Winter Stem Cutting Propagation of Heller's Japanese Holly with and without Use of a Conventional Auxin Treatment

Eugene K. Blythe^{1,3,5} and Jeff L. Sibley^{2,4}

ADDITIONAL INDEX WORDS. *Ilex crenata* 'Helleri', 'Helleri' holly, Heller's box-leaved holly, vegetative propagation, root-promoting compounds, adventitious rooting

SUMMARY. Heller's Japanese holly [*Ilex crenata* 'Helleri' (synonym: *Ilex crenata* f. *helleri*)] is a popular landscape plant in U.S. Department of Agriculture hardiness zones 5b to 8a because of its dwarf habit, slow growth rate, and dark green leaves. Plants can be propagated readily by stem cuttings and use of an auxin treatment is generally recommended to promote rooting. This study was conducted to determine if auxin treatment could be eliminated, thus reducing labor and chemical requirements in the cutting propagation process. In three experiments, terminal stem cuttings of Heller's Japanese holly were taken in winter, prepared both with and without use of a basal quick-dip in an auxin solution [2500 ppm indole-3-butyric acid (IBA) + 1250 ppm 1-naphthaleneacetic acid (NAA)], and rooted in a warm, high-humidity environment. Both nontreated cuttings and cuttings receiving a 1-second basal quick-dip in the auxin solution rooted at, or near, 100%. However, treatment of cuttings with auxin resulted in larger root systems on the rooted cuttings, which could allow earlier transplanting into larger nursery containers. No inhibition of new spring growth was exhibited by cuttings treated with auxin in comparison with nontreated cuttings.

Heller's Japanese holly was selected as a seedling in 1934 by J. Heller, manager of Newport Nursery (Newport, RI), and was named and introduced into the nursery industry in the late 1930s. This dwarf cultivar grows to 2 ft high and 4 ft wide with a dense mounding habit. Popular in landscape situations where a dwarf plant is needed, Heller's Japanese holly is considered the standard by which other dwarf cultivars are judged (Galle, 1997).

Heller's Japanese holly can be used in full sun or partially shaded

settings (Berry, 1994; Gilman, 1999). Plants are readily grown and maintained in the landscape, provided soils are not too dry or too wet (Berry, 1994), and are recommended for landscapes in U.S. Department of Agriculture (USDA) hardiness zones 5b to 8a (Gilman, 1999). Plants are grown primarily for their form and foliage; fruit is rarely produced (Gilman, 1999). Heat can be a limiting factor in nursery production of this crop (Berry, 1994).

An auxin treatment is typically recommended to promote adventitious root formation on stem cuttings of Heller's Japanese holly (Berry, 1994; Dirr and Heuser, 1987). Stem cuttings of other hollies, including 'Dwarf Burford' holly (*Ilex cornuta*), 'Nigra' inkberry (*Ilex glabra*), and dwarf yaupon holly (*Ilex vomitoria* 'Nana') can be successfully propagated from winter cuttings without the use of an auxin treatment (Blythe and Sibley, 2007, 2009; Blythe et al., 2004).

Elimination of unneeded steps is critical to improving nursery production processes (Blythe and Sibley, 2001). Baldwin and Stanley (1981) noted treatment of cuttings with auxin to be one of several nursery operations that merit attention. Even small, but meaningful, changes made over time can improve processes and eliminate waste in nursery operations, all in keeping with the principles of "lean flow" management which has been adopted by a variety of businesses and institutions (Epps, 2009). The objective of this study was to determine whether winter stem cuttings of Heller's Japanese holly could be propagated without use of a conventional basal quick-dip in auxin, thus eliminating one step in the cutting propagation process and reducing chemical use.

Materials and methods

Cutting propagation material of Heller's Japanese holly was collected from healthy landscape plants from three similar planting sites in a residential landscape in Auburn, AL (lat. 32°36'N, long. 85°29'W; USDA hardiness zone 8a) on three dates as repeated experiments to examine the requirement of an auxin treatment to promote rooting. Expt. 1 was initiated on 22 Jan. 2002, Expt. 2 was initiated on 17 Feb. 2002, and Expt. 3 was initiated on 23 Feb. 2002. Terminal, semihardwood, 2.5-inch-long stem cuttings were prepared on each date using the previous season's growth with stems being firm but green. No leaves were removed from the cuttings.

Auxin solutions were prepared by diluting Dip 'N Grow (IBA + NAA; Dip 'N Grow, Clackamas, OR) with deionized water. In all experiments, cuttings received either no auxin treatment or a 1-s basal quick-dip to a depth of 0.5 inch in a solution of 2500 ppm IBA + 1250 ppm NAA. Cuttings were inserted to a depth of 0.5 inch into individual containers using a commercial

This paper was approved for publication as Journal Article No. J-12204 of the Mississippi Agricultural and Forestry Experiment Station, Mississippi State University.

We thank Ned Edwards, Eric Stafne, and Stephen Stringer for reviewing an early draft of this manuscript. Thanks also to Dip 'N Grow Inc. for providing the auxin-containing products used in this study.

Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement to the exclusion of other products that may also be suitable.

¹Coastal Research and Extension Center, Mississippi State University, South Mississippi Branch Experiment Station, Poplarville, MS 39470

²Department of Horticulture, Auburn University, Auburn, AL 36849

³Assistant Research Professor

⁴Professor

⁵Corresponding author. E-mail: blythe@pss.msstate.edu.

Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.3048	ft	m	3.2808
2.54	inch(es)	cm	0.3937
25.4	inch(es)	mm	0.0394
16.3871	inch ³	cm ³	0.0610
1	ppm	mg·L ⁻¹	1
(°F - 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

blend of peat, perlite, vermiculite, and pine bark (Fafard 3B; Conrad Fafard, Agawam, MA) as the rooting substrate. Containers were polystyrene sheets of square pots (11 inch³ soil volume per pot, X-3SQSP; Landmark Plastics, Akron, OH) placed into L1020NCR trays (Landmark Plastics).

Cuttings were placed inside a 4-ft-wide by 8-ft-long by 3-ft-high polyethylene-covered enclosure on top of a 3-inch layer of moistened pine bark (to maintain high humidity) within a double-layer, polyethylene-covered greenhouse at the Paterson Greenhouse Complex at Auburn University (Auburn, AL). Overhead mist was provided within the rooting enclosure by three 2.8-mm orifice nozzles (Pin-Perfect; Damm Corp., Manitowoc, WI) spaced 3 ft apart and raised 1 ft above the cuttings. Overhead mist was supplied once daily for 10 s at noon to maintain a relative humidity of 95% to 100%. Maximum photosynthetically active radiation in the enclosure at the level of the cuttings was 600 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. Daily maximum and minimum temperatures were 81 ± 10 °F and 64 ± 5 °F, respectively. Temperature and humidity were monitored with a data logger (HOBO Pro RH/Temp; Onset Computer Corp., Bourne, MA) placed with the cuttings.

A completely randomized design was used in all experiments with 30 cuttings (replications) per treatment in each experiment. Number of rooted cuttings, number of primary roots emerging from the stem of each rooted cutting, total length of primary roots on each rooted cutting, and number of rooted cuttings with new shoots were determined for each experiment. A cutting was considered to be rooted if it had at least one root greater than 0.5 inch in length. Cuttings in Expt. 1 were more recalcitrant in developing new shoots than cuttings in Expt. 2 and 3, so were allowed additional time until final evaluation. Once it was observed that new shoots had developed on cuttings in Expts. 2 and 3, data were collected from cuttings in all three experiments on 15 May 2002.

Between-treatment differences in number of rooted cuttings and number of rooted cuttings with new shoots were evaluated with Fisher's exact test using the FISHER option of the MULTTEST procedure of SAS

(version 9.2; SAS Institute, Cary, NC) and are presented as percentages. Between-treatment differences for number of roots on rooted cuttings and total root length on rooted cuttings were evaluated with permutation tests using the TEST and PERMUTATION options of the MULTTEST procedure of SAS.

Results and discussion

All cuttings rooted in Expts. 1 and 2 and almost all cuttings rooted in Expt. 3 (Table 1), indicating that winter cuttings of Heller's japanese holly will root acceptably without use of an auxin treatment. However, treatment of cuttings with a basal quick-dip in 2500 ppm IBA + 1250 ppm NAA consistently resulted in a significant increase in the number of roots and total root length on rooted cuttings in comparison with nontreated cuttings. Larger root systems may allow earlier transplanting into larger nursery containers, with the size of the root system in a small container being critical to subsequent shoot growth (Knight et al., 1993).

Rooting results support prior observation by Dirr and Heuser (1987) that Heller's japanese holly may be successfully propagated by stem cuttings late into the winter;

however, the high rooting percentages obtained in this study with cuttings collected in January and February were notably better than the 60% rooting reported by Dirr and Heuser (1987) using cuttings taken in March.

Shoot terminal growth was just beginning at the end of the experiment, with new growth less than 0.25 inch in length. No inhibition of new shoot growth was exhibited by cuttings treated with auxin in comparison with nontreated cuttings (Table 1). However, cuttings in Expt. 1 (collected in January) were generally observed to be slower to produce new terminal growth compared with cuttings in Expts. 2 and 3 (collected in February), suggesting that an additional month of winter chilling helped to stimulate terminal shoot growth earlier in spring. Additional research would be needed to verify this possibility and evaluate other possible difference in rooting and initial shoot growth in response to timing of winter cutting propagation.

In summary, no auxin treatment was required for successful stem cutting propagation of Heller's japanese holly. Use of an auxin treatment may be warranted if a larger root system is needed for earlier transplanting into the next nursery container. Smaller

Table 1. Rooting and initial shoot growth responses of terminal, semihardwood stem cuttings of Heller's japanese holly treated with and without a 1-s basal quick-dip in auxin [indole-3-butyric acid (IBA) + 1-naphthaleneacetic acid (NAA)] in three experiments initiated during winter.^a

IBA + NAA rate (ppm) ^b	Rooted (%)	Roots (no.)	Total root length (mm) ^c	Rooted cuttings with new shoots (%)
<i>Expt. 1</i>				
Nontreated	100	8.7	184	0
2500 + 1250	100	10.6	284	3
Significance ^d	1.000	0.012	<0.001	1.000
<i>Expt. 2</i>				
Nontreated	100	7.0	232	97
2500 + 1250	100	11.4	549	100
Significance	1.000	<0.001	<0.001	1.000
<i>Expt. 3</i>				
Nontreated	93	5.0	136	82
2500 + 1250	100	9.7	329	100
Significance	0.492	<0.001	<0.001	0.021

^aExpt. 1: 21 Jan. 2002; Expt. 2: 17 Feb. 2002; Expt. 3: 23 Feb. 2002 ($n = 30$ in all experiments). Cuttings were rooted in a commercial blend of peat, perlite, vermiculite, and pine bark in a warm, high-humidity rooting environment inside a greenhouse. There were 30 cuttings per treatment in each experiment. All data were collected on 15 May 2002.

^b1 ppm = 1 mg·L⁻¹, 1 mm = 0.0394 inch.

^cProbability values for the differences between treatment means within each experiment were obtained using Fisher's exact test (for percent rooted and rooted cuttings with new shoots) and permutation tests (for number of roots and total root length). Small values (generally less than 0.05) indicate a significant difference.

root systems produced on nontreated cuttings, given additional time to grow, may be quite suitable for later transplanting into the next nursery container. Commercial nursery growers should determine whether an auxin treatment is warranted by improved size, uniformity, or both of the root systems at the point in time that the rooted cuttings are needed for the next step in the production process.

Literature cited

- Baldwin, I. and J. Stanley. 1981. Work flow and costing in propagation. Combined Proc. Intl. Plant Prop. Soc. 31:366–376.
- Berry, J. 1994. Propagation and production of *Ilex* species in the southeastern United States. Combined Proc. Intl. Plant Prop. Soc. 44:425–429.
- Blythe, E.K. and J.L. Sibley. 2007. Sodium cellulose glycolate as a thickening agent for liquid auxin formulations can enhance rooting of stem cuttings. J. Environ. Hort. 25:126–130.
- Blythe, E.K. and J.L. Sibley. 2009. Winter stem cutting propagation of ‘Dwarf Burford’ holly without use of a conventional auxin treatment. HortTechnology 19:130–132.
- Blythe, E.K., J.L. Sibley, K.M. Tilt, and J.M. Ruter. 2004. Auxin application to stem cuttings of selected woody landscape plants by incorporation into a stabilized organic rooting substrate. J. Environ. Hort. 22:63–70.
- Blythe, G. and J.L. Sibley. 2001. The effective propagator: Keeping a focus on key issues in propagation management. Combined Proc. Intl. Plant Prop. Soc. 51:590–594.
- Dirr, M.A. and C.W. Heuser, Jr. 1987. The reference manual of woody plant propagation: From seed to tissue culture. Varsity Press, Athens, GA.
- Epps, S. 2009. Lean flow management for production efficiency. Combined Proc. Intl. Plant Prop. Soc. 59:573–576.
- Galle, F.C. 1997. Hollies: The genus *Ilex*. Timber Press, Portland, OR.
- Gilman, E.F. 1999. *Ilex crenata* ‘Helleri’. Univ. Florida Coop. Ext. Serv. Fact Sheet FPS-268.
- Knight, P.R., D.J. Eakes, C.H. Gilliam, and K.M. Tilt. 1993. Propagation container size and duration to transplant on growth of two *Ilex* species. J. Environ. Hort. 11:160–162.