Survival and Growth of *Callicarpa americana* (American Beautyberry) of Northern and Southern Origin in USDA Hardiness Zones 5 and 6[1]

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Abstract

Our objective was to determine whether provenance of origin and use of organic mulch influence survival, vegetative growth, and the number and size of fruit of *Callicarpa americana* L. (American beautyberry) planted north of its natural distribution in the central United States. Forty-eight plants were established in 2006 at each of four locations north of the natural distribution, two in Missouri and two in Iowa, and at one location within the natural distribution in Arkansas. Plants at each location (24 per provenance) were propagated from seeds collected from plants indigenous to southern Missouri and central Florida. Use of organic mulch increased percentage survival at two of four sites north of the natural distribution after Winter 2006–2007 and across all four northern locations after Winter 2007–2008. Survival of plants from the two origins was similar after Winter 2007–2008. Plants from Florida grew taller than plants from Missouri at the two planting locations in Missouri during the 2007 growing season. Development of fruit was poor in Iowa and was greatest on plants from Florida installed in southern Missouri and on plants from Missouri installed in central Missouri. Survival after Winter 2007–2008 was reduced to an average of 47% at the two sites in Iowa, and, across all sites, more plants from Missouri survived than plants from Florida. Plants within the natural distribution in Arkansas were 68% taller and had clusters of fruit 31% larger in late 2008 than plants at the closest site north of the natural distribution. We conclude American beautyberry can survive when planted in areas with winters colder than those where the species occurs naturally, and that plants from a northern provenance (Missouri) possess a greater capacity to survive than plants from Florida when planted north of the natural distribution in the Upper Midwest. Although the genetic potential for growth and displays of fruit is not manifest north of the species' natural limit, American beautyberry can be an attractive addition to landscapes in United States Department of Agriculture (USDA) hardiness zones as cold as zone 5b, where plants from a northern origin that are mulched during winter should be used.

Index words: provenance differences, organic mulch, native plants, cold hardiness.

Species used in this study: American beautyberry (*Callicarpa americana* L.).

Significance to the Nursery Industry

American beautyberry, an attractive shrub native to North America, is used less frequently in horticultural landscapes than members of its genus native to other continents. Unrealized market potential for American beautyberry may exist due to its striking displays of ripe fruit, ease of culture, and status as an indigenous member of the North American flora. We therefore sought to examine whether the market for this species can be expanded into regions where winters are colder than where the species occurs naturally. Results showed that American beautyberry, particularly plants from a northern provenance, can survive in USDA hardiness zone 6 and, to a lesser extent, in zone 5. Mulching plants before winter improved survival, but size of surviving plants and production and visual impact of fruit were reduced north of the natural distribution of the species, especially in zone 5, where comparatively short growing seasons prevented complete ripening and coloration of fruit. American beautyberry is not as suitable for cold USDA hardiness zones as are some other woody plants native to the southern United States.

Introduction

Shrubs of American beautyberry may grow up to 2.4 m (8 ft) tall and wide and develop clusters of fruit (drupes) at nodes along stems during summer. As they develop, the fruit clusters expand around the petioles of oppositely arranged leaves and become colorful when they ripen late in the growing season. The unusual color of ripe fruit, which usually is lavender-pink but may be white, persists through early winter, providing striking ornamental appeal for several weeks. The species is regarded as tolerant of a range of soil types and either full or partial exposure to sunlight (2). Despite its tolerances, its showy fruit that form reliably, and our capacity to propagate the species readily from seeds and stem cuttings (3), American beautyberry is far less common in North American horticulture than are Asian members of the genus *Callicarpa*.

American beautyberry occurs as far south as Mexico and the West Indies and is prevalent in native landscapes of the southeastern United States, but the natural distribution of the species extends north to two counties in southern Missouri (5). Although the species is regarded hardy in USDA hardiness zones 7 to 11, and perhaps within zone 6 (2), the extent of variation in hardiness within the species is unknown. We have been particularly interested in whether plants propagated from indigenous shrubs at the northern distributional limit of the species in Missouri possess greater cold hardiness than plants from more southern locations. Other North American species native to USDA hardiness zones with winters no colder than those in zone 7 have shown the capacity to withstand temperatures far below those typical of their native habitats. For example, *Alnus maritima* (Marsh.) Muhl. ex Nutt. (seaside alder) is indigenous only in zone 7 but has performed well through multiple years in zone 4a (7).

Our objectives were to assess the infraspecific hardiness of American beautyberry by determining if plants from either

[1]Received for publication June 1, 2010; in revised form July 30, 2010. We thank Mervin Wallace for donation of plant material and Bruce Quint, Jyotsna Sharma, David Brauer, David Burner, Brad Fresenburg, and James Schrader for technical assistance.

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a southern or a northern provenance perform sufficiently to permit their use in horticultural landscapes in USDA hardiness zones 5 and 6, and to test whether the cultural practice of applying organic mulch affects survival of plants installed north of the natural distribution of the species in the Midwest. Because fruit of American beautyberry develop their ornamental color late in the growing season, we also observed whether fruit that formed on shrubs planted at northern locations would express their showy color before seasonal changes halted ripening.

Materials and Methods

Ripe fruit collected from naturally occurring plants in Levy Co., FL (latitude 29.4°N), in late 2004 were sown in flats filled with soilless germination medium that was kept moist with tap water during Winter 2004–2005. The flats were held in a minimally heated greenhouse in Ames, IA, to provide cold stratification (moist chilling). Although air temperature during natural photoperiods varied due to solar gain, air usually was 4 ± 3C (39 ± 5F). Seeds germinated in Spring 2005 as air warmed in the greenhouse, which was vented but not otherwise cooled. Also in 2005, Missouri Wildflowers Nursery, Jefferson City, MO, provided first-year seedlings propagated from plants indigenous in Taney Co., MO (latitude 36.5°N). Plants from Florida and Missouri were potted singly and grown in standard plastic containers [top diameter 15 cm (6 in)] filled with soilless medium (Sunshine LC-1; Sun Gro Horticulture, Vancouver, BC, Canada). Containers were held in a greenhouse under natural photoperiods at 15 to 40C (59 to 103F) during the growing season. Root zones were kept moist with tap water, and a solution of Peters Excel All-Purpose and Cal-Mag® (25 and 75%, respectively; 16.4N–2.2P–16.6K) (Scotts Sierra Horticultural Products, Marysville, OH) was applied once monthly to provide nitrogen (N) at 200 ppm. Dormant plants were held during Winter 2005–2006 in a greenhouse under the conditions used to stratify seeds.

Plants beginning their second year of growth were installed May 9–16, 2006, in plots at five locations (Table 1). At each location, 24 plants from Florida and 24 from Missouri were installed in a completely randomized design in plots exposed to full sun. Plants were spaced 1.2 m (4 ft) apart in eight rows of six. Samples of soil were obtained from each plot. Each sample comprised 10 subsamples from the upper 15 cm (6 in) and was analyzed for pH, N, and organic matter at the Soil and Plant Analysis Facility, Iowa State University, Ames. Cooperators at all locations used landscape fabric, herbicides, and/or manual removal to prevent weeds, and irrigation was provided to prevent wilting until plants were established.

Mulch treatments were applied October 13–15, 2006 except at Booneville, AR, the only location of the five within the natural distribution of American beautyberry. One-third (eight) of the plants from both provenances of origin were assigned randomly to one of three treatments, an unmulched control, moderate mulching, and heavy mulching. Finely shredded bark mulch from the same supplier was used at all sites. For the moderate-mulching treatment, open-topped plastic cones 55 cm (22 in) wide at their bases, 31 cm (12 in) wide at their tops, and 25 cm (10 in) tall were placed over all the stems of a plant and then were filled with mulch. Plants heavily mulched were treated the same, but the cones were 55 cm (22 in) wide at their bases, 25 cm (10 in) wide at their tops, and 61 cm (24 in) tall. A layer of mulch 10 to 15 cm (4 to 6 in) deep also was applied in a ring that was 15 cm (6 in) wide around the base of all mulch cones for stabilization. The rationale for using upright columns of mulch in cones was that it might improve survival of both crowns and stems; in the Deep South, stems of American beautyberry persist over multiple years, but stems of plants elsewhere often die to the ground each winter and reform from the crown every spring.

Mulch cones were removed in 2007 from the two plots in Missouri and the two plots in Iowa during the first week of May and June, respectively. Mulch from the cones was spread evenly across plots. Survival was documented at these times by inspecting each plant for development of shoots from buds on stems formed the previous season or from subterranean crowns. Height and width of each plant, and the number of fruit clusters on the three longest stems of each plant, were determined October 5–7, 2007. Weight of the counted fruit clusters was determined after the clusters were dried at 70C (158F) for 96 hr. Shredded bark mulch was applied on these dates to all plants that had been mulched the previous autumn, but no cones were created. Instead, a layer of mulch 10 cm (4 in) deep was applied over an area 30 cm (12 in) in diameter around each previously mulched plant. This was done because no differences were found in survival between plants that were mulched moderately and heavily the previous winter. Plant survival was assessed during Spring 2008 as it was in 2007.

Data on development of plants during the growing season of 2008 were collected in late September only at Booneville,

Table 1. Characteristics of the climates and soils at five locations where plants of *Callicarpa americana* (American beautyberry) propagated from seeds collected from plants indigenous to Florida (latitude 29.4°N) and Missouri (latitude 36.5°N) were established in 2006 to examine survival and growth through 2008.

Planting location	Latitude (°N)	USDA hardiness zone	Mean annual precipitation[z] (cm / in)	Minimum temperature[z] (C / F) during winter		Soil[y]		
				2006–2007	2007–2008	pH	Total N (%)	OM (%)
Booneville, AR	35.1	7a	122 / 48	–10 / 14	–10 / 14	5.4	0.13	2.1
Mount Vernon, MO	37.1	6a	114 / 45	–15 / 5	–13 / 9	6.4	0.20	3.4
Columbia, MO	39.0	5b	102 / 40	–19 / –2	–17 / –1	6.2	0.26	4.5
Chariton, IA	41.0	5a	94 / 37	–20 / –4	–23 / –9	7.0	0.20	3.7
Ames, IA	42.0	5a	86 / 34	–25 / –13	–27 / –17	7.9	0.14	3.7

[z]Data from http://www.weatheronline.co.uk.

[y]N and OM denote nitrogen and organic matter, respectively.

Table 2. **Survival of *Callicarpa americana* (American beautyberry) in Spring 2007 after overwintering at four locations where plants were installed in 2006 north of the natural distribution of the species. Forty-eight two-year-old plants, 24 grown from seeds collected from plants indigenous to each of two provenances, Florida and Missouri, were either not mulched, mulched moderately, or mulched heavily before winter. Analysis of variance showed no effect of plant origin on survival but showed an interaction of planting location and mulch treatment. Therefore, percentage values for each combination of planting location and mulch treatment are based on 16 replicate plants, eight from each of the two provenances.**

	Survival after winter 2006–2007 (%)		
Planting location	**No mulch**	**Moderate mulch**	**Heavy mulch**
Mount Vernon, MO	75bc[z]	94ab	100a
Columbia, MO	93ab	100a	100a
Chariton, IA	0d	56c	56c
Ames, IA	100a	94ab	100a

[z]Means not sharing at least one letter are different at $P \leq 0.05$ according the Fisher's least significant difference test.

AR, and Mount Vernon, MO, the southernmost planting location north of the natural distribution. Height of plants was measured. Mean internode length was determined as the average of all internodes on the fully expanded portion of the two longest primary stems per plant. The number of nodes with fruit was recorded on the two longest stems per plant. Diameters of fruit clusters and of individual fruit were determined from measures of three representative clusters and three individual fruit from each of those clusters on the two longest stems of 20 plants at both locations, 10 each from Florida and Missouri.

All data were subjected to analysis of variance (ANOVA) with models that included tests of all main effects and possible interactions. When appropriate, means were separated by Fisher's least significant difference (LSD) at $P \leq 0.05$.

Results and Discussion

An interaction of planting location and mulch treatment showed the effect of mulch on survival of plants after Winter 2006–2007 depended on location. Provenance of the plants, Florida or Missouri, did not affect survival. Survival was poorest at Chariton, IA, where it ranged from 0 to 56% depending on mulch treatment (Table 2), whereas survival elsewhere was 75 to 100%. Mulch treatments did not affect survival at Columbia, MO, or Ames, IA, but heavy mulching and both heavy and moderate mulching led to greater survival at Mount Vernon, MO, and Chariton, IA, respectively (Table 2). Reasons for the differences in survival at the two locations in Iowa are uncertain. The planting site at Chariton, in southern Iowa, was at a research farm where plants were not protected from wind. Further north in Ames, plants were installed in an urban, public garden where vegetation and buildings may have buffered environmental extremes. Local weather stations recorded lower minima in Ames, IA, than in Chariton, IA, for Winters 2006–2007 and 2007–2008 (Table 1). Snow cover, which could have insulated crowns and differed among locations, was not recorded. However, total precipitation from November 2006 through April 2007 was greater at Chariton, IA [48 cm (19 in)], than at Ames, IA [39 cm (15 in)], which does not support the possibility that less snow cover at Chariton, IA, led to more injury. Weather-station records were examined for temperature fluctuations in late 2006 that could have caused injury at Chariton, IA, before cold acclimation of plants was complete. We also considered whether an intense low-temperature event followed a warm period in early 2007, possibly leading to injury of plants that had deacclimated. Although potentially injurious events were noted in late November 2006 and early April 2007, temperatures on these dates were no more than 2C (4F) different at Chariton and Ames, IA. A supportable explanation for the especially poor survival at Chariton, IA remains elusive.

There was an interaction of planting location and plant origin on plant size and the number and weight of fruit clusters in late 2007. Plants from Florida were taller and wider than plants from Missouri at the two locations in Missouri (Table 3). In contrast, plants from Missouri were wider than plants from Florida at the northernmost location in Ames, IA. For both plant height and width, the range of means across the four planting locations in Missouri and Iowa was greater for plants from Florida than for plants from Missouri (Table 3). This suggests plants from Florida have greater genetic potential for large size but were less capable of expressing that potential in the North than in the South. The number and weight of fruit clusters were greatest on plants from Florida installed at Mount Vernon in southern Missouri and on plants from Missouri installed at Columbia in central Missouri (Table 3). Provenance of plants did not affect measures of fruiting at the two locations in Iowa, where, within plant

Table 3. **Height and width of plants and number and dry weight of fruit clusters on the three longest stems of *Callicarpa americana* (American beautyberry) late in the 2007 growing season at four locations where plants were installed in 2006. Forty-eight two-year-old plants, 24 grown from seeds collected from plants indigenous to each of two locations, Levy Co., FL, and Taney Co., MO, were either not mulched, mulched moderately, or mulched heavily before winter. Analysis of variance showed an interaction of planting location and plant origin. Each value is a mean of up to 24 replicate plants that survived the previous winter.**

	Plant height (cm)		Plant width (cm)		Fruit-cluster count		Fruit-cluster weight (g)	
	Origin of plant		Origin of plant		Origin of plant		Origin of plant	
Planting location	**Florida**	**Missouri**	**Florida**	**Missouri**	**Florida**	**Missouri**	**Florida**	**Missouri**
Mount Vernon, MO	91a[z]	52cd	111a	78bc	28a	18b	9.3a	3.5b
Columbia, MO	68b	58c	62d	83b	13bc	28a	3.2bc	9.5a
Chariton, IA	50cd	44d	64bcd	59cd	5cd	3d	0.3bcd	0.2cd
Ames, IA	47d	44d	38e	58d	1d	7cd	0.1d	2.0bcd

[z]Means within the two columns for each dependent variable are separated according to Fisher's least significant difference test at $P \leq 0.05$.

Table 4. **Survival of *Callicarpa americana* (American beautyberry) in Spring 2008 at four locations where plants were installed north of the natural distribution of the species. Forty-eight plants, 24 grown from seeds collected from plants indigenous to each of two provenances, Florida and Missouri, were planted in 2006 at each location. Before Winter 2007-2008, surface mulch was applied to all plants that were in the moderate mulch or heavy mulch treatments during the prior winter. Analysis of variance (ANOVA) showed survival was affected by planting location, origin of plant, and mulch; no interactions existed. Therefore, means for planting location (n = 48), provenance (n = 96), and mulch (n = 128 [surface mulch] and 64 [no mulch]) are presented.**

	Survival in spring 2008 (%)
Planting location	
Mount Vernon, MO	88a[z]
Columbia, MO	83a
Chariton, IA	27c
Ames, IA	67b
Origin of plant	
Levy Co., FL	58b
Taney Co., MO	74a
Mulch	
Surface mulch	77a
No mulch	44b

[z]Means within each of the three main-effect categories are separated according to Fisher's least significant difference test at $P \leq 0.05$.

origins, cluster number and weight were reduced compared to plants at one or both locations in Missouri (Table 3).

Planting location, origin of plants, and mulch treatment influenced the percentage of plants alive in Spring 2008, and there were no interactions among these main effects (Table 4). Averaged across both origins and mulching treatments, over 80% of plants survived at both locations in Missouri. Survival was lower in Iowa, especially at Chariton. Across planting locations and mulch treatments, survival was greater for plants from Missouri than for plants from Florida, and across planting locations and provenances, mulch improved survival (Table 4). These data provide evidence that American beautyberry is better adapted for use in central and southern Missouri (USDA hardiness zones 5b to 6b) than in central and southern Iowa (USDA hardiness zones 4b to 5a), that winter-survival capacity within the geographical range of our planting locations is greater for plants from Missouri than for plants from Florida, and that use of mulch enhances survival capacity, possibly by moderating soil temperature (4). Responses of American beautyberry to installation north of its origin in nature are consistent with data on survival of plants of other woody species from diverse provenances after being planted at northern locations (1, 6).

Although differences between means were not consistently significant, survival after two winters (Table 4), and growth and fruiting traits (Table 3), tended to be maximal at Mount Vernon, MO, the location closest to the natural distribution of American beautyberry. We therefore compared plants at Mount Vernon, MO, to those planted within the natural distribution at Booneville, AR. Across origins, plants differed at these locations, and, averaged over locations, plants of the two origins differed (Table 5). Plant height in late September 2008 was 68% greater at Booneville, AR, than it was ≈240 km (150 mi) north in southern Missouri. Plants at Booneville, AR, had longer internodes, more fruit-bearing nodes, and larger fruit clusters than plants at Mount Vernon, MO (Table 5). Averaged over locations, plant height, internode length, number of nodes with fruit clusters, and the diameters of fruit clusters and of individual fruit all were greater for plants from Florida than for plants from Missouri (Table 5).

Potentially confounding factors prevent us from attributing the varying degrees of survival and growth reduction at planting locations north of the site in Booneville, AR, simply to colder winters. For example, soil pH increased, and mean annual precipitation decreases, with increasing latitude of the planting locations (Table 1). Soil pH at the southernmost location north of the natural distribution of American beautyberry, Mount Vernon, MO, was a full unit higher than the pH at Booneville, AR (Table 1). Further research would be needed to determine the relative importance of soil pH, temperature, precipitation, and other environmental factors as causes for shorter plants with fewer fruits in smaller clusters at Mount Vernon, MO, compared with plants at Booneville, AR (Table 5). Similarly, additional experiments in which only one environmental factor is varied would be needed to explain the marked reductions in survival and plant growth at the two locations in Iowa (Tables 3 and 4).

Table 5. **Height of plants, length of internodes, number of fruit-bearing nodes per branch, and diameter of fruit clusters and of individual fruit of *Callicarpa americana* (American beautyberry) from two provenances planted in two locations in 2006. Data were collected in late September 2008. Internode length for each plant was determined as the average of all internodes on the fully expanded portion of the two longest primary stems. These stems also were used to determine the average number of fruit-bearing nodes per branch. Values of n for height, internode length, and fruit-bearing nodes/branch ranged from 20 to 24. Size of fruit was determined from measures of three representative clusters and three individual fruits per cluster on each of 20 plants at both locations, 10 from both origins.**

Treatment	Height (cm)	Internode length (cm)	Fruit-bearing nodes/branch	Diameter (mm) of	
				Fruit cluster	Individual fruits
Planting location					
Booneville, AR	158a[z]	5.7a	13.5a	49.3a	6.3a
Mount Vernon, MO	94b	3.7b	12.3b	37.6b	6.0a
Origin of plant					
Levy Co., FL	149a	5.5a	13.4a	46.3a	6.4a
Taney Co., MO	104b	4.0b	12.4b	40.7b	5.9b

[z]Pairs of means for each dependent variable and treatment main effect are separated according to Fisher's least significant difference test at $P \leq 0.05$.

Although it remains unclear which environmental differences among the planting locations accounted for variation in plant survival and growth, our results nonetheless support important conclusions about the utility of American beautyberry as an ornamental shrub in the central and Upper Midwest. Collectively, the data show the species can be used for landscaping with only limited success north of its natural distribution. Growth and fruiting were reduced as close to the natural distribution as Mount Vernon, MO (Table 5). Although American beautyberry frequently may survive within USDA hardiness zones 6 and 5b (Table 4), plants installed in zones colder than zone 7, where the species occurs naturally, are unlikely to express their full genetic potential to develop showy displays of fruit (Tables 3 and 5). Use of organic mulch can improve winter survival (Tables 2 and 4), but surviving plants in zones 5 and 6 were comparatively small, and the number and weight of fruit clusters were reduced (Table 3). Pigmentation data were not collected, but we observed that fruit in Iowa were exposed to temperatures in early autumn that were low enough to halt their ripening while they still were green to partially lavender-pink. Therefore, we do not recommend use of American beautyberry in zone 5a. Although its full genetic potential is unlikely to be expressed in zones 5b and 6, American beautyberry nonetheless can be an attractive addition to landscapes in those zones, particularly if both mulch and plants from a northern provenance are used.

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