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Exotic conifers as Christmas trees. See Page 2

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION NEW HAVEN

Conifers evaluated for Christmas trees and ornamentals

By John F. Ahrens, George R. Stephens and Richard A. Jaynes

Although many conifers are grown in the United States, most have not been tested as Christmas or ornamental trees in Connecticut. How would exotic conifers compare with species commonly grown in Connecticut, such as white pine and white spruce, in terms of growth rates, response to shearing and shaping, loss of needles and moisture after cutting, and susceptibility to pests? These questions led us in 1974 to evaluate several conifers.

We planted 20 different conifers during April and May 1974 at the Experiment Station's Valley Laboratory in Windsor and Lockwood Farm in Mount Carmel. We included six species of true firs (*Abies* spp.), five spruces (*Picea* spp.), five pines (*Pinus* spp.) and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) grown from seeds from four regions of the United States. In April 1976, we added 11 Douglas-firs from the Rocky Mountains and Pacific Northwest, four grand firs (*Abies grandis* (Dougl.) Lindl.) from Washington and Idaho, and Nordmann fir (*Abies nordmanniana* (Steven) Spach.) from eastern Europe. Our goals were to rate these conifers for wholesale or retail production as Christmas or ornamental trees and to compare them with our commonly grown white spruce (*Picea glauca* (Moench) Voss).

In Windsor the soil is coarse, while in Mount Carmel it is fine textured. At both sites 3 to 12 of each species of conifer were planted, replicated three or four times. The pines, except for one strain, were two-year seedlings; the firs, spruces and Douglas-firs were four- or five-year transplants. Limestone was applied to adjust the soil pH to 6.0; herbicides were applied each spring to control weeds; and shearing was uniform within the conifer types. Terminal leaders were trained as necessary during shearing.

No fertilizer was applied at planting, but 10-10-10 was applied each April thereafter at one ounce per tree at the drip line. Starting the third year, another ounce was applied in June.

Pest control was minimized to reveal susceptibility to insects and diseases. Disease symptoms, winter injury, and times of bud break were recorded in the spring. Each year after shearing height was measured, and after six years the percentage of marketable trees was evaluated. At Windsor, for four consecutive years, three trees of each of the 20 original conifers were cut in December and hung in a dry room for several weeks to determine loss of moisture and needles.

In Tables 1 and 2 we have rated qualities of the conifers, combining results at Windsor and Mount Carmel with our observations at plantations in Connecticut during the past 10 years. In our comments, the percentages of marketable trees are based on results at Windsor. Our ratings for needle and moisture retention are based on the assumption that a Christmas tree will be held dry for a week or more before being placed in a continuous supply of water in the home. Trees for wholesale are usually held dry longer than "choose and cut," therefore they must retain needles and moisture better to be acceptable.

White spruce. Our standard was white spruce, which grows well in a wide range of soils. After six years, 85% of the white spruce were marketable as Christmas trees. It often required little shearing; unfortunately, it retained needles and moisture after cutting only fairly well. White spruce is, therefore, more desirable for choose and cut than for wholesale. The difficult-to-control spruce gall midge is a disadvantage in some areas.

Other spruces. Although the other spruces evaluated [Black Hills, a strain of white spruce from South Dakota; Colorado (*Picea pungens* Engelmann); Norway (*Picea abies* (L.) Karst); and Engelmann, (*Picea engelmannii* Parry)] were suitable for ornamentals, only Colorado retained needles sufficiently well for wholesale. Whereas Norway spruce grew fast (85% marketable after six years), Colorado and Black Hills spruce reached marketable size two to three years later than white spruce. Although many choose Colorado spruce as a Christmas tree because of its beauty and green-to-blue color, its sharp needles make it difficult to handle for wholesale.

Douglas-fir. The Douglas-firs we evaluated all had soft, attractive foliage and produced high quality Christmas trees. All had excellent needle retention and good to excellent moisture retention. Douglas-firs do not tolerate weeds or wet sites and are highly susceptible to late spring frosts. Although strains from the southern Rocky Mountains were generally bluer and grew faster than strains from the Pacific Northwest, all grew as fast or faster than white spruce on our well-drained sites. Susceptibility to Cooley gall aphid and a difficult-to-control needlecast make Douglas-firs from the southern Rocky Mountains (Colorado, Arizona, New Mexico) questionable choices for ornamental use.

True firs. Although the true firs that we evaluated had desirable foliage, they differed widely in other traits. All except Fraser fir are susceptible to late spring frosts. Aphids and spider mites, which are the primary pests of true firs in Connecticut, can be more easily controlled in plantations than in landscapes.

Balsam fir (*Abies balsamea* (L.) Mill.). Although the balsam fir, a fragrant native of higher elevations, has been the traditional Christmas tree, it usually is imported from northern New England and Canada. We found that balsam grew well, with 84% marketable after six years. The excellent needle and good moisture retention make it desirable for Christmas trees. It grows on wet sites better than most conifers. As an ornamental, balsam fir

Table 1. Ratings of conifers grown for Christmas trees. E = excellent, G = good, F = fair, P = poor

Species	Growth*	Needle retention after cutting	Moisture retention after cutting	Tolerance to adverse conditions: Wet	Dry	Frost pocket	Disease & insects	Low fertility
SPRUCES								
white	E	F	F	G	F	F	F	G
Norway	E	F	F	G	F	F	G	G
Black Hills	F	F	F	G	G	F	G	G
Colorado	F	G	G	F	G	F	G	P
Engelmann	P	F	G	P	G	F	G	P
DOUGLAS FIRS								
British Columbia & Washington seed	G	E	G	P	G	P	G	P
Southern Rocky Mountain seed	E	E	E	P	G	P	F	P
TRUE FIRS								
balsam	E	E	G	G	F	P	F	P
Fraser	G	E	G	P	F	E	F	P
Veitch	E	G	G	P	F	P	F	P
concolor	P	E	E	P	G	P	G	P
grand	F	E	P	P	P	P	G	P
subalpine	P	E	G	P	G	P	F	P
PINES								
white	E	E	F	G	F	E	F	F
Scots	E	E	G	P	E	E	P	E
Austrian	E	E	E	P	G	E	G	G
Mexican border	F	E	E	P	G	E	F	F

*Trees grown on moderately drained soils adjusted to pH 6.0, weeds controlled and fertilizer applied annually after the first year.

does not tolerate low fertility and is susceptible to aphids and spider mites.

Fraser fir (*Abies fraseri* (Pursh.) Poir.). A native of the southern Appalachians, the Fraser fir appears and holds its needles like balsam, but it usually has stiffer, darker foliage with more silvery undersides. Although Fraser fir reached marketable size one to two years later than balsam or white spruce, its buds opened later, making it the most tolerant fir to frost. Fraser fir, however, is subject to root rots and frequently dies on imperfectly drained soils. Fraser fir is well adapted for Christmas tree production in Connecticut, but has the same shortcomings as balsam as an ornamental.

Veitch fir (*Abies veitchii* Lindl.). Veitch fir, from Japan, has attractive foliage with silvery undersides. Although it grew as rapidly as balsam and had similar moisture retention, it lacked terminal dominance after shearing, and it required splints tied to many leaders.

Concolor fir (*Abies concolor* Gord. & Glend.). Concolor fir produces longer blue-green needles than other firs. It retained moisture and needles well. Although it grew too slowly for wholesale, it is suited for ornamental and choose and cut where a premium for quality may compensate for slow growth. A strong tap root makes concolor fir difficult to transplant.

Subalpine fir (*Abies lasiocarpa* (Hook) Nutt.). Although subalpine fir has attractive blue-green foliage, its slow growth makes it poor for Christmas trees. After seven years subalpine firs were only 40 inches high as compared with 75 for white spruce. Although subalpine fir could be a beautiful ornamental, its strong tap root makes it difficult to transplant.

Nordmann fir. Although Nordmann fir has attractive foliage, its height after six years was half that of white spruce.

Grand firs. The grand firs grew slowly and were windburned during several winters. After six years their height was about 60% that of white spruce. While eventually producing beautiful Christmas trees with excellent needle retention, cut grand firs dried more rapidly than any species tested.

Eastern white pine (*Pinus strobus* L.). Our native Eastern white pine is widely grown for ornamentals. Although it tolerates a range of sites and soils, most people would not choose a naturally-grown white pine for a Christmas tree because of its loose, layered pattern of growth. Sheared white pines, however, are increasingly popular. White pine grew and responded so well to shearing that 100% were marketable after six years. Since its branches are limber and will not support heavy lights and ornaments, white pine is better decorated with small lights, garlands or ornaments. It also loses moisture more rapidly than other pines. White pine is susceptible to damage in shipping and it appears ragged when wet, making it more difficult to sell in inclement weather. Insecticides and timely shearing can minimize damage from the white pine weevil. Despite these problems, white pine appears to be the Christmas tree that Connecticut growers can market after the fewest years.

Scots pine (*Pinus sylvestris* L.). The Scots pines that we evaluated were a Spanish strain from the Connecticut State Forest Nursery and a French strain. Both produced marketable trees about as quickly as white spruce. Since Scots pine frequently grew crooked stems and was attacked by insects and diseases, the trend among growers is away from Scots pine despite rapid growth and tolerance to frost and dry or infertile sites. The pests and a strong tap root that complicates transplanting, make Scots pine less desirable as an ornamental than white spruce.

Austrian pine (*Pinus nigra* Arnold). Like Scots pine, Austrian pine grew rapidly, but was bothered by fewer pests. Its long, dark green needles and fibrous root system make Austrian pine a desirable ornamental. Austrian pine develops fewer buds following shearing, so it requires more care to develop dense foliage for Christmas trees than do Scots or white pines. Because Austrian pine holds its naturally shedding needles tightly, cleaning by hand or shaking is required to prevent delayed shedding on living room rugs. Cleaning is also required for Scots and white pines because dry needles become caught in branches.

Border pine (*Pinus strobiformis* Engelm.). Although it resembles white pine and has five long, blue-green needles per bundle, border pine grew poorly, had stiffer branches, had sparser foliage, and set fewer buds following shearing than white pine. Bluish needles and exotic appearance make border pine appealing as an ornamental. Slow growth limits its value as a Christmas tree.

Of all the conifers that we have evaluated, seven species appeared adapted for Connecticut growers and consumers.

White spruce should continue to be popular to choose and cut, but some needles will fall even when freshly cut trees are set in water.

Colorado spruce qualifies as an excellent Christmas tree or ornamental, although hand and eye protection may be required when decorating it. Because it grows more slowly than some other conifers, Colorado spruce may be expensive.

Table 2. Ratings of conifers as Christmas trees and ornamentals. E = excellent, G = good, F = fair, P = poor

Species	Christmas trees: Wholesale	Christmas trees: Choose and cut	Ornamental
SPRUCES			
white	P	G	G
Norway	P	G	E
Black Hills	P	G	G
Colorado	G	E	E
Engelmann	P	F	G
DOUGLAS FIRS			
British Columbia and Washington seed	E	E	G
Southern Rocky Mountain seed	E	E	F
TRUE FIRS			
balsam	E	E	P
Fraser	E	E	F
Veitch	F	G	G
concolor	F	G	G
grand	P	P	P
subalpine	P	P	G
PINES			
white	F	E	E
Scots	G	G	P
Austrian	F	G	E
Mexican border	P	F	E

Although Douglas-fir, balsam, and Fraser fir are well suited for choose and cut or wholesale, pests make them less desirable as ornamentals.

Since white pine can be excellent for Christmas trees or ornamentals, Connecticut consumers can expect to see more in choose and cut plantations.

Although Austrian pine is easy to grow and it has longer needles and stiffer branches that will hold heavier ornaments than white pine, it is better as an ornamental than a Christmas tree because it is difficult to shape.

Heavily defoliated white pine has lower mortality than hemlock

by George R. Stephens

The bare skeletons of white pine and hemlock are grim reminders of 1981, when Connecticut experienced its most severe forest defoliation. Nearly 1.5 million acres, half the state, were partially or completely defoliated by the gypsy moth. Although the gypsy moth prefers oak and other hardwoods over pine or hemlock, hungry caterpillars turn to almost any green leaf once favored foods are exhausted.

Connecticut's conifers don't grow in large pure stands, rather, as individuals or clumps scattered among more susceptible and palatable hardwoods. Large expanses of conifers are essentially immune to defoliation by gypsy moth because the foliage is believed to contain compounds that the newly-hatched caterpillars cannot survive on. But, once more favored foods have been eaten and the caterpillars have grown larger, they can survive on conifer foliage.

Although Connecticut has been subjected to substantial defoliation by gypsy moth since 1938, few conifers were ever badly defoliated until 1981. That year, however, especially in Litchfield County, many white pine and hemlock growing with or near susceptible hardwoods were defoliated. Therefore, for 2 years in four locations on White Memorial Foundation forests in Litchfield and Morris I followed the fate of 300 hemlock and nearly 400 white pine that were partially to completely defoliated. Trees of all sizes, from small understory stems of less than an inch to venerable giants more than 24 inches in diameter that dominated the canopy, were observed. The crowns of *codominant* trees grow in full light and comprise the forest canopy, the forest as seen from afar. Crowns of *dominant* trees project somewhat above the canopy. *Intermediate* trees do not participate in the canopy but grow in light passing through gaps in the canopy. *Overtopped* trees grow below the canopy in the shade of other trees. For convenience I call codominant and dominant trees *canopy* and intermediate and overtopped trees *subcanopy* trees. By early fall 1981 tree size, position in the forest canopy and amount of defoliation were recorded. The same trees were observed again in May and October of 1982 and 1983. Refoliation, tree mortality and crown dieback were noted.

In late summer 1981, no severely defoliated hemlock refoliated. However, defoliation apparently ceased before white pine needles were fully-grown because many defoliated white pine had a short brush of needles less than a half-inch long.

In May 1982 many hemlock, but few white pine, were dead. By October 1982, 29 percent of the canopy hemlocks were dead (Table 1). About 29 percent of subcanopy hemlocks had also died. In contrast, no canopy white pine died, and by October 1982 only 9 percent of subcanopy white pine died. A year later mortality rose to 35 percent of canopy and 43 percent of subcanopy hemlock. Loss of subcanopy white pine nearly doubled to 16 percent.

Because both canopy and subcanopy hemlocks died, the size of trees dying ranged from less than 1 to nearly 24 inches in diameter. Because only subcanopy white pine died, the dead trees were small, 1 to less than 8 inches.

Not all trees were defoliated equally. Some were totally defoliated, others hardly at all. However, only severely defoliated trees died (Table 2). Both canopy and subcanopy hemlocks had to be nearly totally defoliated before death occurred; no tree defoliated less than 80 percent died. Similarly, for subcanopy white pine to die, severe defoliation was required; no tree defoliated less than 60 percent died.

Death of entire trees was not the only loss. In some trees only part of the crown died. While these trees may persist, the larger trees will certainly lose their place in the canopy and will contribute little to future timber production. Crown dieback was most evident in hemlock. By October 1983 a third of surviving hemlock canopy trees and a fourth of subcanopy trees had dead crowns. No canopy and few subcanopy white pine suffered crown dieback.

The difference in dieback and tree mortality between the species may be explained, in part, by differences in defoliation. Hemlock was most severely defoliated at the top of the crown. White pine, on the other hand, was most severely defoliated in the lower crown. Additionally, the clusters of terminal and lateral buds for the next year's growth of white pine, which are already present in June, are undisturbed by defoliation. In contrast, the less robust shoots of hemlock tend to grow continuously during late spring and early summer. Apparently, the smaller lateral buds and tender tips without terminal buds are more easily damaged by defoliation. Unlike deciduous trees, hemlock does not sprout. Therefore, loss of lateral buds and growing tips prevents production of additional foliage and buds. Hemlock branches and trees without foliage or buds soon die.

Now we can ask the question: will recurrent defoliation by gypsy moth gradually eliminate conifers from Connecticut forests? The outcome is uncertain. It is clear, however, that severe defoliation as in 1981 will kill hemlocks of all sizes and cause some mortality among understory white pine.

Table 1. Cumulative mortality of hemlock and white pine expressed as percent of stems.

	Hemlock			White Pine		
Canopy position	No. trees	1982	1983	No. trees	1982	1983
Canopy	63	29	35	61		
Subcanopy	239	39	43	321	9	16

Table 2. Average defoliation in 1981 of hemlock and white pine dying in 1982 and 1983 expressed as percent of foliage removed.

	Hemlock			White Pine		
Canopy position	All trees	Died 1982	Died 1983	All trees	Died 1982	Died 1983
Canopy	80	99	100	64		
Subcanopy	75	100	90	77	90	81

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Testing determines compliance with claims on pesticide labels

By Martha Fuzesi

In 1983, the Experiment Station tested 210 official samples from 49 manufacturers. These included pesticide formulations, products for pet care, and products used in pools. Because some products contained more than one active ingredient, 306 guarantees were examined. Table 1 shows how many of each type of product were tested and the percentage meeting the label guarantees.

Pesticide samples are collected by inspectors of the Connecticut Department of Environmental Protection from wholesalers or retailers, from materials being applied by users, or upon complaints by consumers. Because the pesticide formulations tested for compliance with label claims are relatively concentrated, they are analyzed differently from food products being tested for trace amounts of residues under another program being carried out by the Experiment Station in cooperation with the State Departments of Agriculture and Consumer Protection.

Although there are many different pesticides, only one or two methods of analysis may exist for each compound. The current edition and supplements of the Official Methods of the Association of Official Analytical Chemists (AOAC) is generally accepted as containing the most valid methods. The methods have been tested collaboratively between laboratories—including the Experiment Station's Laboratory—and their statistical reliability has been confirmed. Other methods are published in scientific journals or in other literature. As new products appear, they often have no published analytical methods or the methods that are available are non-specific and time consuming. In this case it is necessary to establish new methods through experimentation.

The most common pesticides examined were in materials containing diazinon, carbaryl, malathion, and pyrethrins, which accounted for 40 percent of all tests. The concentration of active ingredient in a product could vary from 0.005 percent in rodenticides to a high of over 80 percent in insecticides. Pesticide formulations with lower percentages of active ingredients are usually sold in fertilizers, baits or pressurized spray cans for use in the home or garden. Those with high concentrations are sold to licensed pesticide applicators who dilute them before use.

Consider diazinon, a broad spectrum insecticide,

Table 1. Results of analyses on products tested during 1983.

Garden and Household Pesticides		Pet Preparations		Pool Products Disinfectants Wood Preservatives	
No.	% Meeting Guarantee	No.	% Meeting Guarantee	No.	% Meeting Guarantee
164	98	20	95	26	74

Pesticide testing in Connecticut

Pesticides are tested to uncover a deficiency, which means that there is insufficient or no active ingredient, or to uncover an over-formulation, which means there is too much of the active ingredient. Insufficient active ingredient could mean that a treatment is ineffective, and over-formulation could be hazardous to the applicator, plants, or animals or could lead to residues that exceed allowable tolerances after treatment.

In 1923, the Connecticut General Assembly enacted a law regulating pesticides that was modeled after the federal Insecticide Act of 1910. It required the Experiment Station to test insecticides and fungicides and to publish results of analyses. In 1964, the law was amended to require that all pesticides be sampled under the joint direction of the Commissioner of Agriculture and the Director of The Connecticut Agricultural Experiment Station.

Pesticides are chemicals used to control insects, plant pathogens, rodents, weeds, and nematodes, or chemicals used to repel pests, control plant growth, disinfect, or preserve wood, or chemicals added to swimming pools. They come in such forms as dusts, wettable powders, baits, and suspensions, or they may be in pressurized containers or impregnated in plastic such as a pet collar.

In 1971, the authority of the Commissioner of Agriculture under the act was transferred to the Commissioner of Environmental Protection. In 1977, the U.S. Environmental Protection Agency closed its regional pesticide laboratory and established a cooperative program with the State of Connecticut to carry out analyses.

Over 30,000 pesticide products formulated from 1,000 different chemical compounds are registered with the federal government. About one in four is registered for sale and use in Connecticut.

which is used against a large variety of orchard, vegetable, and soil pests such as chinch bugs, sod webworms, and Japanese beetle grubs. For a product with a claim of 5 percent diazinon in a granular formulation, the following steps are involved: First, the sample is ground in a Wiley mill to ensure a homogeneous mixture. Then, the active ingredient is separated from the inert ingredients. To do this, a portion representing 0.1 gram of diazinon (2 grams of a 5 percent mixture) is placed in a flask with 100 milliliters of acetone. The acetone/pesticide mixture is agitated with a magnetic stirrer for one hour to dissolve and extract the diazinon. The resulting material is centrifuged or filtered, taking care not to allow any liquid to evaporate. The final concentration in the liquid should be about 1 milligram of diazinon per milliliter. Then, a standard solution of 1 milligram pure diazinon per milliliter is prepared for comparison with the sample. Two microliters (0.002 ml) of the test sample and the standard solution are injected three times alternately into a gas chromatograph with flame ionization detector. The gas chromatograph separates the components of the sample. The resulting strip chart is called a chromatogram. The identity of the test sample is confirmed by comparing the recordings, and the percent diazinon in the sample is calculated by comparing the results for the test sample with results for the standard solution. This test takes approximately three hours from start to finish.

After the testing is completed, the results are sent to the Department of Environmental Protection for use in its regulatory program and a copy is sent to the manufacturer. At the end of the year, the results are compiled and published in a Station Bulletin, which lists brand names, the percentage of active ingredients guaranteed and found. This bulletin is available free from Publications, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504-1106.

Table 2. Pesticide formulations analyzed during three 10-year periods.

Years	Manufacturers	No. of Samples
1942-51	—	210
1964-73	470	1877
1974-83	576	2661

Flowering dogwood decline due to drought, disease, and cold winters

By Gerald S. Walton

The flowering dogwood, *Cornus florida*, grows throughout most of the eastern United States. In New England, its northern limit is southern Vermont, New Hampshire and southwestern Maine. It is planted extensively in the landscaping around homes and is an understory tree in the woods. The number of people who attend the dogwood festival in Greenfield Hills in Fairfield County each year and the number of people who schedule parties and weddings around the time of flowering of the dogwood are testimonies to its beauty.

In Fairfield County in 1979, several dogwoods were observed with discolored leaves and dead twigs and branches in the lower part of the trees. These symptoms of decline have now been observed in dogwood throughout much of the state (Fig. 1). The decline is widespread both in trees in landscape plantings and in the woods. Both white- and pink-flowered dogwoods are susceptible. I have seen only two instances of infection in Kousa dogwood.

When I examine the affected trees closely, I often see small, pinhead-size spore-bearing structures, which vary in color from reddish brown to black. Microscopic examination and isolation of the microbes in culture showed that two fungi—*Botryosphaeria* sp. and *Discula*, previously called *Myxosporium* sp.—were most frequently associated with the decline. Scientists on Long Island have associated only *Discula* with this disorder. *Botryosphaeria* is found on the twigs and branches and is recognized by its black spore-bearing structures. *Discula* is found on the leaves and twigs and is recognized by its reddish to reddish brown spore-bearing structures.

My observations in the field indicate that *Discula* infections are characterized by small (1/8 inch) reddish to maroon spots on the leaves. As the spots enlarge, they often coalesce with other spots, discoloring a quarter or

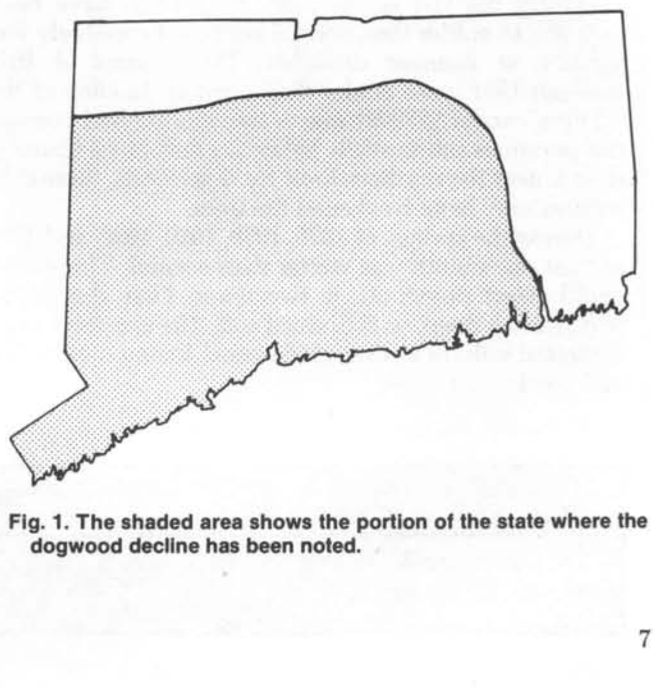

Fig. 1. The shaded area shows the portion of the state where the dogwood decline has been noted.

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more of the leaf. The fungus then grows through the petiole of the infected leaf and into the twig. The infected twig turns light gray. *Discula* has only been observed on twigs smaller than 1/4 inch in diameter.

Although *Botryosphaeria* has been observed only on woody tissue, it has been found on both small twigs and larger branches.

Reviewing previous reports on dogwood diseases, I noted that both fungi were reported to cause a leaf or branch disease of dogwood. Normally, however, these fungi kill at most a few twigs or a branch or two. Why then, if either or both of these two fungi are truly causing the present widespread decline, are we now seeing the death of many lower branches and, in some cases, whole trees?

I hypothesize that the increased susceptibility of dogwood to these fungi is caused by weakening of the trees by unusually harsh weather, by dogwood borers, and by fungal leafspots. These stress factors may work individually or in combination on a single tree.

During the last seven years dogwoods have been exposed to colder than normal winters, excessively wet springs, or summer droughts. The winters of 1977 through 1981 were colder than normal. In each of the winters, except 1979-80, one or two months had average temperatures substantially below normal. Since Connecticut is near the northern limit for dogwoods, these cold winters may have weakened the trees.

During the springs of 1978, 1979, 1980, 1982, and 1984 at least one month was wetter than normal. This excess could affect dogwoods in two ways. First, dogwoods prosper in a deep, well drained soil. The excessive rains saturated soils for an extended period, killing some roots, and weakening a tree.

The spring rains also provide the moisture that is necessary for the fungi, including the previously mentioned *Discula*, to infect the leaves and cause the various leafspot diseases. The spotting of the leaves and the defoliation that sometimes occurs, stress a tree.

The summers between 1977 and 1983 each had extended droughts. For at least a month within each of these years, rainfall was substantially below normal. Dogwoods are sensitive to drought. In fact, when a dry period occurs, dogwoods are one of the first trees to have wilted and discolored leaves.

In addition to the previously mentioned weather factors and the fungal leafspots, dogwood borers were found in many of the declining trees. After examining 142 declining dogwood trees, however, I found that about half had no borers. Thus, although there may be a correlation between the severity of decline symptoms and borer infestation, borers do not appear to be the major factor causing decline.

What can be done to treat a declining dogwood? First, dead branches may be removed. It is upon these that the canker fungi produce the spores that spread the fungi. Although a dogwood is not a heavy feeder, the addition of a fertilizer such as 5-10-10 in the spring may increase the vigor of the tree, assisting it in resisting fungal infection and recovering from previous infections. Finally, sprinkling will relieve drought. The water is most easily applied by running a lawn sprinkler beneath the tree until at least an inch of water has been applied. Such an application can be made every 7-10 days during an extended drought.

I am continuing research that will determine the time when infection occurs and pesticides that may be effective against the two fungi.

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