RESISTANCE TO DOGWOOD ANTHRACNOSE AMONG *CORNUS* SPECIES

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Abstract. Dogwood anthracnose caused by *Discula destructiva* poses a threat to flowering (*Cornus florida*) and Chinese (*C. kousa*) dogwood in the eastern United States and to Pacific or western dogwood (*C. nutallii*) in the Pacific Northwest. Differences exist in the impact the pathogen has on these hosts (subjectively in the order *C. florida* > *C. kousa* and *C. nutallii*). Ten *Cornus* species, including *C. alternifolia*, *C. amomum*, *C. controversa*, *C. alba*, *C. augustata*, *C. florida*, *C. kousa*, *C. mas*, *C. sericea*, and *C. stolonifera*, were evaluated for disease reaction in 1991 and 1992 at locations in eastern Tennessee infested with *D. destructiva*. Greatest disease severity in 1991 was observed on *C. controversa*, *C. florida*, *C. kousa* cv 'Chinensis', and *C. sericea*. In 1992, *C. florida*, *C. sericea*, *C. kousa* cv 'Chinensis', *C. alba*, and *C. stolonifera* cultivars appeared susceptible to anthracnose. Symptoms developing on each appeared similar to those observed on flowering dogwood, and *D. destructiva* was successfully isolated from lesions within the canopy of the trees. Other *Cornus* species tested, including an unnamed Chinese dogwood cultivar, appeared resistant. The results of this study indicate that concerns regarding the anthracnose susceptibility of native and ornamental *Cornus* species may be raised. Finally, the possibility should be considered that infected *Cornus* species (other than *C. florida*) might serve as a mechanism for the introduction of *D. destructiva* into anthracnose-free areas of the United States.

Dogwood anthracnose has become a serious threat to flowering dogwoods (*Cornus florida* L.) of the eastern United States. This disease, caused by the imperfect fungus *Discula destructiva* (8), should not be confused with spot anthracnose caused by *Elsinoe corni*, a common nonthreatening foliar disease of flowering dogwood. Initially referred to as lower branch dieback, dogwood anthracnose was first observed on flowering dogwood in the northeastern United States (4) and on western flowering dogwoods (*C. nuttallii*) in the northwestern United States and southwestern Canada (2). Mortality due to anthracnose has been observed within native flowering dogwood populations. Mielke and Langdon (7) reported that 97% of *C. florida* in Catoctin Mountain Park, Maryland, showed characteristic dogwood anthracnose symptoms and nearly 33% of trees were dead. Schneeberger and Jackson (9) reported 79% mortality of dogwood in that same area. *D. destructiva* is commonly isolated from blighted leaves, twigs, shoots, and berries from anthracnose-infected dogwoods. Infection of epicormic shoots by the fungus may lead to the development of annual cankers, an abundance of which may coalesce, girdle the stem, and lead to tree death. Anthracnose symptoms have been reported on Chinese dogwood (*C. kousa*), another *Cornus* species used in ornamental plantings (1,5); however, controversy exists regarding the susceptibility of Chinese dogwoods to *D. destructiva* infection.

Given the aesthetic and commercial value of flowering dogwood in the southeastern United States and interest in the development of additional ornamental *Cornus* species for the urban market, a study was initiated in 1991 at the Tennessee Agricultural Experiment Station to evaluate 10 *Cornus* species for their relative resistance or susceptibility to anthracnose caused by *D. destructiva*. An important objective of this study was to describe symptoms of anthracnose infection on susceptible *Cornus* species and document the presence of the pathogen within symptomatic plants. By doing so, the potential for the introduction of *D. destructiva* into anthracnose-free areas of the United States via infected *Cornus* species might be reduced and roles for susceptible species as sources of *D. destructiva* within the landscape might be identified.

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Materials and Methods

Trees were grown in 5-gallon containers in a composted bark mix commonly used in the production of woody ornamental species. In addition, a timed-release fertilizer (Osmocote™ 14-14-14) was incorporated into the growing medium to maintain adequate nutrient status within the containers.

Seven *Cornus* species (with 5 replications), including *C. alternifolia* [common name: Pagoda dogwood (3)], *C. amomum* [common name: silky dogwood (3)], *C. controversa* [common name: giant dogwood (3)], *C. florida*, *C. kousa*, *C. kousa* cv 'Chinensis', *C. mas* [common name: Cornelian cherry dogwood (3)], and *C. sericea* [common name: Redosier dogwood (3)], were placed in a disease resistance trial at Ozone, Tennessee, in May 1991. This site was chosen due to its recent history of severe anthracnose infection (Windham, unpublished). Trees were placed under native flowering dogwoods with severe dogwood anthracnose symptoms, watered by hand as necessary, and rated weekly for disease development using the Horsfall-Barratt disease assessment scale (6). Comparisons regarding disease susceptibility or resistance were made in relation to symptoms developing on the flowering dogwood.

Ten *Cornus* species (with 6 replications), including those species listed above for the year-1 resistance screening test (except *C. sericea*), plus 4 *C. stolonifera* [also referred to as *C. sericea* (3)] cultivars ('Kelseyi', 'Flaviramea', 'Ruby', and 'Isantii'), 2 *C. alba* [common name: Tatarian dogwood; closely allied to *C. sericea* (3)] cultivars ('Elegantissima Variegata' and 'Bloodgood'), *C. mas* cv 'Golden Glory', and *C. augustata* were placed in field sites at Ozone, Tennessee, and at 2 locations within the Great Smoky Mountains National Park in May 1992. These species were evaluated 3 times over the course of the growing season, as described above.

Results and Discussion

In both 1991 and 1992, significant differences in response to anthracnose infection were observed among species and cultivars. Results from 1991 (Table 1) indicate that—while not statistically different from *C. florida*—*C. controversa*, *C. sericea*, and most surprisingly, *C. kousa* cv 'Chinensis' were at least as susceptible to anthracnose as was *C. florida*. In 1992 (Table 2), 3 of the 4 *C. stolonifera* cultivars, as well as *C. kousa* cv 'Chinensis' and *C.*

Table 1. Results of 1991 anthracnose resistance screening study.[1]

	% Diseased foliage[2]		
Species	June 21	July 5	July 27
C. alternifolia	3 ab	2 a	1 a
C. amomum	0 a	3 a	1 a
C. controversa	22 bcd	48 b	61 bc
C. florida	30 d	37 b	40 b
C. kousa	11 abc	11 a	2 a
C. kousa var. *chinensis*	33 d	54 b	71 c
C. mas	8 abc	7 a	2 a
C. sericea	23 cd	40 b	48 bc

[1]Anthracnose estimated using the Horsfall-Barratt disease assessment scale (6). The percentage of diseased foliage represents the visual estimate of the percentage of symptomatic leaves within the tree canopy.

[2]Within each column, means followed by the same letter do not significantly differ according to Duncan's New Multiple Range Test (p = 0.05).

Table 2. Results of 1992 anthracnose resistance screening study.[1]

	% Diseased foliage[2]		
Species	July 17	July 28	Sept 2
C. alba 'Bloodgood'	6 a[3]	6 a	48 b
C. alba 'Elegantissma'	8 a	18 b	88 c
C. alternifolia	3 a	7 a	8 a
C. amomum	3 a	3 a	11 a
C. augustata	5 a	5 a	5 a
C. controversa	3 a	23 b	13 a
C. florida 'Cherokee Princess'	38 b	72 c	76 c
C. kousa	15 a	7 a	13 a
C. kousa var *chinensis*	18 ab	60 c	88 c
C. mas	2 a	4 a	5 a
C. mas 'Golden Glory'	3 a	3 a	8 a
C. stolonifera 'Flaviramea'	28 b	71 c	82 c
C. stolonifera 'Isanti'	4 a	9 ab	46 b
C. stolonifera 'Kelseyi'	38 b	61 c	58 bc
C. stolonifera 'Ruby'	3 a	4 a	6 a

[1]Differences in disease severity between locations were significant. As such, data were combined and means separation performed.

[2]Anthracnose estimated using the Horsfall-Barratt disease assessment scale (6). The percentage of diseased foliage represents the visual estimate of the percentage of symptomatic leaves within the tree canopy.

[3]Within each column, means followed by the same letter do not significantly differ according to Duncan's New Multiple Range Test (p = 0.05).

alba, were as susceptible as *C. florida* was to anthracnose.

The status of anthracnose resistance among Chinese dogwoods has been debated. Previously, we have reported on infections occurring within *C. kousa* populations present on Lookout Mountain, Tennessee (1). *D. destructiva* was successfully isolated from Chinese dogwoods exhibiting characteristic anthracnose symptoms and no unusual environmental condition accompanying the disease was observed. The results of this study (Tables 1 and 2) indicate that *C. kousa* cultivars indeed vary with respect to their resistance and/or susceptibility to dogwood anthracnose. The cultivar *C. kousa* var. 'Chinensis' proved quite susceptible to dogwood anthracnose. In contrast, the *C. kousa* seedling material included in this test may possess a genetic basis for disease resistance to anthracnose that could be identified and exploited in future tree improvement programs. The differential response of *C. alba* and *C. stolonifera* cultivars (Table 2) also offers additional evidence for a genetic basis for anthracnose resistance.

A key concern raised by our results is the infection of *Cornus* species other than *C. florida*, *C. kousa*, and *C. nuttallii* by *D. destructiva*. Three of the four *C. stolonifera* cultivars included in this study were anthracnose-susceptible (Table 2). Both *C. alba* selections tested, albeit to varying extents, were infected by *D. destructiva*. Perhaps of most concern, however, is the development of *D. destructiva* anthracnose symptoms on *C. sericea*. Yellow- and red-twig dogwoods are highly valued by homeowners for their characteristic twig color in fall and winter and are commonly found in a wide variety of landscapes. The susceptibility of these ornamental *Cornus* species to anthracnose raises the possibility that they 1) might play a role in anthracnose epidemics as they become infected and harbor *D. destructiva* propagules that might in turn infect flowering dogwoods or 2) might serve as a means for the introduction of *D. destructiva* into anthracnose-free areas through the transport of infected *C. sericea*, *C. alba*, and *C. stolonifera*. Those involved in the scientific, regulatory, and production communities should bear in mind these results as experiments, regulations, and growing practices are developed.

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Résumé. L'anthracnose du cornouiller causée par *Discula destructiva* constitue une menace pour le *Cornus florida* et le *C. kousa* dans l'Est des États-Unis et pour le *C. nutallii* pour les régions au nord sur la côte du Pacifique. Des différences existent en regard de l'impact que la maladie a sur ces hôtes (de façon subjective dans cet ordre, *C. florida* > *C. kousa* et *C. nutallii*). Dix espèces de *Cornus* ont été plantées en divers endroits du Tennessee infestés par *D. destructiva* pour effectuer des essais de résistance à la maladie au cours des années 1991 et 1992. Au cours de l'année 1991, le degré de sévérité de la maladie a été le plus élevé pour *C. controversa*, *C. florida*, *C. kousa* cv 'Chinensis' et *C. sericea*. En 1992, les espèces qui étaient susceptibles à l'anthracnose sont *C. florida*, *C. sericea*, *C. kousa* cv 'Chinensis', *C. alba* et *C. stolonifera*. Les symptômes développés sur chacun d'eux étaient similaires à ceux observés sur le *C. florida* et les champignons de *D. destructiva* ont pu être isolés avec succès à partir de lésions présentes dans le cime des plantes. Un cultivar chinois non identifié de cornouiller est apparu résistant à l'anthracnose.

Zusammenfassung. Der Hartriegelkrebs, verursacht durch *Discula destructiva* stellt eine Bedrohung für *Cornus florida*- und *C. kouza*-Bestände in den östlichen USA und für *C. nutallii* im pazifischen Nordwesten dar. Es bestehen Unterschiede in der Einflußnahme des Erregers auf die Wirtspflanze (in der Reihenfolge *C. florida, C. kouza* und C. *nutallii*). 1991 und 1992 wurden an Standorten im Osten von Tennessee zehn Cornus-Arten, die mit *D. destructiva* infiziert wurden, in krankheitsresistente Versuchsanlagen ausgepflanzt. 1991 wurde der schwerste Ausbruch der Krankheit bei *C. controversa, C. florida, C. kouza* var. 'Chinensis' und *C. sericea* beobachtet. 1992 erschienen *C. florida, C. sericea, C. kouza* var 'Chinesis', *C. alba* und Unterarten von *C. stolonifera* anfällig für die Anthracnose. Die an den einzelnen Sträuchern auftretenden Symptome erschienen ähnlich denen, die an *C. florida* beobachtet wurden und *D. destructiva* konnte erfolgreich aus den Wurden innerhalb der Krone isoliert werden. Eine unbenannte Unterart des chinesischen Hartriegels erschien resistent gegen die Anthracnose.