Cutting Propagtion of *Ilex angulata*©

Fang Geng, Zhihui Li, Xiaoling Jin, and Liyun Wang
Central South University of Forestry and Technology, Changsha, Hunan, 410004 China

Donglin Zhang
University of Maine, 5722 Deering Hall, Orono, Maine, 04469 U.S.A.
Email: donglin@umit.maine.edu

Ilex angulata **Merr. et Chun, a small tree or shrub, is an important and popular landscape plant in China. The market demand is high because of its round habit, zigzag branches, pink flowers, and brilliant red fruits. To introduce this wild species for cultivation, semi-hardwood stem cuttings were collected in June 2009 and treated with liquid KIBA, KNAA, and Hormodin at 1,000 and 3,000 mg·L^{-1}. Rooting hormones significantly increased root percentages and root quality, regardless of cuttings with or without heels. The highest rooting rate, 91.7%, was obtained under KNAA at 1,000 mg·L^{-1}. The effect of hormone types on rooting of *Ilex angulata* was not significant. As rooting hormone concentrations increased from 1000 to 3,000 mg·L^{-1}, the rooting percentages of heeled cuttings with all hormone treatments decreased significantly from 66.7 to 50.0% (Hormodin), 75.0% to 50.0% (KIBA), and 75.0% to 25.0% (KNAA), respectively. Cuttings treated with KIBA produced better root systems. The largest root ball, 250.1 cm^3, was observed from cuttings treated with KIBA at 1,000 mg·L^{-1}. Cuttings treated with KIBA had root ball volumes of 39.4–250.1 cm^3, while those with Hormodin and KNAA had root ball volumes of 33.8–107.2 cm^3 and 53.5–167 cm^3, respectively. For the propagation of *Ilex angulata*, semi-hardwood cuttings treated with KNAA and KIBA at 1,000 mg·L^{-1} were recommended.**

INTRODUCTION

Ilex angulata (*lengzhi dongqing* in Chinese), a member of Aquifoliaceae, is a newly introduced evergreen woody ornamental plant. Although it was discovered in 1935 (Chen et al., 1999), this small evergreen tree had not been cultivated until recent years. It had attracted gardeners by its dense, glossy green and elliptical foliage, slender zigzag, vertical ridge branches, and rounded habit. Its pink flowers and bright red fruits also contributed to its popularity in the ornamental world. Flowers bloom in April and fruits are persistent from July to October. The plant is indigenous to China and mainly distributed in Guangxi and Hainan province (Chen et al., 1999). This plant naturally occurs at an elevation of 350–600 m (1,000–2,000 ft) in the mountainous jungles or woodlands. The specimens and seeds were collected and brought into the U.S.A. in 1932 (Chun and Tso, 1935). Later, *I. angulata* Merr. et Chun var. *longipedunculata* S.Y. Hu was collected by How (1949) from Po-ting, Hainan, China. However, only a few reports about this plant (and its variety) were published in the U.S.A., especially its application in landscape and propagation. *Ilex* species can be reproduced by seed germination; however, seed germination of holly species is a very slow procedure and often requires 1–3 years. This is due to the immature embryos of most species and to complicated seed coverings from stony to woody to leathery

(Galle, 1997). Cutting propagation is the most popular method to reproduce plants clonally (Dirr and Heuser, 1987) and many *Ilex* species, especially its cultivars, had been regenerated from rooting of stem cuttings (Galle, 1997). *Ilex angulata* is an excellent landscaping plant with great market potential. However, no research on clonal propagation about this plant was reported, which limited its popularity. Cutting propagation and its commercial application were investigated in this paper.

MATERIALS AND METHODS

Materials. Semi-hardwood cuttings of *I. angulata* were collected from the campus of Central South University of Forestry and Technology in Changsha, Hunan, China (U.S.D.A. Zone 7–8) on the 9 June 2009. All cuttings were divided into two groups: with heel and without heel. The propagation medium was a mixture of peat moss and perlite (1 : 3, v/v). The rooting hormones were potassium salt of indole-3-butyric acid (K-IBA), potassium salt of naphthaleneacetic acid (K-NAA), and talc

Table 1. Treatments of rooting hormones on semi-hardwood cuttings of *Ilex angulata*.

Treatment	Rooting hormones ($mg \cdot L^{-1}$)
1	Control (CK)
2	Hormodin #1 (1,000) powder
3	Hormodin #2 (3,000) powder
4	K-IBA (1,000) liquid
5	K-IBA (3,000) liquid
6	K-NAA (1,000) liquid
7	K-NAA (3,000) liquid

indole-3-butyric acid (Hormodin #1 and Hormodin #2) (Table 1).

Methods. This study was conducted from June to November 2009 in the propagation greenhouses at Central South University of Forestry and Technology. Terminal stem cuttings were taken in the early morning on the 9 June. All cuttings were placed into black plastic bags, immediately sprayed with water, and then transported to the greenhouses. Each cutting was pruned from the base to an approximate length of 15 cm (5–6 in.) with 3–4 top leaves maintained. To reduce respiration and energy loss, leaf area of each remaining leaf was reduced by two-thirds on the cuttings. The bottom portion was stripped and received a slight double wound. Stem cuttings were treated with distilled water (as the control) and six rooting hormones listed in Table 1. The basal 3–4 cm of each cutting was dipped into the liquid solution for 15 sec, and then air-dried for at least 15 min. Some cuttings were dipped into water first, and then dusted with talc hormone (Hormodin #1 and Hormodin #2). All treated cuttings were stuck into a $6 \times 6 \times 8$ cm^3 cell in 32-cell flat trays filled with the propagation medium. All cuttings were randomly placed on a mist bench in the greenhouse. The mist system was set for 20 sec every 10 min in the first week, then 20 sec every 20 min thereafter during daylight hours.

A randomized complete block design was applied in this experiment. There were three replicates per treatment and eight cuttings per replicate per treatment. Rooting percentage and root quality, which measured by root ball volume (rooting ball

Table 2. Rooting rates and root quality (root ball volume) of *Ilex angulata* by semi-hardwood stem cuttings under various rooting hormones and concentrations.

Hormone type and concentration ($mg \cdot L^{-1}$)	Cuttings with heel		Cuttings without heel	
	Rooting rate (%)	Root-ball volume (cm^3)	Rooting rate (%)	Root-ball volume (cm^3)
Control (CK)	25.0 c	8.0 d	33.3 e	11.6 e
Hormodin #1 (1,000)	66.7 a	107.2 b	58.3 c	76.7 d
Hormodin #3 (3,000)	50.0 b	33.8 cd	66.7 bc	69.7 d
K-IBA (1,000)	75.0 a	118.2 b	66.7 bc	250.1 a
K-IBA (3,000)	50.0 b	39.4 c	75.0 b	206.7 b
K-NAA (1,000)	75.0 a	167.0 a	91.7 a	139.1 c
K-NAA (3,000)	25.0 c	53.5 c	41.7 de	65.1 d

Note: Mean rooting rate and root-ball volume within the column followed by the same letter are not significantly different using LSD at $\alpha \leq 0.5$.

length, width, and height) were recorded after 4 months. All data were analyzed using SAS software. Mean separation was carried out using the least significant difference method with alpha at 0.05 level.

RESULTS AND DISCUSSION

Ilex angulata could be commercially propagated by semihardwood stem cuttings with rooting hormones. Compared to the control, rooting hormones had significant effects on rooting of *I. angulata* stem cuttings, regardless of the presence or absence of a heel (Table 2). Cuttings without any rooting hormone (control) produced a rooting percentage of 25% (with heel) and 33.3% (without heel) and all treated cuttings produced significantly higher rooting rates up to 91.7%, which was the highest rooting percentage under the treatment of 1,000 mg·L^{-1} K-NAA without a heel. Cuttings without heel generally rooted better, but no significant difference was observed. Our results did not support that cuttings with a heel usually rooted better than that without a heel by Hartmann et al. (2002). The type of rooting hormones did not show any significant effect either. Hormone concentrations had the greatest influences on rooting rates and root quality (indicated by root-ball volume). Low concentration (1,000 mg·L^{-1}) yielded significant higher rooting percentages and better root quality. The highest root ball volume (250.1 cm^3) was recorded under the treatment of 1,000 mg·L^{-1} K-IBA quick dip. It is possible that hormone concentration at 3,000 mg·L^{-1} may be too high for *I. angulata*, which caused stem "burn" and resulted in a reduction of rooting percentages and root quality (Table 2). Application methods (powder vs. quick dip) did not have significant effect on either rooting rates or root quality.

CONCLUSION

As an important small ornamental tree, *I. angulata* could be clonally propagated by semi-hardwood stem cuttings. Cuttings should be collected in early to middle June in U.S.D.A. Zone 7–8 and prepared with 1,000 mg·L^{-1} rooting hormones and rooted with peat : perlit (1 : 3, v/v) medium under mist systems. Hormone types and application method had no significant effect and only newly sprouted stem cutting should be collected (no old wood).

LITERATURE CITED

Chen, Shukun, Haiying Ma, Yuxing Feng, Gabrielle Barriera, and **Pierre-André Loizeau.** 1999. Flora of China- Aquifoliaceae, Vol. 47. Science Press, Beijing.

Chun, N.K., and **C.L. Tso.** 1935. *Ilex angulata* Merrill & Chun. Sunyatsenia 2:266.

Dirr, M.A., and **C.W. Heuser.** 1987. The reference manual of woody plant propagation: From seed to tissue culture. Varsity Press, Athens, Georgia.

Galle, Fred C. 1997. Hollies: the genus *Ilex*. Timber Press, Inc., Portland, Oregon.

Hartmann, H.T, Kester, D.E., Davies, Jr., F.T., and **Geneve, R.** 2002. Hartmann and Kester's plant propagation: Principles and practices. Pearson Education, Inc., Upper Saddle River, New Jersey.

How, Foon-Chew. 1949. *Ilex angulata* Merrill & Chun var. *longipedunculata* S. Y. Hu. J. Arnold Arbor. 30:313.