DISEASE IMPACT IN COTTONWOOD PLANTATIONS

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Abstract.--Previous reports have indicated that stem cankers and foliage diseases are the most important disease problems in eastern cottonwood plantations in the southern United States. In a recent survey of 1- to 11-year-old plantations in Arkansas, Louisiana, and Mississippi, incidence of stem cankers was 4 percent or less in most age classes and foliage diseases, while present, had caused no serious defoliation. Tree mortality was less than 4 percent in most age classes and almost all of the mortality was attributed to suppression and wind damage, rather than disease. In several age classes, including the youngest, more than 20 percent of planting spaces were unoccupied. A possible explanation for the unoccupied planting spaces is found in previous reports which indicate that canker diseases can cause losses of 20 percent during the first growing season.

Additional keywords: Populus deltoides, disease impact, growth reduction, mortality.

Commercial plantings of eastern cottonwood (Populus deltoides Bartr.) in the southern United States now extend over an estimated 40,000 to 50,000 acres. Planting is continuing and investments are growing. To determine what impact diseases were having in these plantations, a survey was conducted in 1974 and 1975. The survey included plantations in Arkansas, Louisiana, and Mississippi. The results of the survey are reported in this paper. Also, in this paper, a review is presented of previous reports of disease impact on Populus spp. with particular emphasis on those diseases of potential importance in P. deltoides plantations in the southern United States.

Canker diseases.--Cankers are considered the most important diseases of P. deltoides. They occur in trees of all ages, and can affect the main stem, branches, or twigs causing mortality or dieback. Cankers are usually most prevalent under conditions of drought, other environmental stress, and on poor sites.

The fungus, Fusarium solani (Mart.) Snyder and Hans. causes a canker of P. deltoides and other Populus spp. Cankers caused by F. solani were observed in 1957 in 4- to 10-year-old plantations of black poplar species and hybrids in Wisconsin (Berbee 1962). In a study plot established in a natural stand of eastern cottonwood in Quebec, 84 of 183 trees displayed one or more cankers caused by F. solani. The canker-weakened trees were frequently windthrown or or infected by other fungi. Canker incidence was greatest in suppressed trees

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(Boyer 1961). In 1961, following unusually deep flooding, stem cankers were observed in natural stands of P. deltoides at seven locations along the Mississippi River. All cankers were below the high water marks on the stems. In one 20-year-old stand, 27 percent of the trees were dead and 12 percent were broken. F. solani, was consistently isolated from the cankers. In a 1962 survey of natural stands along the Mississippi and Arkansas Rivers, 40 percent of the trees sampled along the Mississippi had cankers initiated in 1961. Along the Arkansas, which had suffered less flooding, canker incidence was lower. The highest tree mortality recorded along the Mississippi was 4 percent in the 15 year age class. Incidence of 1961 cankers was 51 percent for sites annually flooded compared to 23 percent for sites rarely flooded. This variation in canker incidence was considered to be associated with the amount of wounding caused by floating debris (Toole 1962, 1963). Cankers caused by F. solani were observed in 1965 in a 7-year-old planting of a P. deltoides clone in Iowa. Cankers, ranging up to a foot in length, occurred on 75 percent of the trees. A serious loss of lumber quality was attributed to stem degrade by the cankers. The disease was considered a potential threat to hardwoods, particularly in plantations (Dochinger 1967).

The fungus, Septoria musiva Peck, causes a canker and leaf spot on poplars and has been reported in Canada, Argentina, and the United States. Blow (1948) reported Septoria canker in test plantings of hybrid poplar clones in Alabama, Mississippi, and Tennessee. The disease caused severe damage in some clones. Waterman (1954) considered Septoria canker an important and destructive disease of hybrid poplars with black, balsam, and cottonwood parentage in the United States, but stated that although native poplar species are susceptible to leaf spot caused by S. musiva, they are resistant to stem infection by this fungus in their natural range. Waterman reported extensive losses to Septoria canker in plantings of hybrid poplars in five states: Massachusetts, Vermont, New York, Maine, and Maryland. Septoria canker along with a canker caused by Diplodia tumefaciens (Shear) Zalasky has been destructive in plantations of balsam poplar, P. balsamifera L., and on clones of introduced and natural hybrid poplars in Canada (Bier 1939, Zalasky et al. 1968).

The fungus, Cytospora chrysosperma (Pers.) Fr., causes a canker disease on poplars. C. chrysosperma is a common bark inhabiting fungus on native poplars, introduced species and varieties of ornamental poplars (Christensen 1939), and also occurs as a saprophyte on dead twigs (Anon. 1958). Cytospora canker is considered to be of rather minor importance on native forest trees, but is one of the major causes of decline of ornamental poplars (Christensen 1939). This disease occurs throughout North America and Europe, and is primarily a problem on poor sites and under conditions of environmental stress (Schreiner 1931, Müller-Stoll and Hartmann 1950, Blomberg 1962). C. chrysosperma and another canker-causing fungus Dothichiza populea Sacc. and Br., were isolated from dying trees in a 3-year-old eastern cottonwood plantation in the Piedmont of Georgia the year following a prolonged cold period which had caused splitting of bark (McAlpine 1963). In 1963, basal cankers killed thousands of trees in 2- to 3-year-old P. deltoides plantations near Fitler, Mississippi. Results of a May survey showed that 21 percent of all trees sampled had cankers, although in some plantings up to 80 percent of the trees had cankers. No new cankers were observed after July, and most of the infected trees sprouted from the rootstocks. Rainfall had been low during both the 1962 and the 1963 growing seasons. Fungi isolated from the cankers were C. chrysosperma, Phomopsis

macrospora, and Fusarium solani. In subsequent studies, all three fungi were found to be capable of infecting P. deltoides, but C. chrysosperma caused the most mortality. For all three fungi, canker size and probability of mortality were found to be dependent upon site quality and environmental conditions (Filer 1964, 1967). Unfavorable soil conditions and drought were considered to be major factors contributing to decline, subsequent C. chrysosperma infection and tree mortality in a 5-year-old shelterbelt plantation of P. deltoides in Nebraska (Wright 1957). Zalasky et al. (1968) reported Cytospora cankers on terminal shoots of clones of P. deltoides and other black poplars following winter injury in Canada. Poor survival in test plantings of hybrid clones of P. deltoides and other poplars in Saskatchewan was reported to be associated with high incidence of Cytospora canker. Survival of 6 to 25 percent was recorded for clones with the highest canker incidence, while survival of 94 to 100 percent was recorded for clones with few or no cankers (Cram 1960).

Eastern cottonwood plantations, established with unrooted cuttings in the southern United States may sustain up to 20 percent mortality during the first growing season as a result of canker diseases. Cankers are most severe on poor sites and under environmental stress conditions. Five canker fungi acting singly or together, are involved: Septoria musiva; Fusarium solani; Cytospora chrysosperma; Phomopsis macrospora Kobashi and Chiba; and Botryodiplodia theobromae Pat. Of these, S. musiva is considered the pioneer organism (Morris et al. 1975). The same fungi can cause cankers in older trees, gaining entrance through mechanical or insect wounds. The cankers usually do not kill trees over 4 years of age, but can weaken the stem and lead to wind breakage (Morris et al. 1975).

Dothichiza canker is considered the most severe disease problem of poplars in many parts of Europe (Anon. 1958). This disease is caused by the fungus Dothichiza populea Sacc. and Br. It occurs in Europe, Canada, and the United States. P. deltoides along with other species and hybrids of the black poplar group are susceptible. In the United States, D. populea has occasionally caused stem cankers in young plantations in localized areas, but has not been significant enough to justify a search for control measures (Waterman 1957). The disease is considered to be more significant in Europe where it has been observed particularly on young planted trees and on trees weakened by other factors (Waterman 1957). Severity of the disease is greatest under stress conditions such as those associated with drought or transplanting (Anon. 1958).

Foliage diseases.--A variety of foliage diseases occur on P. deltoides. Among these are rusts, leaf spots and blotches, leaf and twig blights, leaf blister, and anthracnose. The prevalence and severity of these diseases vary greatly from year to year. Some foliage diseases contribute to defoliation, and when present during successive years, can also contribute to reduction of tree vigor and growth.

Leaf rust has been considered the most serious and widespread foliage disease of poplars. The rusts of poplars are caused by several species in the genus Melampsora (Anon. 1958, Jokela 1966). The most common and widespread leaf rust in Canada and the United States is caused by Melampsora medusae Thum. (Hepting 1971). In the lower Mississippi Valley, this rust infects the foliage of P. deltoides trees of all sizes and may contribute to defoliation in early autumn (Toole 1967). M. medusae is considered a possible threat to maximum fiber production of poplar clones in Wisconsin based on a 2-year epiphytotic of the rust

in plantings of four clones of P. deltoides and hybrids of this same species (Schipper and Dawson 1974). Schreiner (1959) reported that Melampsora spp. can cause epiphytotics in European poplar plantations, but did not consider them a serious threat because of the availability of rust-resistant clones. Rust-resistant clones of P. deltoides are available for use in the southern United States (Morris et al. 1975).

A leaf spot caused by Septoria musiva, has been reported throughout the range of P. deltoides in the United States, and also in Canada. The leaf spot can contribute to defoliation, but is considered much less significant than the stem canker caused by the same fungus (Anon. 1958). In addition to P. deltoides, several species and varieties of other black poplars are also susceptible (Thompson 1941). Septoria populicola Peck. causes a less common leaf spot on poplars in Canada and the United States and a third Septoria sp. occurs on poplars in the United States, Europe, and the Argentine but has not been particularly damaging (Anon. 1958).

A highly noticeable leaf blotch caused by Septotinia populiperda Waterman and Cash has occurred on plantation trees of hybrid poplar clones in the eastern United States (Waterman and Cash 1950), but is reported to be not very important (Peace 1962). This disease also occurs on black poplar hybrids in Europe, but again is not considered serious (Anon. 1958). A leaf spot caused by Marssonina populi (Lib.) Magn. occurs on P. deltoides in eastern and central United States (Anon. 1960). It is one of the most widespread leaf spots of poplars (Hepting 1971). A 16 percent loss in volume of poplar wood was attributed to a related fungus, Marssonina brunnea in Italy (Cellerino 1969). In an additional report from Italy, the loss of poplar wood rose to 45 percent from several years foliage infections by M. brunnea. Losses were the least (15%) in 'Carolinian' types (apparently natural hybrids of P. deltoides) (Castellani 1970/1971).

Several other foliage diseases of minor importance have been reported. A leaf spot caused by Cercospora populina E and E has been reported on P. deltoides in Louisiana and Texas (Anon. 1960). A Phyllosticta sp. causes a leaf spot of P. deltoides in the eastern United States (Morris et al., 1975). Taphrina spp. cause a noticeable leaf blister on many poplars in Europe and North America. This disease usually does not cause defoliation and consequently is not considered a significant problem (Peace 1962). Taphrina populina Fr. has been reported on P. deltoides in the United States (Morris et al. 1975). Colletotrichum gloeosporiodes Penz causes an anthracnose of P. deltoides in the southern United States (Morris et al. 1975). Several Venturia spp. cause leaf spots and shoot blights of Populus spp., but they are rare on P. deltoides (Hepting 1971). They are particularly severe in Italy where infection occurs on many black hybrids (Anon. 1958, Peace 1962). Pestallozia populinigrae Sawada and Ito causes a disease of young shoots of P. nigra, P. nigra "italica", and P. deltoides monolifera in Japan (Peace 1962). Foliage symptoms possibly caused by a virus have been reported in Europe (Brčá and Blattný 1962). In the Netherlands, these symptoms have been observed on several poplars with the symptoms being most pronounced on commercial cultures of P. deltoides (Berg 1962).

Root diseases.--Root diseases are not known to be of much significance in poplars (Schreimer 1959, Peace 1962, Hepting 1971). In experimental shelterbelt plantings in Texas and Oklahoma, 3.3 percent of 6,731 plains poplar trees, P. sargentii Dode, were killed over a 6 year period by Phymatotricham root rot,

caused by the fungus Phymatotrichum omnivorum (Shear) Duggar (Wright and Wells 1948). P. deltoides and P. nigra were observed to be moderately to highly susceptible to Phymatotrichum root rot in inoculation tests (Taubenhaus and Ezekiel 1936).

While root diseases have not caused widespread damage to poplars in Europe, some localized growth and mortality losses have been attributed to Armillaria mellea (Vahl) Fr., Rossellinia necatrix (Hart.) Bul., R. amphispha erioides L., R. quercina Hart., R. aquila Fr.) de Not, Pholista aegerita, Botrytis cinerea Pers. and other fungi (Schreiner 1959).

Several root rot fungi occurring in the United States and other parts of the world on various hardwood species are capable of infecting poplars, but have not been reported in P. deltoides plantations in the United States. These fungi include Pleurotus ostreatus (Fr.) Quel., Polyporus lucidus Leys. ex. Fr., and Corticium galactinum Fr. Burt. (Foster 1964, Morris et al. 1975). Clitocybe tabescens Bres. has been associated with damage to several hardwood species in the southern United States (Rhoades 1950, Owen et al. 1960), and has been observed there in P. deltoides plantations, but no losses have been reported (Morris et al. 1975).

Nematodes have not been associated with any significant injury to American poplars (Ruehle 1967). Seven species of nematodes have been found in association with P. deltoides in South Carolina (Ruehle 1968). At least a portion of the decline of P. deltoides in South Dakota shelterbelts has been attributed to the nematode, Xiphinema americanum Cobb (Malek 1968, Malek and Smolik 1975).

Trunk rots.--The fungi which can cause wood decay of poplars have not been a problem in young trees such as those usually found in plantations (Anon. 1958). In Europe, where the rotation age is 35 years or less, wood decay fungi have seldom caused significant economic loss in black poplars (Schreiner 1959).

Vascular diseases.--Wetwood is a common disease of poplars in the United States (Hepting 1971). In 1964 and 1965, a survey was conducted for this disease in natural stands of P. deltoides along the Mississippi River between Vicksburg, Mississippi and Memphis, Tennessee (Toole 1968). Trees sampled were 6 inches d.b.h. or larger. Of all sampled trees, 86 percent contained wetwood. In many stands all of the trees sampled contained wetwood. Of trees less than 6 inches d.b.h. sampled in one plantation, less than 50 percent contained wetwood. A bacterium was isolated from a high percentage of wood samples obtained from symptomatic trees during the survey, and was considered the probable causal organism. While apparently not a cause of tree mortality, wetwood is of concern in cottonwood because it causes degrade and could cause difficulty in wood drying (Toole 1968).

Threat of introduced diseases.--Caution has been expressed over the possible spread of some poplar diseases to continents where they don't presently occur. Bacterial canker has been observed in northern Europe, and was regarded as the most significant disease of poplars there until resistant trees became available. With some exceptions, black hybrids are resistant to bacterial canker. While not definitely determined, P. deltoides appears susceptible. Therefore, introduction of bacterial canker into North America could present a problem (Anon. 1958, Rol et al. 1958, Kristic 1964). Violet root rot, caused by Helicobasidium mompa Tanaka, a disease capable of damaging a wide range of hosts,

including poplars, occurs in Japan, Korea, and Formosa and is considered a threat to other parts of the world (Foster 1964). Septoria musiva, has not been reported in Europe and could be a serious problem if introduced there. Caution has also been expressed over the possibility that some widely-distributed fungi such as Malampsora spp. and Dothichiza populea, may contain strains which, if introduced into new areas, could cause damage (Rol et al., Schreiner 1959).

Threat of diseases to cottonwood clones and plantations.--The risk of disease impact is considered greater in plantations than in natural stands (Boyce 1963). An additional risk exists in cottonwood because only a few clones may be available for use in particular areas. Since all trees in a clone would probably display similar disease reactions, impact of an introduced disease could be severe (Rol et al. 1958).

IMPACT SURVEY

To determine impact from canker and other diseases in P. deltoides plantations in the southern United States, a survey was conducted in Arkansas, Louisiana, and Mississippi in 1974 and 1975.

METHODS

Plantations surveyed were a minimum of 10 acres in size and ranged in age from 1 to 11 years. In each plantation, about 150 trees were examined in three rows of 50 trees each. Trees were classified by condition - healthy or dead and by crown class - dominant to suppressed. Each tree was examined for symptoms and signs of stem, foliage, and root diseases, and evidence of wind breakage, windthrow, and insect attack. Unoccupied planting spaces were also recorded.

RESULTS AND DISCUSSION

Twenty-eight plantations ranging in age from 3 to 7 years were surveyed in 1974 (Table 1). Thirty plantations were surveyed in 1975 including 22 of the same plantations surveyed in 1974, along with an additional 8 plantations representing ages 1, 2, 10, and 11 years (Table 2).

A high proportion of planting spaces were unoccupied in most age classes. Whether this was due to disease or other causes is not known. However, it has been reported that cankers can cause mortality of up to 20 percent during the first growing season (Morris et al. 1975). Tree mortality was low in most age classes. Mortality ranged from none in several plantations to 10 percent in one 10-year-old plantation. Most of the observed mortality was attributed to suppression or wind. Incidence of stem cankers was low in most age classes. As previously stated, five fungi have been associated with stem cankers, of which Septoria musiva is considered the pioneer organism (Morris et al. 1975). Some of the stem cankers were associated with wounds caused by the poplar borer, Saperda calcarata Say. A small amount of windthrow was observed, but none was associated with root disease. Although foliage diseases were prevalent in most plantations in both 1974 and 1975, no serious defoliation was observed. The most common foliage diseases observed were the rust caused by Melampsora medusae, and leaf spots caused by Septoria musiva, and a Phyllosticta sp.

Results of this survey indicate that impact of diseases in P. deltoides plantations is currently low. Several of the same plantations should be surveyed again in 2 to 3 years to determine the incidence of disease. An effort should

Table 1. Summary of Data from Cottonwood Plantation Survey, 1974

Age Class	Location	Total Plantations	Total Trees and Planting Spaces	Trees Missing	Total Living & Dead Trees	Trees Dead	Living Trees		
							Stem Canker	Wind Damage	Borer
(Years)		(No.)	(No.)	(%)	(No.)	(%)	(%)	(%)	(%)
3,4	Ark.	3	590	24	447	0	0.2	2.0	0
	La.	4	774	23	594	0.2	3.2	4.0	1.0
	Miss.	10	2010	26	1491	0	0.7	1.6	0.5
6,7	Ark.	3	611	26	450	0	0.4	5.6	1.1
	La.	4	918	34	603	0.7	2.7	3.2	0.7
	Miss.	4	872	31	598	1.0	1.8	4.8	1.2

Table 2. Summary of Data from Cottonwood Plantation Survey, 1975

Age Class (Years)	Location	Total Plantations (No.)	Total Trees and Planting Spaces (No.)	Trees Missing (%)	Total Living & Dead Trees (No.)	Trees Dead (%)	Living Trees		
							Stem Canker (%)	Wind Damage (%)	Borer (%)
1,2	La.	1	192	22	150	0.7	2.0	0	3.4
	Miss.	4	814	26	602	3.3	4.0	0	9.8
4,5 a/	Ark.	3	599	25	445	1.1	0	0	0.7
	La.	3	533	16	448	0.4	1.6	3.3	0.2
	Miss.	6	1282	29	895	0.6	0.8	3.1	0.2
7,8 a/	Ark.	3	609	26	443	1.6	7.2	7.7	0.9
	La.	4	857	37	524	2.7	7.1	1.8	3.5
	Miss.	3	687	35	440	2.0	0.7	3.6	1.8
10,11	La.	1	150	b/	150	10.0	3.7	10.4	2.2
	Miss.	2	391	10	291	3.1	2.4	6.9	2.4

a/ Also surveyed in 1974 (see Table 1).

b/ Unable to determine because of thinning.

be made to find a definite explanation for the high percentage of planting spaces which are unoccupied after the first growing season.

SUMMARY

The impact of diseases in P. deltoides plantations in the southern United States has apparently been low with the exception of some young plantations where losses caused by cankers have approached 20 percent. Foliage diseases may have caused growth reduction in some years and locations, but little data has been reported on their impact.

Recent survey results obtained from plantations in three southern States, revealed minimal canker incidence and no serious defoliation caused by foliage diseases. Tree mortality observed was caused primarily by suppression and wind damage. A high proportion of planting spaces were unoccupied in most age classes. A possible explanation for the unoccupied planting spaces is found in previous reports of canker-caused mortality during the first growing season.

The potential impact of diseases in P. deltoides plantations is unknown. Of some concern however, is that plantations consisting of either one or only a few clones may be particularly susceptible to diseases. Also of concern is that some diseases which presently occur in foreign countries, could perhaps cause significant impact if introduced into the southern United States.

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