers were skeptical because most believed these diseases were incited by viruses. But in 1967 mycoplasma, group-like microorganisms, were linked to such diseases as mulberry dwarf, potato witches'-broom, aster yellows, and Paulownia witches'-broom (Doi et al., 1967) and later to many other yellow diseases (Grandados et al, 1968; Harrison and Roberts, 1969; Story and Halliwell, 1969; Davis and Whitcomb, 1970). Various chemicals have been used to control mycoplasma related diseases, but none appear better than tetracycline (Asuyama and Iida, 1973). Tetracycline antibiotics were used in 1967 to suppress mulberry dwarf disease (Ishiie et al., 1967). Oxytetracycline has been approved by the Environmental Protection Agency as a chemical control of lethal yellows of palms in Florida (McCoy, 1972). Other formulations of tetracycline can also suppress symptom development.

Mycoplasma were first identified in the phloem of diseased elms in 1972 (Wilson et al., 1972). Even before positive identification, control of the disease with tetracycline was attempted in Mississippi (Filer, 1973b) because the symptoms fit the classical pattern of yellow diseases (Doi et al., 1967). The Mississippi test has now yielded 5 years' data, and the results reported here indicate tetracycline antibiotics show promise as controls of elm phloem necrosis.

MATERIALS AND METHODS

All test trees were growing in urban areas in the vicinity of Greenville, Miss.

In June 1970, four 50-year-old American elms (Ulmus americana L.) 30 to 40 inches in d.b.h. were selected in a residential area where phloem necrosis had caused mortality the previous year. All trees were growing within a 40,000 ft^2 area on good soil and received adequate moisture. Two trees had symptoms of phloem necrosis, and two exhibited no symptoms. The tree selected to receive the tetracycline antibiotic had a thin crown and butterscotch-colored phloem that smelled of wintergreen. Another tree with these symptoms and two symptomless trees received no antibiotics. The tetracycline was administered through the tree trunk by gravity-flow injection as described by Filer (1973b). The tree received 1,000 mg of tetracycline in a liter of water 10 times at intervals of 7 to 10 days during June, July, and August.

In 1971, the elm treated in 1970 received eight applications of 2,000 mg of tetracycline at 14-day intervals from June through September. In addition, three new American elms and two cedar elms (U. crassifolia Nutt.) were treated with chlortetracycline at different intervals and rates (Table 1). All five treated trees showed disease symptoms before treatment. Three healthy cedar and two healthy American elms served as untreated checks.

Table 1. Elms treated with chlortetracycline and tetracycline antibiotics in 1971 to suppress elm phloem necrosis.

Species	DBH	Treatment intervals	Rate per application	Total for year	Antibiotic
	inches		*mg*		
American elm	33.0	1 application	2,000	2,000	Chlortetracycline
Cedar elm	19.0	Biweekly	2,000	6,000	Chlortetracycline
American elm	8.0	Biweekly	2,000	6,000	Chlortetracycline
Cedar elm	7.0	Biweekly	1,000	7,000	Chlortetracycline
American elm	15.0	Biweekly	1,000	7,000	Chlortetracycline
American elm 1/	33.0	Biweekly	2,000	16,000	Tetracycline

1/ Treated tree from 1970 test.

In June 1972, six more cedar elms were added to the test. Three were treated with oxytetracycline, and three were used as untreated checks (Table 2). Treatments of previous years were continued as described in Table 1.

Table 2. Amounts of oxytetracycline applied to cedar elms in 1972.

DBH (inches)	Date			
	6/28	7/7	8/4	8/11
	mg			
18.7	1,400	2,000	2,000	2,000
20.5	2,000	2,000	2,000	2,000
9.6	1,000	1,000	1,000	1,000

In 1973, six cedar elms and three American elms were treated with oxytetracycline at various dates and rates (Table 3). All the trees except one cedar elm had been included in previous years' treatments; one American elm from earlier tests was omitted because of a change in ownership. Instead of gravity-flow injection, a pressure injection system (Filer, 1973a) was used to speed application. Before and after treatment, trees were assigned to various health classes: (1) no leaf symptoms, (2) few wilted leaves, (3) few wilted and dead leaves, (4) branch dead, and (5) several branches dead.

Trees treated in 1973 were rated and treated again in 1974 (Table 4). The antibiotic was applied monthly from budbreak until the total milligrams for the season was injected.

In a separate experiment, 10 American elms on the state capitol grounds at Jackson, Miss., were treated with tetracycline by gravity-flow injection in April and July 1972 (Table 5). A pressure injection system (Filer, 1973a) was used for the final application in October 1972.

RESULTS AND DISCUSSION

All the Greenville trees treated during the 5 years appeared healthy by spring 1976. The infected American elm treated with tetracycline in summer 1970 showed dieback symptoms on 1 percent of the crown the following fall. By late spring 1971, these symptoms occurred in 25 percent of the crown, but the tree recovered fully within 12 weeks after treatments resumed and produced an excellent seed crop. One cedar elm developed severe phloem necrosis symptoms

Table 3. Elms treated for phloem necrosis with oxytetracycline in 1973. [1/]

Species	DBH	Dates treated 4/8	5/8	6/10	7/18	8/8	9/10	Total antibiotic
	inches	*mg*						
American elm	8.0	750 (1)		(1)		(1)		750
Cedar elm	9.0	750 (1)	750	(1)		(1)		1,500
Cedar elm	10.0	(1)		(1)	2,000	2,000 (1)		4,000
Cedar elm	18.0	3,000 (2,4)		(4)	3,000	3,000 (1,4)		9,000
Cedar elm	19.0	3,000 (1)	3,000	3,000 (1)	3,000	(1)		12,000
Cedar elm	20.0	750 (1)	750	750 (1)	750	(1)		3,000
Cedar elm	7.0	1,500 (1)		(1)		(1)		1,500
American elm	15.0	1,500 (1)	1,500	1,500	1,500	(1)		6,000
American elm	32.0	3,000 (1)	3,000	3,000 (1)	3,000	3,000 (1)	3,000	18,000

Table 4. Elms treated for phloem necrosis with oxytetracycline in 1974. [1/]

Species	DBH	Dates treated 4/16	5/16	6/17	7/15	8/15	9/16	Total antibiotic
	inches	*mg*						
American elm	8.0	750 (1)					(1)	750
Cedar elm	9.0	750 (1)	750				(1)	1,500
Cedar elm	10.2	2,000 (1)	2,000				(1)	4,000
Cedar elm	18.0	3,000 (3,5)	3,000	3,000			(1,5)	9,000
Cedar elm	19.0	3,000 (1)	3,000	3,000	3,000		(1)	12,000
Cedar elm	20.0	750 (1)	750	750	750		(2)	3,000
Cedar elm	7.0	1,500 (5)					(2)	1,500
American elm	15.0	1,500 (1)	1,500	1,500	1,500		(1)	6,000
American elm	32.0	3,000 (1)	3,000	3,000	3,000	3,000	3,000 (1)	18,000

[1/] Values in parentheses indicate health class of tree: 1 = no leaf symptoms, 2 = few wilted leaves, 3 = few wilted leaves, dead leaves, 4 = branch dead, 5 = several branches dead.

Table 5. American elmswith phloem necrosis symptoms treated with tetracycline antibiotic in 1972.

DBH (inches)	Health class 1/	Tetracycline applied 4/10 2/
		mg
60.0	1	2,500
61.0	1	3,000
70.0	3	3,000
72.0	1	2,500
66.0	4	4,000
80.0	4	4,000
63.0	4	2,500
60.0	3	2,500
60.0	3	2,500
63.0	3	4,000

1/ 1 = no leaf symptoms, 2 = few wilted leaves, 3 = few wilted and dead leaves, 4 = branch dead, 5 = several branches dead.

2/ Trees also treated with 2,000 mg on July 12 and October 6, 1972.

after a single injection in April 1973, and one-third of the crown died. The tree also became infested with ambrosia beetles, which were controlled chemically. Injections were resumed in July 1973, and when the tree was observed in fall 1975, two-thirds of the crown appeared normal. One large limb and one-third of the trunk diameter were dead; however, new trunk cambium was being formed.

The three untreated elms selected as checks in 1970 died, one in 1970 and two in 1971. Of the five 1971 check trees (three cedar and two American elms), four died in 1972; one cedar elm survived until spring 1973. Of the check trees used in 1972 (three cedar elms), two died in 1973; one elm was alive in 1975 but had a thin crown and dead branches. Several untreated trees in the vicinity of the test area also died, and many of those surviving showed phloem necrosis symptoms. Cedar, American, September (U. serotina Sarg.), and winged (U. alata Michx.) elm appeared to be equally susceptible.

In the Jackson test, three of the 10 trees treated in 1972 died in 1973. These trees had a disease rating of 4 in March 1972 and a rating of 5 by November, when over half the crown showed disease symptoms. Apparently, the trees were too severely infected to benefit from the treatment. Treatments were discontinued after 1972; and by 1976 only three trees were alive--all showed disease symptoms.

CONCLUSIONS

1. Most native American elms are susceptible to phloem necrosis.

2. Usually trees with one-third or less of the crown dead (disease rating less than 5) can be successfully treated.

3. For protective treatment, the minimum dosage rate is 100 mg of tetracycline antibiotics per inch of diameter applied after budbreak in monthly treatments. At least two such treatments each year are needed to insure tree survival. For therapeutic treatment, apply when symptoms first appear.

4. Additional monthly treatments are required if symptom reoccurs. Leaf wilt and mortality in new growth may occur 60 to 90 days after antibiotic injections in severely infected trees. If less than 100 mg tetracycline per inch of tree diameter is used, the symptoms may reappear as early as 30 days after treatment.

5. Data presented on elm can be applied with some modification to control other yellow diseases of trees in the urban ecosystem. The technique described is environmentally safe and controls only the target pathogen.

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