# POSTER SESSION PAPERS

## Cold Hardiness Evaluation of *Cornus kousa* Provenances©

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### PLANT EXPLORATION BACKGROUND

For the past quarter-century one of the primary missions of the Morris Arboretum has been domestic and international plant exploration and introduction. The goals of this plant exploration program are to:

- Broaden the genetic pool of known species
- Extend hardiness and increase vigor
- Broaden adaptability to difficult microclimates
- Increase insect and disease resistance
- Conserve rare species
- Select improved horticultural forms
- Evaluate and introduce appropriate new species

In pursuit of these goals, in the late 1970s the Arboretum identified regions around the world with climates similar to that of Philadelphia and we have been systematically targeting these areas for plant exploration and collection. As a result, since 1979 we have participated in 18 plant-collecting trips, to the following areas:

- Korea: 1979, 1981, 1984, 1989, 1991
- China: 1981, 1991, 1993, 1994 (2), 1995, 1996, 1997, 1998, 2002
- Southern Appalachian Mountains: 2000
- Armenia: 2002
- Republic of Georgia: 2004

These collecting trips have resulted in a living collection that contains over 4600 plants of wild-collected and documented origin, representing 936 taxa. Our collection has broad holdings in woody plants suitable for the Mid-Atlantic region of the United States and particular strengths in conifers, *Hamamelis, Acer*, *Magnolia*, *Ilex*, and *Quercus*.

The collection of *Cornus kousa* at the Morris was assembled to represent the diversity of the species and to evaluate performance among known provenances of kousa dogwood. Given the limited introduction of kousa dogwood from the northern extremes of its range, the lack of previous testing of kousa for cold hardiness, and anecdotal information on potential hardiness of the Korean plants, we decided to compare cold hardiness among plants of known origin from China, Korea, and Japan. Knowing that the Bernheim Arboretum had amassed a field trial of a large number of *C. kousa* cultivars a research project was initiated in the winter of 2001-2002 to examine potential differences in cold hardiness of provenances of *C. kousa* held at the Morris Arboretum by conducting freezing tests of twig samples at the Bernheim Arboretum. This poster presents the results of 3 years of freezing studies that examined the lowest survival temperature (LST) of stem tissue of trees of known wild-collected origin.

***Cornus kousa.*** *Cornus kousa* is a small flowering tree that is a beautiful counterpart to our native flowering dogwood, *C. florida*, with both trees exhibiting showy flower bracts. *Cornus florida* blooms before its leaves emerge in late April to early May, and *C. kousa* blooms after its leaves have emerged, usually in June. Because of their differences in blooming time, both are very useful garden plants and E. H. Wilson wrote that, "…Although these dogwoods of North America and the Orient are close relatives they are very dissimilar as garden plants and … there is room for both and no necessity for invidious comparisons" (Wilson, 1926).

With a combination of environmental and pathological factors leading to "dogwood decline" in our native dogwoods in the past few decades, there has been increased interest in evaluating and utilizing kousa dogwood for disease resistance and plant breeding (Orton 1985, Ranney et al., 1995). The disease and insect resistance of kousa dogwood led to a hybridization program using *C. florida* and *C. kousa*, resulting in the development of the Rutgers University Stellar® series of hybrids, such as *C.* 'Rutban', Aurora® hybrid dogwood, *C.* 'Rutcan', Constellation® hybrid dogwood, and *C.* 'Rutdan', Celestial™ hybrid dogwood (Orton, 1990). Little if any work has been done on increasing cold hardiness of either dogwood. Flowering dogwood is grown generally into U.S.D.A. hardiness Zone 5b and kousa dogwood grown occasionally in Zone 5a (Flint, 1997).

**Table 1.** Accessions of *Cornus kousa* planted at the Morris Arboretum and used in this experiment. All accessions are of wild collected and documented origin.

| Taxon | Morris Arboretum accession number | Source |
|---|---|---|
| *Cornus kousa* | 86-007*B | 1984 Expedition to Korea, Northwestern Coast |
| | 86-007*E | Korea, Kyonggi-Do, |
| | 86-007*J | KNW 243 |
| *Cornus kousa* | 86-016*A | 1984 Expedition to Korea, Northwestern Coast |
| | 86-016*B | Korea, Kyonggi-Do |
| | 86-016*F | KNW 278 |
| *Cornus kousa* | 86-115*B | 1984 Expedition to Korea, Northwestern Coast |
| | 86-115*C | Korea, Kyonggi-Do |
| | 86-115*F | KNW 1003 |
| *Cornus kousa* | 88-043*A | 1987 Warner and Howick Expedition to Japan |
| | 88-043*F | Japan, Honshu (Aomori), WH 645 |
| *Cornus kousa* var. *chinensis* | 83-042*A | 1980 Sino-American Botanical Expedition |
| | 93-049*J | China, Hubei, SABE 1316 |

## MATERIALS AND METHODS

Thirteen *Cornus kousa* plants representing five accessions growing at the Morris Arboretum were selected to represent plants collected across the species' native range (Table 1). Fifty-five terminal 8 to 10 cm long stem samples for each accession were collected and processed on three dates (December, January, and March) each in 2001–2002, 2002–2003, and 2003–2004.

Stems samples from the Morris Arboretum's trees were mailed overnight to the Bernheim Arboretum for processing. Samples were subjected to the following controlled freezing protocol. Stems were placed into polyethylene bags and were suspended in a microprocessor-controlled (Honeywell, Fort Washington, Pennsylvania) freezer (model 40-9.4; Scientemp, Adrian, Michigan). The chamber temperature was then decreased to -5 ºC over 8 h and then decreased at a rate of 4 ºC/h (Haynes et al., 1992) to a minimum test temperature of -39 ºC. Five replicate bags were removed from the chamber at 3 ºC intervals and were placed immediately in a walk-in cooler and held at 5 ºC for 24 h. Stems were then incubated in the sample bags for 7 days at approximately 21 ºC before evaluation. Temperature was monitored by an Omega HH506R Digital Thermocouple Thermometer (Omega Engineering Inc., Stamford, Connecticut). Air circulation inside the chamber was provided by an internal fan. Control stem samples were prepared as described above and held at 2 ºC.

Following incubation, samples were sectioned longitudinally through the terminal 4 cm of the stem. Tissues were evaluated visually for damage with stems showing any oxidative browning in the vascular region considered damaged (Stergios and Howell, 1973). Tissues not injured by the freezing treatments remained green throughout the vascular region and were thus rated as alive. The number of stems damaged at each temperature was recorded, and from these data a percent survival was determined. From this percentage, a lowest survival temperature (LST) was determined as the lowest temperature at which 100% of the stems remained uninjured (Sakai et al., 1986). Data were analyzed by using the Statistical Analysis System (SAS Institute, Cary, North Carolina). Analysis was performed using the General Linear Model (GLM). Means of lowest survival temperatures were separated using the Duncan's multiple range test.

## RESULTS

Analysis of our results indicated no differences in lowest survival temperature (LST) for the year or month that data were collected. Our analysis indicated differences in LST of accessions from different countries (Table 2). There were no significant differences in lowest survival temperature between plants from Japan (-26.3 ºC) and China (-29.8 ºC). Plants from Korea showed significantly lower LST (-34.2 ºC ) than plants from either China or Japan (Table 2).

**Table 2.** Results of lowest survival temperature (LST) analysis by country (p=0.001).

| Country | LST (ºC) | N | Grouping |
|---|---|---|---|
| Japan | -26.3 | 18 | A |
| China | -29.8 | 14 | A |
| Korea | -34.2 | 71 | B |

Further analysis of the data indicated differences in LST among the Korean accessions (Table 3). Accession #86-007 (-36.4 ºC) showed significantly lower LST than #86-115 (-32.3 ºC) but showed no difference compared to #86-016 (-34.2 ºC). There was not a significant statistical difference between accession #86-016 and #86-115 from Korea (Table 3).

**Table 3.** Results of lowest survival temperature (LST) analysis of Korean accessions (p= 0.01).

| Accession no. | Morris Arboretum LST (°C) | N | Grouping | |
|---|---|---|---|---|
| 86-115 | -32.3 | 27 | A | |
| 86-016 | -34.2 | 20 | A | B |
| 86-007 | -36.4 | 24 | | B |

## DISCUSSION

The results from this experiment indicate greater lowest survival temperature of plants of *C. kousa* from Korea compared to plants of either Chinese or Japanese origin. Plants from China were collected at ≈32° north latitude, those form Korea from 38° north latitude and those from Japan at 41° north latitude. The southern origin of the Chinese kousa dogwood most likely explains the lack of hardiness found in these plants. Latitudinal differences may not account for the differences in hardiness between plants from Japan and Korea. Although the Japanese plants were collected from the northern-most location of any of the plants in this study, they were collected from an area with a well-tempered maritime climate.

Reports from the 1984 plant expedition to northwest Korea noted that *C. kousa* was found growing in areas where minimum winter temperatures routinely reach -30 to -35 °C (Paul Meyer, pers. comm.). Among the Korean accessions, there is overlap in the lowest survival temperature, most likely representing the natural variation among the native populations. The evidence presented in this paper supports the field observations that *C. kousa* of Korean origin holds potential for greater cold hardiness and for possibly extending the useful northern limit where this species can be grown.

## PROPAGATION AND FUTURE DIRECTIONS

**Propagation:**

- Semi-hardwood cuttings in mid-July
- Extended photoperiod
- Do not disturb cuttings after rooting (leave in propagation flats for winter)
- Following spring: pot rooted cuttings after leaves have fully expanded
- 5000 ppm KIBA and water, single wound ≈50% rooting
- 8000 ppm IBA in talc, single wound ≈66% rooting
- 5000 ppm IBA in propylene glycol, single wound ≈85% rooting

**Future Directions.** It is the hope of this author that this study provides insight into potentially greater cold hardiness of *C. kousa*. Currently kousa dogwood is grown to only a limited extent in Zone 5, and is seen rarely in Indianapolis, Chicago, or north. Plants able to withstand temperatures of -35 °C (≈ -30 °F), that is hardiness Zone 4a, would represent a significant improvement in the hardiness of this species. To this end, we have selected the most attractive plant from each of our three Korean accessions for further evaluation. The next steps in this project are to propagate and grow plants to sufficient size for distribution to arboreta and nurseries throughout U.S.D.A. Zones 4 and 5 for field evaluation. It is my strong hope that our plant exploration efforts from 20 years ago will increase the useful range of this horticulturally desirable species.

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# "Fertil" Plugs for Winter Propagation at Canadale Nurseries Ltd.©

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