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Cold Hardiness of *Magnolia grandiflora* L. Cultivars[1]

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Abstract

Established cultivars of *Magnolia grandiflora* L. with observed cold hardiness limits and recently introduced cultivars with unknown cold hardiness limits were subjected to laboratory cold hardiness evaluation. The laboratory cold hardiness data corresponded closely to the observed field performance of 'Edith Bogue', 'Little Gem', 'Spring Grove #16', and 'Spring Grove #19'. 'Edith Bogue' is considered the most cold hardy cultivar under landscape conditions. It also proved the most cold hardy in laboratory tests with leaves and stems hardy to at least −24°C (−11°F) and −27°C (−17°F) over the three test dates. 'Little Gem', the least cold hardy under field conditions, was also the least cold hardy in laboratory tests. The Spring Grove cultivars survived −32°C (−25°F) in 1976 and 1983 and −30°C (−22°F) in 1989 under landscape conditions. Laboratory test data corroborated observed field hardiness.

Three recent introductions, 'Bracken's Brown Beauty', 'Phyllis Barrow' and 'Select #3' showed different laboratory cold hardiness profiles. 'Bracken's Brown Beauty' developed the greatest stem cold hardiness followed by 'Select #3' and 'Phyllis Barrow'. 'Select #3' and 'Phyllis Barrow' exhibited similar leaf cold hardiness, while 'Bracken's Brown Beauty' had less hardy leaves.

Results indicated that promising clones of *Magnolia grandiflora* could be laboratory tested for cold hardiness with the resultant data used to predict survivability and geographic adaptability.

Index words: freeze tolerance, clonal selection, Southern magnolia

Plants used in this study: Southern Magnolia cvs. 'Bracken's Brown Beauty', 'Edith Bogue', 'Little Gem', 'Phyllis Barrow', 'Select Tree #3', 'Spring Grove #16' and 'Spring Grove #19', (*Magnolia grandiflora* L.).

Significance to the Nursery Industry

Laboratory cold hardiness determinations corresponded closely with observed cold hardiness of *Magnolia grandiflora* 'Edith Bogue', 'Little Gem', 'Spring Grove #16' and 'Spring Grove #19'. The two hardiest clones in nature, 'Edith Bogue' and 'Spring Grove #16', were also most cold hardy in laboratory tests. 'Little Gem', the least hardy in nature, showed similar results in laboratory tests.

This relationship suggests that the laboratory technique is a valid indicator of potential cold adaptability for *Magnolia grandiflora*. Utilizing laboratory cold hardiness data for assessing geographical adaptability allows growers to more accurately determine whether the plant can be grown in their area and/or in what areas it should be marketed. It is a powerful tool in the plant introduction process for it shortens the time-honored trial and error method of field testing for cold hardiness. If clones with similar landscape characteristics are being considered for release, the laboratory technique could be used to determine the most cold hardy clone. Also in breeding work, where significant time in years is required to produce a new cultivar, this technique can be used to screen seedlings for cold hardiness.

Introduction

Magnolia grandiflora is adapted in zones 7 to 9 (1, 17) but selections cold hardy to zone 5b are known (10). The native range extends from North Carolina to Florida and east Texas, chiefly in the coastal plain. Distribution in the wild suggests, at best, zone 8 hardiness (7). Seedlings at Spring Grove Arboretum, Cincinnati, Ohio have survived −32°C (−25°F) in 1976 and 1983 (4, 5) and more recently, in Dec. 1989, −30°C (−22°F). 'Edith Bogue', one of the most cold hardy clones, has prospered at the Morris Arboretum, Philadelphia, Pennsylvania (zone 6) and 'Samuel Sommer' survived −24°C (−12°F) at Reinhardt College, Walesca, Georgia (10).

In the past 10 years a resurgence in *Magnolia grandiflora* cultivar introduction has occurred largely because of improved rooting procedures (3). Many new cultivars are being introduced with limited knowledge of cold hardiness. Within the genetic plasticity of *M. grandiflora*, the possibility of introducing cold hardy cultivars exists. In this study, laboratory cold hardiness determinations of established cultivars were compared to cold hardiness estimates based on field performance. Validation of laboratory cold hardiness tests as indicators of natural hardiness of *Magnolia grandiflora* had not previously been done. Previous work with *Acer rubrum* clones (12) and broadleaf evergreens (2) indicated that laboratory methodology can be used to reliably predict cold hardiness.

Materials and Methods

During the 1989–1990 winter, stem and leaf samples of 'Bracken's Brown Beauty', 'Little Gem', 'Phyllis Barrow' and 'Select #3' magnolias were collected from trees grown in the Athens, Georgia area, while samples of 'Edith Bogue' were sent from the Morris Arboretum in Philadelphia, Pennsylvania and samples of the Spring Grove selections were sent from Spring Grove Arboretum, Cincinnati, Ohio. Samples from Philadelphia and Cincinnati were collected and sent to our lab via overnight mail express service.

Shoots of current season's growth were removed from

[1]Received for publication October 9, 1990; in revised form March 11, 1991. This research was supported, in part, by a grant from the Horticultural Research Institute, Inc., 1250 I. Street, N.W., Suite 500, Washington, D.C. 20005.

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each plant, wrapped in wet paper towels, placed in plastic bags and transported on ice to Griffin, Georgia. Within 4 hours of arrival, the plant samples were prepared for the freezing test. The leaves were removed and the terminal 7 cm (2.75 in) of each stem severed, wrapped in moist cheesecloth and placed into test tubes. Whole leaves were treated like the stems. The tubes were then submerged in ethylene glycol in a Forma Scientific Model 2425 temperature bath preset to -2.0 ± 0.5°C (28 ± 1°F). Temperatures were measured by thermocouples placed next to the stem or leaf and recorded by a Model CR7-X Campbell Scientific datalogger. The cheesecloth was nucleated with ice crystals and the temperature held constant at -2.0 ± 0.5°C (28 ± 1°F) overnight (about 14 h), then the temperature was lowered at a rate of 4°C (7°F) per hour. Four leaves and stems of each taxon were removed from the bath at progressively lower 3°C (5°F) temperature intervals. Controls were prepared and kept at 4°C (39°F).

After thawing at 0°C (32°F), the samples were removed from the tubes and incubated at room temperature and 100% relative humidity for 10 to 14 days. At this time stems and leaves were visually evaluated for injury (9, 11, 14, 16, 18). Tissues showing brown discoloration and breakdown of cells in the cambium and phloem were rated as dead. The number of leaves and stems killed at each temperature was recorded and from these data the lowest survival temperature (LST) was determined. The LST (13) is the lowest temperature at which little or no injury is observed. There was no variability between replicates when determining the LST for a specific cold hardiness determination. The lack of variation between replicates can be explained since individual taxa were used which, by their nature, are uniform and also the cold hardiness was determined only within a 3°C (5°F) range. The low temperature limit of the temperature bath was -30°C (-22°F), therefore, several taxa in midwinter were not killed and are reported as having a LST of less than -30°C (-22°F).

Results and Discussion

Laboratory data corresponded closely with observed cold hardiness of 'Edith Bogue', 'Little Gem', and 'Spring Grove #16' and 'Spring Grove #19' (Table 1). 'Edith Bogue' was the most cold hardy cultivar which agrees with previous field observations (1). Stems were equal to or more cold hardy than leaves. The leaves displayed excellent cold hardiness and in February tolerated -30°C (-22°F). Spring Grove clones survived -32 (-25°F), and -30°C (-22°F) in the landscape (4, 5). Leaves were injured but regrowth in spring was complete indicating minimal damage to buds and stems. Observations of regrowth on June 4, 1990 indicated that 'Spring Grove #16' recovered faster than 'Spring Grove #19'. 'Spring Grove #16' is the largest and the more ornamentally desirable of the two trees. Cold hardiness data provided another criterion to more effectively assess which tree should be introduced. Unfortunately, the origin of the Spring Grove trees is unknown. Both clones set abundant fruit and cold hardiness progeny testing would be worthwhile to select for hardier seedlings.

'Little Gem' showed the least laboratory cold hardiness which corresponds to its performance in the landscape. (Personal communication, Mr. Richard Figlar, Magnolia Society, Pomona, NY). The observed landscape cold hardiness of 'Edith Bogue', 'Spring Grove #16', 'Spring Grove #19' and 'Little Gem' corresponded with the laboratory data.

'Bracken's Brown Beauty' (PP #5520, 1985) is possibly the most handsome and commercially acceptable cultivar. It is growing in Pomona, NY alongside 'Edith Bogue' and no injury has occurred. Over the three sample dates, it was the most stem hardy. However, leaf cold hardiness was not as great as the other cultivars. 'Bracken's Brown Beauty' was selected from a population of seedlings grown from seeds collected in Easley, SC (zone 7). 'Edith Bogue' originated as a Florida seedling sent to Miss E.A. Bogue, Montclair, New Jersey. Apparently provenance which is so important in determining hardiness of *Cercis canadensis* L. (6), *Fraxinus americana* L. (8) and other species (15) may be of minor importance in determining *M. grandiflora* hardiness.

'Phyllis Barrow' was selected by the authors for large lustrous almost black-green upper leaf surface with a rusty brown tomentose undersurface, large tree stature (parent is 70′ high), ease of rooting (70% or greater), and growth rate (5 to 6′ in a single season from a rooted cutting). The original

Table 1. Lowest survival temperature [°C (°F)] of seven cultivars of *Magnolia grandiflora* L.

Taxa		Collection dates		
		Dec. 12	Jan. 10	Feb. 12
'Bracken's Brown Beauty'	(lvs)	−6 (21)	−18 (0)	−18 (0)
	(stems)	−30 (−22)[z]	−30 (−22)[z]	−30 (−22)[z]
'Edith Bogue'	(lvs)	−27 (−17)	−24 (−11)	−30 (−22)[z]
	(stems)	−27 (−17)	−30 (−22)[z]	−30 (−22)[z]
'Little Gem'	(lvs)	−18 (0)	−18 (0)	−18 (0)
	(stems)	−18 (0)	−9 (16)	−24 (−11)
'Phyllis Barrow'	(lvs)	−9 (16)	−24 (−11)	−21 (−6)
	(stems)	−21 (−6)	−24 (−11)	−21 (−6)
'Select Tree #3'	(lvs)	−9 (16)	−21 (−6)	−24 (−11)
	(stems)	−24 (−11)	−30 (−22)[z]	−30 (−22)[z]
'Spring Grove # 16'	(lvs)	−27 (−17)	−21 (−6)	−18 (0)
	(stems)	−30 (−22)[z]	−27 (−17)	−30 (−22)[z]
'Spring Grove #19'	(lvs)	−24 (−11)	−24 (−11)	−20 (−4)
	(stems)	−30 (−22)[z]	−24 (−11)	−24 (−11)

[z]Was not killed at the lowest temperature tested -30 (-22), the limit of the freezing bath.

seedlings came from Savannah, Georgia and therefore the leaves and stems were cold hardier than expected.

'Select Tree #3' displayed high stem and moderate leaf hardiness (Table 1). This cultivar was selected by Select Trees, Inc., P.O. Box 6671, Athens, Georgia 30604 for rapid growth and ease of rooting. Ornamental characteristics were secondary in the choice of this cultivar. This tree was grown from an Athens, Georgia seed tree whose origin is unknown.

The laboratory data coupled with previous observations of field performance of 'Edith Bogue', 'Little Gem', 'Spring Grove #16' and 'Spring Grove #19', provide a quantitative measure of cold hardiness. Therefore, laboratory cold hardiness data for new *Magnolia grandiflora* introductions can be used to predict their geographical adaptability.

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