Research Reports

Evaluation of Eight Species of *Cornus* for Resistance to Dogwood Anthracnose[1]

James L. Sherald[2], Tammy M. Stidham[3], and Libby E. Roberts[4]
Center for Urban Ecology, National Biological Survey
4598 MacArthur Boulevard, N.W.
Washington, DC 20007

Abstract

Eight species and one cultivar of *Cornus*: *C. florida* L. (flowering dogwood), *C. kousa* (Buerger ex Miquel) Hance (Chinese dogwood), *C. alba* L. (Siberian dogwood), *C. alternifolia L.* (pagoda dogwood), *C. sericea* L. (red-osier dogwood), *C. sericea 'Flaviramea'* (yellow twig dogwood), *C. racemosa* Lam. (gray stem dogwood), *C. amomum* Mill. (silky dogwood), and *C. mas* L. (Cornelian cherry) were subjected to natural infection by *Discula destructiva* for two or three years. The area of exposure exhibited a 35% increase in mortality of native *C. florida* over a four year period. Only the eight *C. florida* test plants developed dogwood anthracnose symptoms and six of these plants died after three years. All other species remained free of dogwood anthracnose. Under more severe disease conditions other *Cornus* species may develop dogwood anthracnose. Ideally, resistance testing should be performed under laboratory or greenhouse conditions where inoculum and environmental conditions can be controlled.

Index words: dogwood, dogwood anthracnose, resistance, *Discula destructiva*.

Species used in this study: flowering dogwood (*C. florida* L.); Chinese dogwood (*C. kousa* (Buerger ex Miquel) Hance); Siberian dogwood (*C. alba* L.); pagoda dogwood (*C. alternifolia* L.); red-osier dogwood (*C. sericea* L. (= *C. stolonifera* Michx.); yellow twig dogwood (*C. sericea 'Flaviramea'*); gray stem dogwood (*C. racemosa* Lam.); silky dogwood (*C. amomum* Mill.);, and Cornelian cherry (*C. mas* L.).

Significance to the Nursery Industry

Dogwood anthracnose is a major concern in the nursery and landscape industry. Although *Cornus florida* and *C. nuttallii* are known to be susceptible, there is considerable interest in the susceptibility of many other *Cornus* species and cultivars. Currently the only way to evaluate resistance is by exposing plants to natural infection. Many of the species tested in this study were found to be resistant, however, exposure to anthracnose in areas with more conducive disease conditions has shown some of the same species to be susceptible. The study demonstrates the need for the development of controlled screening procedures where the inoculum and environmental conditions can be managed to achieve uniform infection and symptom development. Such a system is essential before resistance levels can be reliably determined.

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[2]Plant Pathologist.
[3]Biological Technician.
[4]Horticulturist.

Introduction

Dogwood anthracnose, caused by *Discula destructiva* Redlin (11), has been recognized as a serious disease since

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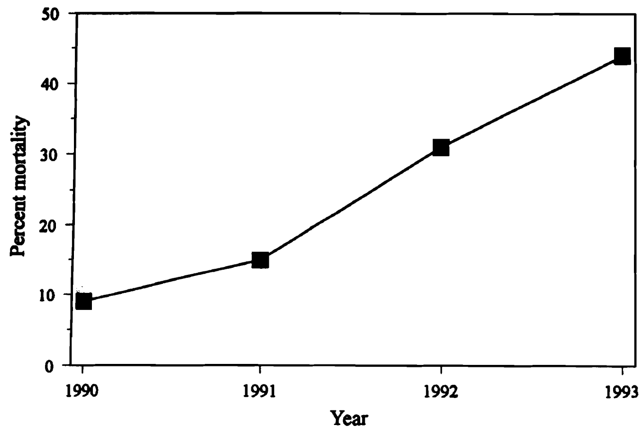

Fig. 1. **Mortality of native dogwoods, *Cornus florida*, caused by *Discula destructiva* from 1990 through 1993 in a 0.04 ha (0.10 A) plot in Rock Creek Park, Washington, DC.**

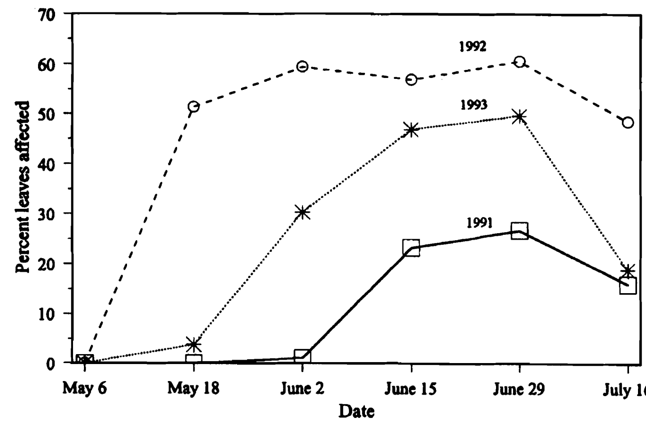

Fig 2. **Percent leaves exhibiting leaf spots caused by *Discula destructiva*. Percent represents the mean of eight *Cornus florida* plants.**

the late 1970s. The disease affects the flowering dogwood *Cornus florida* L. in the East and the Pacific dogwood, *C. nuttallii* Aud., in the Pacific Northwest (2, 7). Since its first report in the northeast, the disease has spread down the Appalachians to northern Alabama. In the last 15–20 years, approximately 20% of the natural range of *C. florida* has become affected. In some areas the disease has caused severe mortality. Areas that have the propensity for prolonged leaf wetness, such as those at higher elevations, north facing slopes, and proximity to water courses are the most severely affected (1, 3, 19). In Catoctin Mountain Park in north-central Maryland, surveys in 1984 and 1988 found 33% and 79% mortality respectively in the transects surveyed (10, 16). Currently, only *C. florida* and *C. nuttallii* are known to be primary hosts of *D. destructiva*. *Cornus nuttallii* is not as severely affected since the disease does not usually cause trunk cankering and mortality as occurs in *C. florida* (12); however, severe infection can cause mortality (18).

Although dogwood anthracnose is most severe in natural settings, the disease also affects landscape plantings, causing widespread concern within the nursery and landscape industries. The genus *Cornus* is composed of approximately 60 species, subdivided into 8 subgenera (4, 13). Approximately 20 species are native to North America. There is concern both in the United States and abroad that the disease may be a threat to other native as well as horticulturally significant species and cultivars. *C. alternifolia* L., for example, is native to the United States and commonly found throughout much of the northern range of *C. florida*. Like *C. florida*, *C. alternifolia* is an important source of food for birds and small mammals. *C. mas* L. is a significant species in Europe and widely used as an ornamental in Europe and the United States. Little is known about the susceptibility of these and other *Cornus* species to dogwood anthracnose. *C. kousa* (Buerger ex Miquel) Hance, the Chinese dogwood, is believed to be resistant. However, in an unusual setting where overhead irrigation was provided, *C. kousa* developed leaf symptoms and some trees died (9). Hibben et al. also reported that *C. kousa* and *C. kousa chinensis* became infected with dogwood anthracnose in an area in New York where *C. florida* had almost been eliminated by dogwood anthracnose; however, these species had significantly less infection than *C. florida* (8). In the same study, *C. racemosa* Lam. and *C. canadensis* L. showed no symptoms. Santamour also observed small circular lesions less than 1 mm (0.04 in) in diameter, affecting 29% of the leaves on *C. kousa*, but no leaf loss was observed (15). In the same study, *C. florida* provenances were severely affected. In a study performed in the Great Smoky Mountains National Park and in Ozone Tennessee, nine species of *Cornus*, including cultivars of four species, were evaluated (20). Species included *C. florida*, *C. kousa*, *C. alba* L., *C. alternifolia*, *C. amomum* Mill., *C. angustata* Chun, *C. controversa* Hemsley, *C. mas*, and *C. stolonifera* (*C. sericea*). Symptoms developed in all species and *D. destructiva* was isolated from each. Significant differences in varietal or cultivar response were noted in *C. alba*, *C. kousa*, and *C. stolonifera*. Since many *Cornus* species have natural and horticultural significance their vulnerability to dogwood anthracnose should be well understood. Consequently, our study was designed to examine the susceptibility of several species of *Cornus* within an area of Washington, DC where dogwood anthracnose was prevalent and causing mortality.

Materials and Methods

Plant material. Eight commercially available species and one cultivar were evaluated in the study: *C. florida* (flowering dogwood), *C. kousa* (Chinese dogwood), *C. alba* (Siberian dogwood), *C. alternifolia*, (pagoda dogwood), *C. sericea* L. (= *C. stolonifera* Michx.) (red-osier dogwood), *C. sericea 'Flaviramea'* (yellow twig dogwood), *C. racemosa* (gray stem dogwood), *C. amomum* (silky dogwood), and *C. mas* (Cornelian cherry). Plants were purchased as bareroot saplings (0.61–0.92 m [2.5–3.0 ft]) and potted in 11 or 19 l (3 or 5 gal) plastic containers. Bottoms were removed to encourage rooting outside the pots allowing for temporary establishment at the site for three years. Drip irrigation was installed to provide water during periods of drought.

Test site. Eight to ten plants of each selection except *C. amomum* and *C. mas*, were randomly placed 0.8–0.9 m (2.5–3.0 ft) apart under the canopy of infected dogwoods in Rock Creek Park, Washington, DC, on April 5, 1991. *C. amomum* and *C. mas* were installed on April 6, 1992. The site was located on a slight slope with an exposure of 105° at an

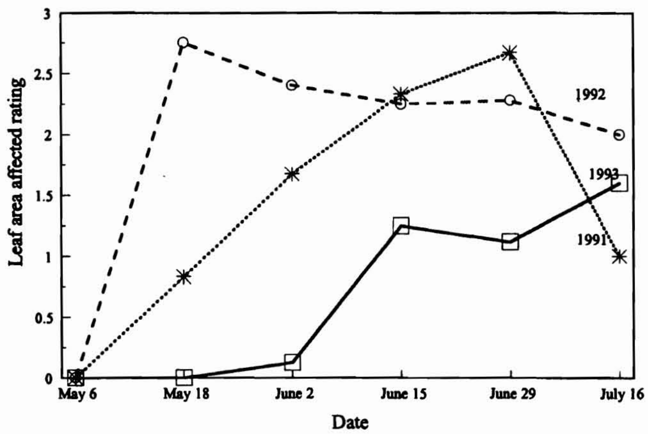

Fig. 3. **Rating of leaf area affected by dogwood anthracnose. Ratings represent the mean of eight *Cornus florida* plants. Ratings: 0 = healthy, 1 = trace–5%, 2 = 6–25%, 3 = 26–50%, 4 = 51–75%, 5 = >75%, and 6 = dead.**

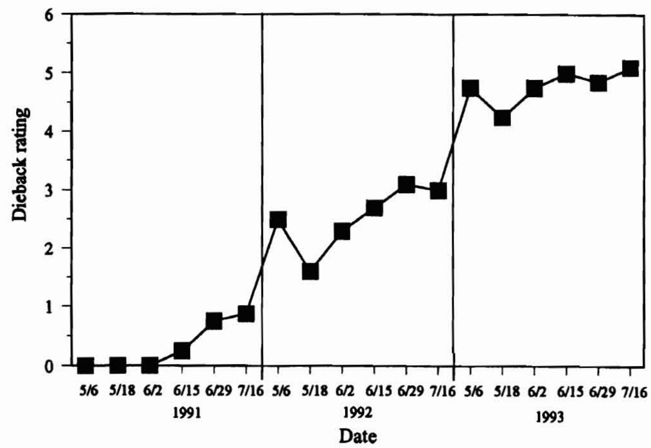

Fig. 4. **Dieback rating from 1991 through 1993. Ratings represent the mean of eight *Cornus florida* plants. Ratings: 0 = healthy, 1 = trace–5%, 2 = 6–25%, 3 = 26–50%, 4 = 51–75%, 5 = >75%, and 6 = dead.**

elevation of 104 m (341 ft) above sea level. Dogwood anthracnose was first detected at the site in 1989. Mortality of native dogwoods in the study area was determined from 1990 through 1993. A 0.04 ha (0.10 A) circular plot (radius 11.3 m [37 ft]) in the middle of the site where the experiment was established was examined each year. All native dogwoods within the plot were mapped, numbered and evaluated for mortality.

Disease evaluation. Plants were evaluated for symptoms biweekly from May 6 to July 16 through 1993. All leaves were counted to determine the percent leaves affected. The percent leaf area affected and dieback were rated according to the following scale: 0 = healthy, 1 = trace–5%, 2 = 6–25%, 3 = 26–50%, 4 = 51–75%, 5 = >75%, and 6 = dead. Samples were collected from each affected plant for isolation and identification of the pathogen. Twig and leaf samples were placed in a moist chamber to induce sporulation and conidia were transferred to potato dextrose agar for culture.

Results and Discussion

Native *C. florida*, 106 trees, were numbered and mapped within the 0.04 ha (0.10 A) plot. In 1990, 9% mortality was already evident among the native dogwoods (Fig. 1). By 1993, mortality had risen to 44%. Affected trees exhibited leaf spots and stem cankers characteristic of dogwood anthracnose and *D. destructiva* was isolated from affected trees.

Among the test plants, leaf symptoms first appeared on one plant of *C. florida* on May 18, 1991 approximately six weeks after the plants were installed (Fig. 2). By June 15, 1991, seven of eight *C. florida* plants exhibited symptoms. Each year the percent leaves affected in *C. florida* increased from May until early to mid June and then remained constant until late June when defoliation began to occur (Fig. 2). Leaf necrosis increased through mid to late June (Fig. 3). Symptom development, number of leaves and percent leaf area affected, was most rapid and severe in 1992 (Figs. 2 and 3).

Dieback was first evident in the *C. florida* test plants on June 15, 1991. Two of eight plants had developed ratings of 1 and 2 (mean 0.03) 10 weeks after the plants were placed in the plot (Fig. 4). By July 16, 1991, the rating had risen to 0.8 with 7 trees showing dieback. On May 6, 1992, the mean dieback rating for *C. florida* had risen to 2.5, with all 8 plants exhibiting dieback. By July 16, one plant had died. At the first rating in 1993 three more trees had died, raising the rating to 4.9. Another tree died in 1993 and the dieback rating reached 5.3 with the surviving two trees rated as 2 and 3 on July 16. The decline in the May 18 dieback ratings in 1992 and 1993 was a result of overestimating dieback on May 6 before the trees were in full leaf.

Throughout the three-year exposure to natural infection none of the other species developed symptoms characteristic of dogwood anthracnose. In 1992 and 1993, leaves of *C. kousa* and *C. mas* developed a few small circular necrotic lesions on several leaves; however, fruiting could not be induced in the moist chamber and no fungi were isolated. No dieback occurred on any species other than *C. florida*.

Dogwood anthracnose was well established in the site when the study was initiated. Mortality of naturally occurring trees increased by 35% in the three years of the study and infection of *C. florida* test plants occurred readily. All eight *C. florida* trees became infected in a single year and six were dead after three years. *D. destructiva* was isolated from each of the infected trees.

The lack of symptom development in *C. alba, C. sericea, C. sericea 'Flaviramea', C. mas, C. amomum, C. kousa, C. alternifolia,* and *C. racemosa* after two or three years exposure to infection indicates that these species were resistant to dogwood anthracnose under the prevailing conditions of the site. Under more optimal conditions for disease development, some of these species might have developed symptoms. For example, Windham et al. found that after exposure to natural infection for only one year *C. florida, C. alba, C. angustata, C. kousa, C. amomum, C. alternifolia, C. mas. C. florida, C. stolonifera (C. sericea),* and *C. controversa* all developed symptoms (20). The Tennessee study may have been conducted in areas where conditions were more conducive to disease than those in Rock Creek Park, where the elevation is only 104 m (341 ft) and the rainfall for April through July, 1991–1993, was 34.67 cm (13.65 in), 43.50 cm (17.12 in), and 36.01 cm (14.18 in) respectively.

The Rock Creek study found *C. kousa* to be resistant. *C. kousa* has developed some symptoms under artificial overhead irrigation as well as in natural settings (8, 9, 15, 20). Windham et al. noticed that *C. kousa* var. *chinensis* was more susceptible than *C. kousa* (20). *C. kousa* var. *chinensis* is not a recognized cultivar and is suspect even as a variety (14). There may be a range of resistance within the selections referred to as *"chinensis"* as well as within the species and its many cultivars. Windham et al. also noted significant differences in susceptibility among cultivars of *C. alba* and *C. stolonifera* (20).

Six *C. kousa* x *C. florida* hybrids have been developed; 'Aurora', 'Constellation', 'Galaxy', 'Ruth Ellen', 'Stellar Pink', and 'Stardust' (17). All six hybrids were installed in Rock Creek Park in April 1992. In the two years they were evaluated, all developed leaf spotting characteristic of dogwood anthracnose; however, no severe leaf necrosis or dieback occurred. *D. destructiva* was isolated from each hybrid.

A provenance study of *C. florida* indicated no apparent host genetic barriers to the geographic spread of dogwood anthracnose (15). In areas of high mortality, however, trees with little or no symptom development have been observed (5, 6). These trees may be escapes or may be resistant to dogwood anthracnose.

From our study and others it is apparent that 1.) susceptibility will vary depending upon the environmental conditions under which the plants are tested, 2.) other species besides *C. florida* and *C. nuttallii* are susceptible, and 3.) there is a range of susceptibility within species of *Cornus*.

The susceptibility of species, named cultivars and putative resistant selections must be further examined. Ideally, resistance tests would be performed under conditions where the inoculum and environmental parameters can be controlled to reliably induce uniform infection and disease development. It is also important to be able to simulate conditions of the areas of concern, since species may be resistant under some environmental conditions and not under others. Unfortunately, attempts to consistently achieve infection under controlled conditions have not been successful. Further study is necessary to decipher the critical factors that must be attained to achieve consistent results in a controlled environment.

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