Cutting Propagation of *Zelkova serrata*©

He Li, Yujie Yang, Xiaoling Jin and Zhihui Li
Central South University of Forestry and Technology, Changsha, Hunan 410004, China
Email: susuzx98@uga.edu

Donglin Zhang and Jinying Dong
Department of Horticulture, University of Georgia, Athens, Georgia 30602, USA

INTRODUCTION

Zelkova serrata is a deciduous tree in Ulmaceae from Japan, Taiwan, and eastern China. It is used for bonsai, shade tree, or park landscape because of its attractive habit, foliage colors, and heat and drought tolerance. Typically the plant reaches to 15-24 m tall with a spreading, upright-branching, vase-shaped crown (Fleme, 1983). *Zelkova* gained popularity because it was utilized to substitute American elm for its Dutch elm disease resistance and no elm leaf beetle (Dirr, 2011).

How to propagate this beautiful plant? Seed germination does not require pretreatment, and germination percentage would increase with prechilling at 4°C for 60 days (Ishii, 1979). However uniform *Z. serrata* seedlings can rarely be obtained by seed germination. Tissue culture had been successful, leaves and axillary buds were cultured on Murashige and Skoog (1962) medium containing half strength nitrogenous compounds to regenerate *Z. serrata* plants (Tomita, 1991), but tissue culture usually has high production cost and high technical requirement.

To regenerate uniform plants with lower cost for commercial production, rooting of stem cuttings is the most common application (Dirr and Heuser, 2006). Dirr and Frett (1983) rooted *Z. serrata* semi-hardwood cuttings treated with 0, 0.8, 1.6, and 3.2% IBA-quick dip and obtained rooting percentages at 32, 48, 62, and 54%, respectively. In our experiments, softwood and hardwood stem cuttings from 1-year-old seedlings treated with different types of rooting hormones at various concentrations were investigated in 2013-2014 hoping to regenerate *Z. serrata* all year round for market demand by rooting different types of cuttings.

MATERIALS AND METHODS

Plant Materials

Zelkova serrata softwood stem cuttings were obtained from full flush growth of container growing plants on 18 Sept. 2013 at Horticulture farm of University of Georgia. Cuttings were placed into water immediately after being removed from mother plants. They were trimmed to 10-15 cm and leaves of the bottom 3-5 cm were stripped, and then were treated with various concentrations of different rooting hormones. Hardwood cuttings were much easier to prepare. They were collected from 1-year-old seedlings and directly treated with rooting hormones on 18 Dec. 2013.

Experimental Treatments

Both softwood and hardwood cuttings were treated with K-IBA at 1,000 ppm, K-IBA at 3,000 ppm, K-IBA at 8,000 ppm, Hormodin® 1 (1,000 ppm), Hormodin® 2 (3,000 ppm), Hormodin® 3 (8,000 ppm), K-NAA at 1,000 ppm, K-NAA at 3,000 ppm, K-NAA at 8,000 ppm plus control (no hormone). For the application of powdery Hormodin, cuttings were dipped into water first and then dusted with powder. For liquid hormone, cuttings were dipped into the concentrations for 10-15 s, then air dry for at least 10 min before placing them into the rooting media.

Treated softwood cuttings were randomly inserted into 32-cell flat trays filled with the rooting medium, which contained Fafard 3L Mix (main ingredients: peat moss and bark) and perlite at 1:1 (v:v). Treated cuttings were thoroughly watered before placing them on the mist bench. The mist bench was covered with 70% shade cloth and the mist system

was set for 20 s every 20 min at the first week, then 10 s every 20 min thereafter. Hardwood stem cuttings were rooted into the seedbed with bottom heat, which was filled with a mix of 1 sand and 1 Nature's Helper® Organic Soil (v/v) as rooting medium. All cuttings were completely covered with transparent plastic film and watered as needed.

Data Collection
Rooting percentage, number of roots, and average length of roots of cuttings were collected. Data of softwood cuttings were collected on 21 Nov. 2013 and that of hardwood were recorded on 9 May 2014. Root quality was indicated by total root length (= number of roots*average length of roots).

Experimental Design
A randomized complete block design was applied in the experiments with four replicates for each treatment and eight subsamples (cuttings) per replicate per treatment. All data were analyzed by SAS and mean separations were the least significant difference with alpha at 0.05 level.

RESULTS AND DISCUSSION

Softwood Cuttings
Rooting hormones significantly increased rooting percentage from 6.3% (control) to 40.6% and total root length from 0.2 cm to 9.0 cm. Both the highest rooting percentage and best root quality were under Hormodin 2 (3,000 ppm) treatment.

Different types of hormones resulted in significant difference on rooting of softwood cuttings. Hormodin (IBA) treatments yielded higher rooting percentage and better root quality than K-NAA treatments. Under 1,000 ppm treatments, Hormodin 1 yielded double rooting percentage (25.0%) and about four times longer total root length (2.6 cm) than that of K-NAA, of which rooting percentage was 12.5% and total root length was 0.6 cm (Table 1).

Application methods did significantly affect the rooting. Liquid K-IBA (1,000 ppm) treatment yielded a rooting percentage of 31.3% and root length at 8.4 cm, which were much better than powdery Hormodin 1. As concentrations of K-IBA increased, the results reduced. While Hormodin treatments had the best result at 3,000 ppm, and both higher and lower concentration reduced the results (Table 1). It is possible that the liquid hormone had rapid effect than that of powdery hormone.

Lower concentrations of hormones (1,000 or 3,000 ppm) were helpful to the rooting. However, higher concentration (8,000 ppm) might be too strong for softwood cuttings without improving the rooting percentage (Table 1) even though the high concentration resulted in highest rooting percentage on semi-hardwood cuttings (Dirr and Frett, 1983).

Table 1. Impact of hormones on rooting percentage and total root length of *Zelkova serrata* softwood cuttings. Different letters mean significant differences at α=0.05.

Treatment	Rooting (%)	Total root length (cm)
Control	6.3d	0.3b
K-IBA 1,000 ppm	31.3ab	8.4a
K-IBA 3,000 ppm	12.5cd	1.3b
K-IBA 8,000 ppm	6.3d	0.9b
Hormodin® 1 (1,000 ppm)	25.0bc	2.6b
Hormodin® 2 (3,000 ppm)	40.6a	9.0a
Hormodin® 3 (8,000 ppm)	6.3d	0.6b
K-NAA 1,000 ppm	12.5cd	0.6b
K-NAA 3,000 ppm	15.6cd	2.3b
K-NAA 8,000 ppm	6.3d	0.2b

Hardwood Cuttings

Rooting hormone also did significantly affect the rooting of hardwood cuttings. Treatment K-IBA 3,000 ppm was the best rooting hormone for the rooting, which yielded rooting percentage at 40.6% (Fig. 1A) and total root length at 16.2 cm (Fig. 1B).

The K-NAA worked more efficiently than K-IBA. Under 1,000 ppm treatments, K-NAA yielded higher rooting percentage and better root quality than K-IBA. The K-IBA had a peak at 3,000 ppm, while K-NAA 3,000 and 8000 ppm had negative effect on root quality (Fig. 1B).

Application methods of hormone affected rooting as well. With concentrations of 1,000 and 3,000 ppm, higher rooting percentage and better root quality were observed under K-IBA treatments, and there was significant difference between K-IBA and Hormodin (Fig. 1). This might be the result of the difference in absorption between liquid and powdery hormone.

The lower concentrations of K-IBA and Hormodin treatments produced much higher rooting percentage than that of 8,000 ppm, and concentration at 3,000 ppm resulted in much better root quality than 8,000 ppm. The K-NAA at 1,000 ppm also yielded better rooting results than that of higher concentrations (Fig. 1).

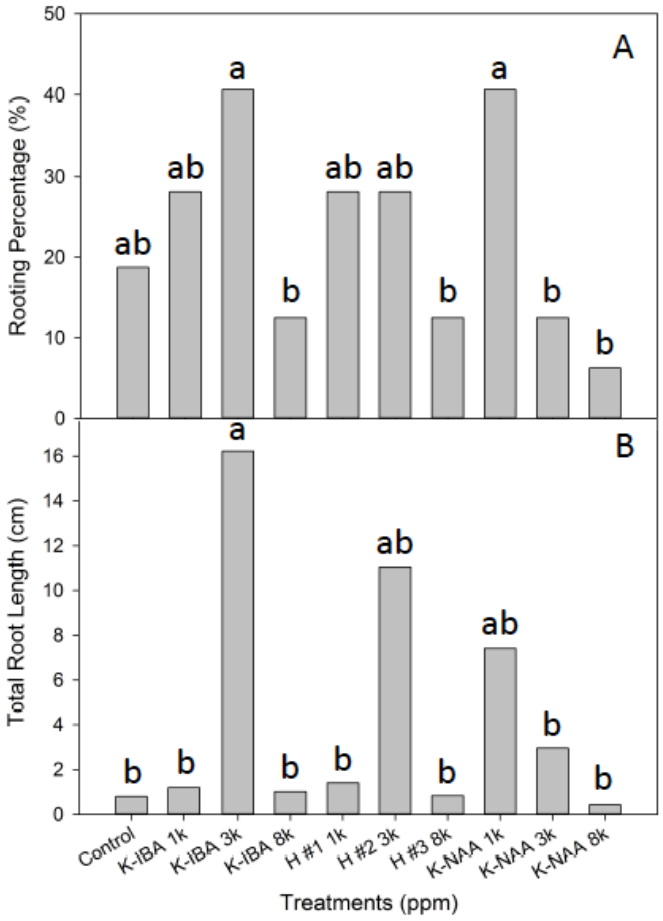

Fig. 1. Impact of hormones on rooting percentage (A) and total root length, (B) of *Zelkova serrata* hardwood cuttings. Different letters mean significant differences at α=0.05.

CONCLUSION

Commercial production of *Z. serrata* could be regenerated from different types of stem cuttings treated by rooting hormone. Hormone types, application methods, and concentrations did significantly affect the rooting of *Z. serrata* cuttings. For better rooting percentage and higher quality of liners, Hormodin 2 should be applied for softwood cuttings, and liquid K-IBA at 3,000 ppm is recommended for hardwood cuttings.

Literature Cited

Dirr, M.A. and Frett, J.J. 1983. Rooting Chinese elm and Japanese zelkova cuttings. Plant Propagator 29(2):10-11.

Dirr, M.A. and Heuser, C.W. 2006. The Reference Manual of Woody Plant. Propagation (2nd ed.). Timber Press, Portland, Oregon.

Dirr, M.A. 2011. Dirr's encyclopedia of trees and shrubs. Timber Press, Portland, Oregon.

Flemer, W. III. 1983. *Zelkova serrata* tree. United States Patent and Trademark. Office, Washington, D.C.

Ishii, Y. 1979. Effect of light and temperature on the germination of *Zelkova serrata*, seeds with various prechilling times. J. Japan. For. Soc. 61(10):362-366.

Murashige T. and Skoog F. 1962. A revised medium for rapid growth and bio-assays with tobacco tissue cultures. Physiol. Plant. 15(3):473-497.

Tomita, M. 1991. Plantlet regeneration from leaf explant of *Zelkova serrata* Makino. Plant Tissue Culture Letters 8(3):201-205.