

Cornus florida 'Appalachian Spring': A White Flowering Dogwood Resistant to Dogwood Anthracnose

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Flowering dogwood (*Cornus florida* L.) has been an important ornamental tree and a profitable product of the nursery industry for many years. However, during the last decade the popularity of this tree has waned because of severe epiphytotic of dogwood anthracnose (Daughtrey et al., 1996). Since symptoms of dogwood anthracnose were first described in the eastern United States (Pirone, 1980), the disease has been observed throughout much of the native range of the flowering dogwood (Anderson et al., 1994).

One of the reasons for the rapid spread of dogwood anthracnose has been the uniform susceptibility of this species to this disease. Santamour et al. (1989) tested seed provenances of flowering dogwood from 20 states and concluded there was little hope for selection and development of anthracnose-resistant plants. Alternatives for the nursery and landscape industries were to choose other dogwood species that were resistant to the disease (Brown et al., 1996; Holmes and Hibben, 1989; Ranney et al., 1994) or to substitute other plants for dogwoods in landscapes where the threat of dogwood anthracnose was severe (Daughtrey, 1988).

The objective of the project was to search for and select flowering dogwoods potentially resistant to dogwood anthracnose. We chose Catoctin Mountain Park, Md., as a site because of the high number of trees that had occurred naturally there before dogwood anthracnose became established in the park, the extremely high level of disease incidence and tree mortality that had occurred over a 10-year period (Mielke and Langdon, 1986; Schneeberger and Jackson, 1989; Sherald et al., 1996), and the knowledge that a few trees have survived

the epidemic for 10 years (Keith Langdon, National Park Service, personal communication). From our search, four surviving plants of indigenous flowering dogwoods were identified in 1990 as having potential resistance to dogwood anthracnose (Graham et al., 1995). Trees were propagated via cuttings in 1991 and the four clones were subjected to rigorous trials by personnel of the Tennessee Agricul-

tural Experiment Station (TAES) and the U.S. Dept. of Agriculture (USDA) Forest Service in 1992. The most resistant of these clones was selected for further study and was tested again in 1996 in a double blind trial by TAES and the USDA Forest Service. After successfully completing this trial, this clone was selected for release as 'Appalachian Spring'. This new cultivar will provide the industry with a flowering dogwood with intermediate to large white bracts, prolific blooming, abundant fruiting, and resistance to dogwood anthracnose.

Origin

The most disease-resistant tree was growing at 509 m in the forest understory on a southeastern aspect of Catoctin Mountain, Md., and had a diameter at breast height of 3 cm and a height of <4 m. The tree had sparse bloom (24 blooms), but had vigorous foliage and was selected because of the high level of mortality that had resulted from dogwood anthracnose in near proximity to the tree in 1990. Three dead flowering dogwoods were located within



Fig. 1. Bracts of 'Appalachian Spring' are long, but not overlapping.

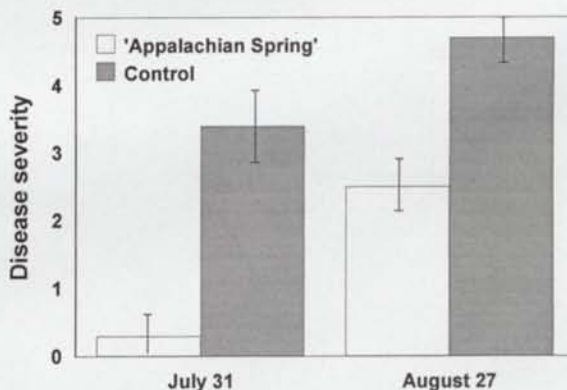


Fig. 2. Comparison of susceptibility of seedlings of *Cornus florida* and *C. florida* 'Appalachian Spring' to dogwood anthracnose in forest location near Ozone, Tenn. Disease incidence was estimated using an inverted Mielke-Langdon scale (Mielke and Langdon, 1986) where 0 = healthy tree, 1 = 1% to 25% of foliage symptomatic, 2 = 26% to 50% of foliage symptomatic, 3 = 51% to 75% of foliage symptomatic, 4 = 76% to 99% of foliage symptomatic, and 5 = 100% of foliage is dead.

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4 m of the tree. Although trunks of hundreds of dead flowering dogwoods were observed within 500 m of the tree, no other living dogwood trees were observed in the immediate areas south, east, or west of the tree. Searches for other living trees to the north of the selected tree were partially impeded because entry to this area was severely restricted.

Cuttings were made from the tree on 29 July and 8 Aug. 1990, and rooted under mist in a greenhouse at the TAES in Knoxville, Tenn. The plants were transplanted and maintained in nursery containers for 2 years and two trees were transplanted to the field in 1994. Cuttings were periodically taken from these cloned trees for propagation.

Description

'Appalachian Spring' (Fig. 1) is a flowering dogwood with white bracts, an upright

growth habit and prolific blooming. Of the two trees rooted in 1990 and transplanted to the field in Spring 1994, bloom number per tree averaged 194 and 299 in 1996 and 1997, respectively. Bract length averaged 7.1 cm for the largest pair of bracts (typically the inner pair that immediately subtend the inflorescence receptacle) of 160 blooms in 1997. The bracts do not overlap as in 'Cloud 9'. Foliage of 'Appalachian Spring' is dark green, turning to red in fall, and the abundant berries are bright red.

Disease resistance

'Appalachian Spring' demonstrated superior resistance to dogwood anthracnose when containerized trees (n = 5) were placed alongside 2-year-old trees of *C. florida* (n = 10) under the canopy of naturally diseased trees in a forest near Ozone, Tenn., in 1992 (Fig. 2). Of

the 10 trees that served as controls, only four survived the experiment, whereas all trees of 'Appalachian Spring' remained vigorous. Also in 1992, three trees of 'Appalachian Spring' were included in a large screening of dogwood trees by USDA Forest Service personnel for resistance to dogwood anthracnose. Only 'Appalachian Spring' survived, but its foliage had numerous lesions symptomatic of dogwood anthracnose. In a test conducted in conjunction with the USDA Forest Service in 1996 at Bent Creek, N.C., three trees of 'Appalachian Spring' displayed superior resistance to dogwood anthracnose in comparison with trees of 'Cloud 9' (Table 1).

Genomic analysis—DNA fingerprinting

'Appalachian Spring' was compared with one cultivar with red bracts (Cherokee Brave) and cultivars with white bracts ('Cloud 9', 'Pygmy', 'Springtime', 'Fragrant Cloud', 'Cherokee Princess', and 'Cherokee Daybreak') using DNA amplification fingerprinting (DAF) (Caetano-Anollés et al., 1991). Extraction, amplification, and electrophoresis of DNA and data analysis were similar to those reported by Scott et al. (1996).

The eight cultivars included in the genetic analysis proved to be fairly heterogeneous; 57% (72/126) of the character loci were polymorphic. Unique markers were found for each of the cultivars, except 'Fragrant Cloud' and 'Cloud 9', using four octamer primers. Five distinctive markers were identified for 'Appalachian Spring'. The genetic distances between the white-bract cultivars, with the exception of 'Cloud 9' and 'Appalachian Spring', were between 23% and 39%, indicating a relatively heterogeneous genome. 'Appalachian Spring' was separated from the other cultivars by 35% to 40% (Table 2). Principal Coordinate Analysis of the data generated by DAF easily distinguished the eight cultivars and placed 'Appalachian Spring' outside the cluster of the other white-bracted cluster (Fig. 3).

Table 1. Percentage of leaves with symptoms of dogwood anthracnose (%L), percentage of leaf area symptomatic for dogwood anthracnose (%A), and percentage of diseased foliage (%L × %A) of trees of *Cornus florida* 'Appalachian Spring' and 'Cloud 9' subjected to high levels of inoculum of *Discula destructiva* within the U.S. Forest Service inoculation facility at Bent Creek, N.C., in 1996.

Cultivar	26 Aug.			17 Sept.		
	%L	%A	%L × %A	%L	%A	%L × %A
Appalachian Spring	5 (±4) ²	5 (±4)	0.3 (±0.2)	20 (±15)	17 (±15)	5 (±4)
Cloud 9	67 (±36)	71 (±26)	56.0 (±30)	79 (±36)	78 (±10)	65 (±31)

²Numbers in parentheses represent standard deviations from the mean (P ≤ 0.05).

Table 2. Similarity matrix based on Jaccard coefficients among eight cultivars of flowering dogwood.

Cultivar	1	2	3	4	5	6	7	8
Cherokee Brave (1)	1.000							
Cloud Nine (2)	0.813	1.000						
Pygmy (3)	0.690	0.720	1.000					
Fragrant Cloud (4)	0.657	0.711	0.765	1.000				
Springtime (5)	0.667	0.750	0.718	0.738	1.000			
Cherokee Princess (6)	0.619	0.781	0.716	0.697	0.709	1.000		
Cherokee Daybreak (7)	0.657	0.767	0.705	0.705	0.738	0.716	1.000	
Appalachian Spring (8)	0.654	0.650	0.612	0.612	0.604	0.639	0.612	1.000

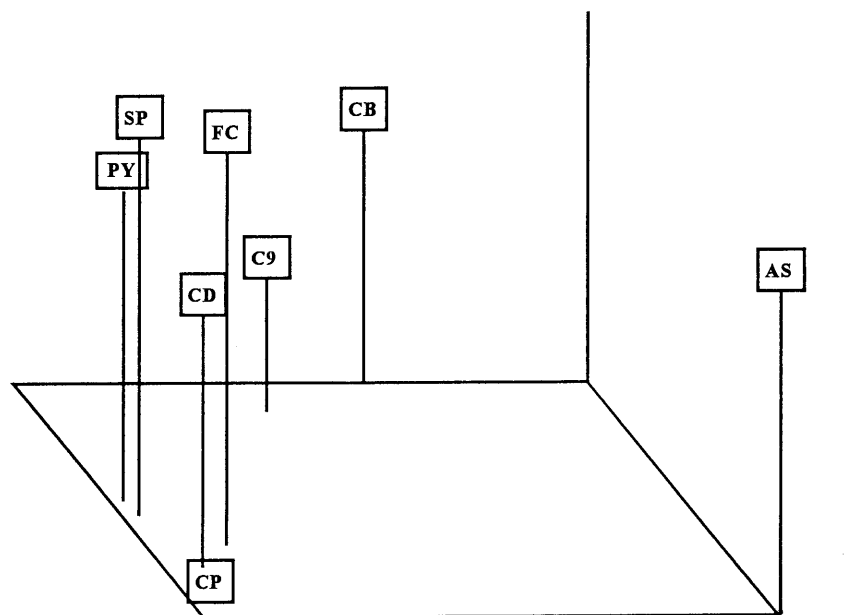


Fig. 3. Principal Coordinate Analysis of DNA amplification fingerprinting (DAF) data for eight cultivars of flowering dogwood: 'Appalachian Spring' (AS), 'Cherokee Brave' (CB), 'Cherokee Daybreak' (CD), 'Cherokee Princess' (CP), 'Cloud 9' (C9), 'Fragrant Cloud' (FC), 'Pygmy' (PY), and 'Springtime' (SP).

Availability

Since the tree was found in a forested area, 'Appalachian Spring' cannot be patented. However, the name 'Appalachian Spring' and the use of 'Appalachian' for a series of new dogwood cultivars is being trademarked. A small number of bud sticks were distributed to four wholesale nurseries in Tennessee that specialize in propagating large numbers of dogwoods from limited genetic material. We anticipate that limited numbers of budded trees will be available to the public in several years. Those interested in obtaining plants or bud wood should contact M.T.W. or R.N.T.

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