Sweetgum Blight as Related to Alluvial Soils of the Mississippi River Floodplain

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A BLIGHT OF UNKNOWN origin and cause has been very common throughout much of the range of sweetgum (*Liquidambar styraciflua* L.) since 1950. It is characterized by a gradual dying of the tree, often from the top down (Fig. 1).

The first visible indication is a thinning of a portion of the crown, caused when some buds fail to open and others produce only dwarfed, yellowish leaves. The ends of affected branches gradually die, often retaining the dead leaves for some time. Diseased branches may show up anywhere in the crown, but are most common in the upper part. Sometimes a tree with only a few branches visibly affected one year is dead the next, while in other trees the upper crown and leaders die back slowly, a branch or two a year. Occasionally the dying stops and the trees seem normal except for the dead, dried top (Garren, 1949; Miller and Gravatt, 1952; Toole, 1954). A cut into the wood of diseased branches often reveals tan or dark brown irregular streaks in the normally white sapwood. On diseased trees, a high percentage of the fine feeder roots are dead, although the larger roots appear healthy (Fig. 2).

The blight has been observed on a wide variety of sites, with damage apparently greatest in areas least suited for sweetgum. Some stands are completely ruined by it (Fig. 3) while others show little damage. Young, Toole, and Berry (1954), Hepting (1955), and Young (1955) have studied the progress and range of the disease, but of the investigators none has been able to determine the cause or discover a pathogenic agent (Berry, 1955).

Although there are no detailed reports on the relation of soils to blight, the gross symptoms are similar to drought-induced dying and also have occurred in other species (Hepting, 1955). The study reported here was undertaken to determine whether intensity of the blight on alluvial soils of the Mississippi River floodplain is related to soil differences.

Methods

During the summer of 1956, 76 sweetgum stands were sampled in the Mississippi River floodplain (Fig. 4). All but four were on soils of the three following groups:

1. Recent natural levees bordering the Mississippi River. These soils show little profile development as yet, but differ primarily in stratification, and thus in texture

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and drainage. They are neutral to alkaline, as they have not had time to become leached.

2. Old natural levees bordering former courses of the Mississippi River. These soils differ from the first group mainly in being leached and acid, and in having more profile development.
3. Slack-water areas. The slack-water soils were formed in places where water moved slowly enough to deposit fine sediments. The resulting soils, locally called gumbo and buckshot, constitute the greater portion of forest land left in the Delta. Differences within this group are principally in thickness of the clay and silt deposited on the sandier strata underneath.

Three of four samples not classified in the above groups belong to Red River alluvium or Perry soil. The fourth is an old natural-levee soil formed in material washed down from loess.

Each of the three major soil groups was regarded as a separate sampling universe. Within each group, any sweetgum stand that was 35 to 60 years old and had a basal area of more than 100 square feet per acre was carefully examined as encountered.

Disease index for each stand was then computed. No effort was made to keep the number of samples proportional to area in the soil group; instead, extra effort was devoted to locating stands of qualifying age and density in the less frequently occurring soil groups. Absence, presence, or severity of blight did not influence choice of sample.

After a stand was selected, a sampling point was established. From this point each sweetgum tree whose d.b.h. subtended an angle greater than 104.18 minutes (Grosenbaugh, 1955) was classified as to blight

FIGURE 1. *Sweet gum stand moderately affected with blight. Tree on right has typical symptoms. Tree on far left healthy.*

status. Classification was as follows:

	Class index value
Apparently healthy	0
Up to 1/8 of crown affected	1
1/8 to 1/2 of crown affected	4
More than 1/2 of crown affected	8
Dead tree	10

However, in calculating blight indices for stands, only unsuppressed sweetgum trees were considered. Suppressed trees were rejected because of the possibility of confusing symptoms of suppression with symptoms of blight. The sum of the index values for unsuppressed individual trees, divided by the number of such trees, gave the blight indices used. In effect, blight status was weighted by basal area per acre represented by sample trees.

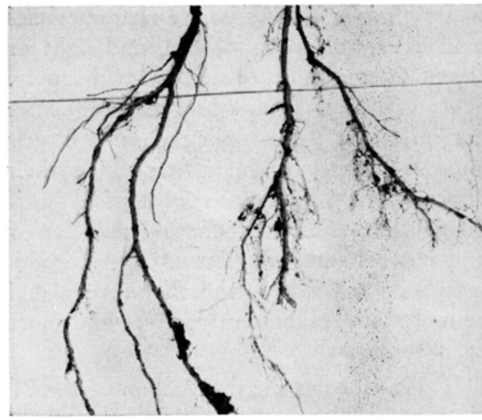

FIGURE 2. *The roots on the right are from a healthy sweetgum; those on the left are from a blighted tree. Note the lack of fine roots on the sample from the diseased tree.*

FIGURE 3. *A badly diseased sweetgum stand.*

Both bulk and core soil samples were collected from 2 locations near each sampling point. Soil from the surface to 4 feet down was sampled in 12-inch increments. Bulk samples were composited while core samples were kept separate.

The bulk samples were used to determine particle size, pH, soluble salt concentration, P_2O_5 equivalent per acre, exchangeable sodium, exchangeable potassium, organic matter content, moisture and xylene equivalents (from which imbibitional water was calculated), and moisture retained at 15 atmospheres pressure. The cores were used to determine bulk density, total pore volume, and moisture retained at 60 cm. water tension (.06 atm.). Available water capacity was then calculated as the difference in moisture retained at tensions of .06 and 15 atmospheres, as these two tensions roughly approximate field capacity and wilting point for well-drained soils of medium texture.

Results

The study strongly indicated that sweetgum blight in the Delta is primarily a reaction to a shortage of soil moisture. It was worst on soils or sites whose characteristics tended to limit soil moisture, and light or absent where moisture was in good supply. Since variations in age and stocking were minimized in the sampling design, it was impossible to make inferences as to their effects. There seems to be empirical justification, however, for believing that denser and older stands would make greater demands on soil water, and therefore would be more vulnerable than younger and more open stands.

Table 1 shows the distribution of the 76 plots by soil type and indicates the range and average disease index for each.

Analysis of variance showed significant differences of the blight indices of the soil series at the 5-percent level within groups, but among groups the only significant difference was between slack-water soils and the average of old and recent natural-levee soils. The mean disease index was 1.2 ± .28 for the recent and old natural-levee soils and 2.2 ± .27 for the slack-water soils.

Soil properties and blight. Simple correlation coefficients were calculated for blight index and the following soil variables at each of the four soil depths:

pH, K, Na, P_2O_5, soluble salt concentration, imbibitional water, available water-holding capacity, clay, silt, sand, porosity, bulk density, and organic matter.

The following variables were most highly correlated with plot disease index:

Potassium in the 1- to 2-foot soil level
Sodium in the 2- to 3-foot soil level
Imbibitional water in the 0- to 1-foot and 1- to 2-foot soil levels
Bulk density in the 0- to 1-foot soil level.

The variables with the highest simple correlation coefficients—potassium, sodium, imbibitional water, and bulk density—were tested for curvilinearity. Linear regressions were adequate except that a curvilinear function involving imbibitional water in the 0- to 1-foot soil level was significantly better than a linear function. Information about the five best regressions is given in Table 2. The coefficients of correlation for potassium, sodium, bulk density, and imbibitional water in the 1- to 2-foot level were significant at the 5-percent level. The correlation for imbibitional water in the 0- to 1-foot level was significant at the 1-percent level. The relationships of disease index to sodium and to potassium at specified depths are illustrated in Figure 5. Figure 6 graphs the curvilinear relation between disease index and imbibitional water at a given depth.

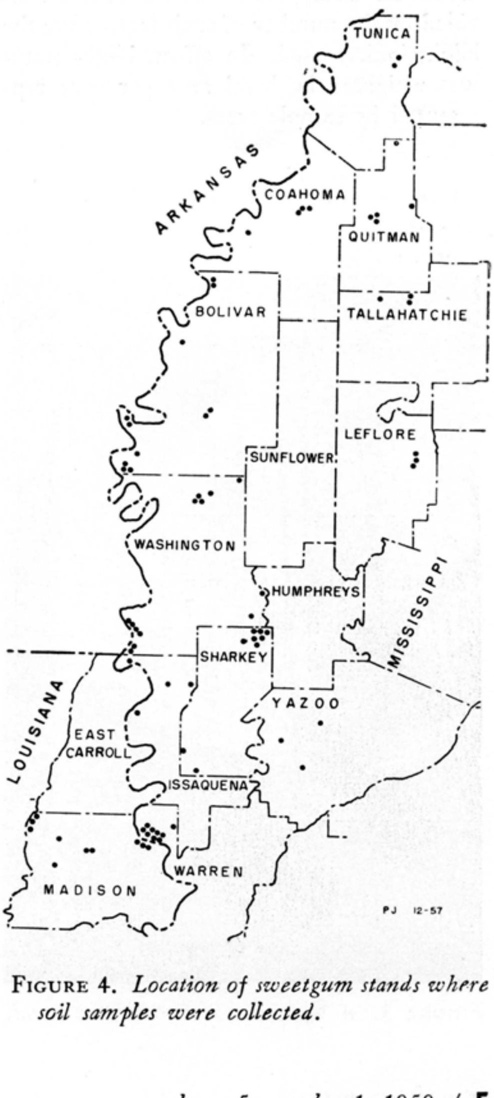

FIGURE 4. *Location of sweetgum stands where soil samples were collected.*

TABLE 1. Range in sweetgum blight index by soil group and series.

Soil group and series	Samples (number)	Stand blight index		
		Lowest	Highest	Average
Recent natural levee soils:				
Robinsonville	3	0	0.6	0.2
Commerce	9	0	2.7	1.5
Mhoon	4	0	3.4	1.1
Group	16	0	3.4	1.1[1]
Old natural levee soils:				
Dundee	4	0	1.8	.8
Forestdale	15	0	3.2	1.4
Group	19	0	3.2	1.3[1]
Slack-water soils:				
Alligator	14	0	4.2	1.6
Sharkey	15	0	9.3	2.3
Tunica	2	3.0	9.7	6.3
Bowdre	6	0	8.5	1.7
Group	37	0	9.7	2.2[1]
Others:				
Perry	3	.2	.9	.6
Brittain	1	2.9	2.9	2.9
Group	4	.2	2.9	1.2[1]

[1]Averages weighted by number of sample points.

The relationship of bulk density in the 0- to 1-foot level to disease index was negative. The looser soils, with low bulk density, probably had a higher disease index because they drained quicker and thus retained less water. At depths greater than one foot, bulk density was not significantly correlated with disease index.

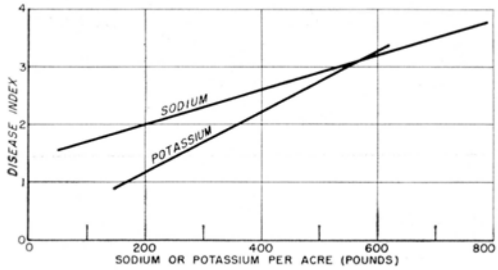

FIGURE 5. *Sweetgum blight index as related to sodium in the 2- to 3-foot soil level and potassium in the 1- to 2-foot level.*

Soil pH and P_2O_5 equivalent were among the factors not significantly correlated with blight index; it is unlikely that either influences moisture supply. The narrow range in the data for soluble salts, silt, sand, clay, porosity, and organic matter may account for the lack of significant correlation between these variables and blight index.

Available water capacity, of course, is a property connoting storage space, but it does not tell how much water was available during the drought. From other observations and experience, the authors strongly believe that if the available water capacity could have been compared with accurate measurements of total or seasonal rainfall at each of the plots, a significant relationship to disease index would have been found.

Discussion

These data demonstrate that the intensity of sweetgum blight in stands growing on alluvial soils of the Mississippi River floodplain is correlated with certain soil characteristics. The soil group on which blight was most severe—the slack-water soils—is also considered the least desirable for other crops because of its comparatively poor physical properties. Although the natural-

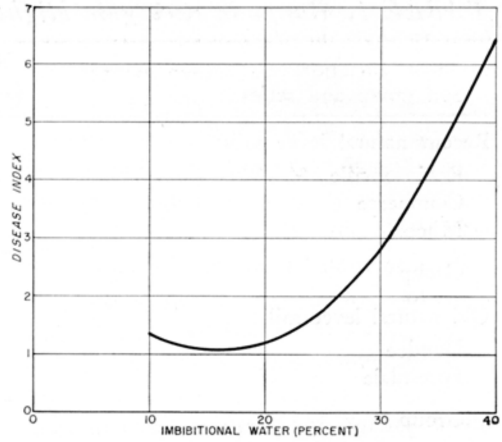

FIGURE 6. *Sweetgum blight index as related to imbibitional water in the 0- to 1-foot soil level.*

TABLE 2. Final regressions used in correlating intensity of sweetgum blight with soil factors.

Form[1]	Mean squared residual	Degrees of freedom for error	Coefficient or index of correlation
(A) $Y = b_0+b_1x_1$	3.516	74	0.243*
(B) $Y = b_0+b_1x_2$	3.545	73	.233*
(C) $Y = b_0+b_1x_3$	3.533	74	—.233*
(D) $Y = b_0+b_1x_4+b_2x_4^2$	3.265	73	.355**
(E) $Y = b_0+b_1x_5$	3.498	74	.252*

COEFFICIENTS FOR ABOVE REGRESSIONS

Coef.	A	B	C	D	E
b_0	0.0923	1.3625	6.6723	3.7094	0.4503
b_1	.0046	.0028	—4.0429	—.3184	.0601
b_2	--------	--------	--------	.0097	--------
C_{00}	.020491	.000058	1.678545	.878511	.098668
C_{01}	—.000502	—.000063	—1.347343	—.090311	—.004194
C_{11}	.000001	.000001	1.090037	.009802	.000206
C_{02}	--------	--------	--------	.002105	--------
C_{12}	--------	--------	--------	—.000236	--------
C_{22}	--------	--------	--------	.000006	--------

[1]Where: Y = sweetgum blight disease index
x_1 = pounds of potassium per acre in the 1- to 2-foot soil level
x_2 = pounds of sodium per acre in the 2- to 3-foot soil level
x_3 = bulk density in the 0- to 1-foot soil level
x_4 = percent imbibitional water in the 0- to 1-foot soil level
x_5 = percent imbibitional water in the 1- to 2-foot soil level
Subscripts denote order of single or joint term appearance in regression, not variable subscripts in term.
*Significant at the 5-percent level.
**Significant at the 1-percent level.

levee soils showed significantly less blight intensity than the slack-water group, considerable variation was noted within each group. If more plots within the age and stocking requirements had been sampled, perhaps a significant difference could have been established between some of the soil series within groups.

Because most of the feeder roots occur in the top foot of soil, the physical soil variables in this level should have the greatest effect on water available to the tree. In fine-textured soils such as those under study, salts of sodium and potassium tend to accumulate at deeper levels in amounts sufficient to reduce the available water. Lack of significance of other soil variables that might be expected to have importance may be due to variation within the sample.

The period of significant blight development, i.e., since 1950, coincided with a severe and prolonged drought in the study area. The water table in the lower Mississippi River floodplain dropped as much as 8 feet, attesting the severity of the drought. It is possible, and even probable, that those soil factors tending to restrict available water supply are importantly operative in the blight complex only in times of serious rainfall deficits or when lesser deficits are aggravated by excessive soil drainage by ditching. Under favorable conditions sweetgum grows well on a variety of soils, including upland pine sites; during periods of soil moisture stress it apparently recedes from less favorable sites.

That blight has not occurred regularly in the past strongly suggests that the effect of soil properties on its intensity is indirect, through a shortage of soil water. More serious individual drought years have been recorded than occurred since 1950, but no recorded drought has been as prolonged in the lower Mississippi River floodplain. Although the evidence is strong that sweetgum blight is primarily a response to soil moisture shortages, it does not completely exclude the possibility that soil properties act indirectly on blight through a pathogen as yet undiscovered.

Summary

Seventy-six sweetgum stands in the lower Mississippi River floodplain were sampled to determine the relationship between blight and soil properties. A blight disease index was determined for each plot, and bulk and undisturbed soil-core samples were collected from each 12-inch layer down to 4 feet. Various chemical and physical laboratory determinations were made on these samples, and the results correlated with disease index.

Stands on slack-water soils had significantly more blight (disease index 2.2) than those on the soils of natural levees (disease index 1.2). For all the samples, blight increased as potassium increased in the 1- to 2-foot soil level, as sodium increased in the 2- to 3-foot level, as imbibitional water increased in the 0- to 1-foot and 1- to 2-foot levels, and as bulk density decreased in the surface foot.

The data strongly suggest that sweetgum blight in the area studied is primarily a reaction to soil moisture shortages.

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