Research Reports

Propagation of *Ulmus parvifolia* 'Emerald Prairie' by Stem Cuttings[1]

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Abstract

Stem cuttings of *Ulmus parvifolia* Jacq. 'Emerald Prairie' ('Emerald Prairie' lacebark elm), consisting of 7.5 to 10 cm (3 to 4 in) terminal shoot portions, were collected four times throughout the year from mature stock plants and treated with the potassium (K) salt of indole-3-butyric acid (K-IBA) ranging from 0 to 20,000 ppm (2.0%). Rooting percentages were affected greatly by K-IBA treatment and stock plant growth stage. Little to no rooting was observed without K-IBA application, whereas overall rooting for treated softwood, early semi-hardwood, late semi-hardwood, and hardwood, cuttings was 92, 86, 87, and 8%, respectively. Mean root number varied by growth stage and K-IBA concentration. Higher concentrations of K-IBA increased the number of roots on rooted cuttings except for hardwood cuttings. In general, rooting percentage and mean root number were highest at the softwood stage with 15,000 or 20,000 ppm (1.5 or 2.0%) K-IBA, resulting in 97% rooting and 15 or 22 roots per rooted cutting, respectively. However, leaf abscission was high on softwood cuttings. Semi-hardwood cuttings achieved similar rooting percentages and may exhibit better survival and growth due to greater leaf retention.

Index words: adventitious rooting, auxin, indolebutyric acid, lacebark elm.

Significance to the Nursery Industry

Lacebark elms (*Ulmus parvifolia*) are generally heat, drought, and cold tolerant trees widely adapted to many landscape situations. They can be grown successfully in a range of soil conditions, are well-suited as street trees, and their exfoliating bark makes them attractive specimen trees. Additionally, they are resistant to Dutch elm disease [*Ophiostoma ulmi* (Buism.) Nannf. and *O. novo-ulmi* Brasier], Japanese beetles (*Popillia japonica* Newman), and elm leaf beetles (*Xanthogaleruca luteola* Mueller), which have limited the use of other elms (*Ulmus* L. spp.) in the landscape. 'Emerald Prairie' lacebark elm was selected for its rapid growth rate, dark green foliage, and superior resistance to black leaf spot [*Stegophora ulmea* (Schweinitz: Fries) Sydow & P. Sydow]. Results herein indicate that 'Emerald Prairie' lacebark elm can be rooted successfully at the softwood and semi-hardwood growth stages in percentages greater than 90%. However, percent rooting and root number were highest for softwood cuttings treated with 15,000 or 20,000 ppm (1.5 or 2.0%) of the potassium salt of indolebutyric acid (K-IBA).

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Introduction

Few trees have proven themselves to be as durable and reliable as lacebark elm. Individual seedlings can develop into a variety of forms ranging from multi-stemmed shrubs 3 m (10 ft) in height to large shade trees 21 m (70 ft) tall. Generally, the species grows 12–15 m (40–50 ft) tall with a high spreading canopy. With its beautiful exfoliating bark, lacebark elm can be used as a specimen tree. However, it is also frequently used as a street tree. The species can survive in a wide array of soil types and has been shown to be heat and drought tolerant (5). Although listed as being hardy to USDA Hardiness Zone 5, variation may exist among individual seedlings and cultivars.

'Emerald Prairie' lacebark elm was selected due to its rapid growth rate, dark green leaf color, and high resistance to black leaf spot (3). In field trials near Wichita, KS, this cultivar has grown an average of 0.6 m (2 ft) per year over an 18-year period with superior foliage quality compared to other cultivars: darker green and no leaf black spot. Trees are hardy to USDA Hardiness Zone 5 and have survived extended periods with little irrigation.

Due to several desirable landscape attributes, there is great interest in propagation and culture of 'Emerald Prairie' lacebark elm. Although some investigators have successfully rooted stem cuttings of lacebark elm, percentages either were not reported, were relatively low (48%), or were highly variable depending on growth stage (1, 2). For the species in general, it was reported that cuttings must be taken 6–8 weeks following budbreak for successful rooting (4), suggesting timing is important. Pair (5) demonstrated that rooting of softwood cuttings of selected clones of lacebark elm was improved following treatment with a liquid formulation of 10,000 ppm (1.0%) IBA, and hardwood cuttings could also be rooted successfully. Hardwood cuttings of four clones of lacebark elm rooted 100% when treated with a liquid formulation of 10,000 ppm (1.0%) IBA.

Currently, there is no protocol for propagation of 'Emerald Prairie' lacebark elm by stem cuttings. Personal communication with various growers has revealed some difficulty rooting cuttings of this clone, and the previously mentioned success with hardwood cuttings (5) has not been repeatable with 'Emerald Prairie'. Therefore, the objective of this study was to investigate the influence of stock plant growth stage and auxin concentration on adventitious rooting of stem cuttings of this particular cultivar of lacebark elm.

Methods and Materials

Terminal stem cuttings, approximately 20 cm (8 in) in length, were collected throughout the crown of mature stock plants growing at the John C. Pair Horticultural Center near Wichita, KS. Trees were growing in a sandy loam soil under uniform fertility when cuttings were collected on June 5, 2003 (softwood), July 14, 2002 (early semi-hardwood), August 15, 2002 (late semi-hardwood), and February 20, 2003 (hardwood). In order to collect sufficient cutting material for the entire experiment, two stock plant sources were used. Early semi-hardwood cuttings were collected from the original clone that was 18 years of age and 9 m (30 ft) tall. Cuttings for all other growth stages were collected from each of 10 clonally propagated trees approximately 7 years of age and 3.6 m (12 ft) tall.

At each growth stage, cuttings were collected in early morning and kept moist during processing. From the initial cutting material, terminal cuttings 7.5 to 10 cm (3 to 4 in) in length were prepared from the most recent season's growth. Leaves were removed from the lower half of the cuttings prior to auxin treatment. Stem tissue at the proximal end of hardwood and semi-hardwood cuttings was highly lignified, dark brown to grey in color, and resembled that of mature stem tissue. Tissue at the proximal end of softwood cuttings was less lignified, brown in color, and flexed without breaking when pressure was applied.

Following preparation, the basal 1 cm (0.4 in) of all cuttings was treated for 3 sec with 0, 5000 (0.5%), 10,000 (1.0%), 15,000 (1.5%) or 20,000 ppm (2.0%) K-IBA dissolved in distilled water. Cuttings were air dried for 10 min before inserting the basal 4 cm (1.6 in) into flats 9 cm (3.5 in) deep containing a medium of perlite:peat (3:1 v/v) and placed on a raised greenhouse bench. Bottom heat was maintained at 24 ± 1C (75 ± 2F) for hardwood cuttings only. In addition to the above K-IBA treatments, treatments of 1000 (0.1%), 3000 (0.3%), or 8000 ppm (0.8%) IBA in a talc formulation were included with the softwood cuttings. For each growth stage the experimental design was a randomized complete block with six blocks, and six cuttings per treatment per block.

Cuttings were maintained under natural photoperiod and irradiance with days/nights of 24 ± 5C (75 ± 9F)/18 ± 5C (65 ± 9F) for softwood and semi-hardwood cuttings and day/nights of 20 ± 3C (68 ± 5F)/16 ± 5C (60 ± 5F) for hardwood cuttings. Intermittent mist operated daily 6 sec every 6 min from sunrise to sunset for the softwood and semi-hardwood

Table 1. **Effect of K-IBA concentration on percent rooting of stem cuttings of 'Emerald Prairie' lacebark elm.**

K-IBA concn. (ppm)	Softwood	Early semi-hardwood	Late semi-hardwood
0	0[z]	11	0
5,000	86	69	64
10,000	86	92	97
15,000	97	97	92
20,000	97	86	94
Linear	**[y]	**	**
Quadratic	**	**	**

[z]For each value N = 36

[y]**Significant at $P \leq 0.01$.

Table 2. **Effect of K-IBA concentration on mean root number per rooted stem cutting of 'Emerald Prairie' lacebark elm.**

K-IBA concn. (ppm)	Softwood	Early semi-hardwood	Late semi-hardwood
0	—	1.2	—
5,000	7	6.2	6.2
10,000	10.6	11.0	8.9
15,000	15.2	16.4	12.4
20,000	22.3	17.3	16.1
Linear	**[z]	**	**
Quadratic	NS	NS	NS

[z]NS, ** Nonsignificant or significant at $P \leq 0.01$, respectively.

cuttings and for 6 sec every 10 min for hardwood cuttings. Mist was applied by deflection type nozzles with a capacity of 32.2 liters (8.5 gal.) per hour.

At 6 weeks, cuttings were harvested and data recorded. Data included percent rooting and number of roots ≥ 1 mm (0.04 in) in length on rooted cuttings. A cutting was considered rooted if it had one adventitious root ≥ 1 mm in length. Data were subjected to analysis of variance and regression analysis.

Results and Discussion

Stem cuttings treated with K-IBA rooted in high percentages at the softwood and early and late semi-hardwood growth stages. Overall percent rooting of treated cuttings was 92, 86, 87, and 8% for softwood, early semi-hardwood, late semi-hardwood, and hardwood cuttings, respectively. Rooting occurred rapidly and a well branched root system developed around the bases of the cuttings 6 weeks after treatment.

At the softwood and semi-hardwood growth stages, percent rooting varied with K-IBA treatment (Table 1). Percent rooting of hardwood cuttings was poor and unaffected by K-IBA treatment (data not presented). However, percent rooting of softwood and semi-hardwood cuttings was improved dramatically by K-IBA application. On softwood and late semi-hardwood cuttings, no rooting was observed with the nontreated (0 ppm K-IBA) cuttings and only 11% of nontreated early semi-hardwood cuttings rooted. Percent rooting increased substantially with 5000 ppm (0.5%) K-IBA to 86, 69, and 64% for softwood, early semi-hardwood, and late semi-hardwood cuttings, respectively. The greatest rooting percentage for these three growth stages occurred with K-IBA concentrations ≥10,000 ppm (1.0%). In all three instances, rooting response to K-IBA treatment was quadratic, with optimum rooting of 97% (Table 1). Softwood cuttings treated with talc formulations of IBA up to 8000 ppm (0.8%) failed to root (data not shown). This suggests that adventitious root formation in ‘Emerald Prairie’ lacebark elm is highly sensitive to auxin formulation and successful clonal propagation by stem cuttings should utilize liquid formulations applied as a basal quick-dip.

Mean root number per rooted cutting was also strongly influenced by K-IBA concentration. Similar to percent rooting, root number for the hardwood cuttings was unaffected by K-IBA application (data not presented). Mean number of roots for the softwood, early semi-hardwood, and late semi-hardwood cuttings increased in a linear fashion with increasing K-IBA concentration (Table 2). In fact, root number increased ≈ 30 to 50% with each increase in K-IBA concentration. The greatest mean root number (22 roots per rooted cutting) was attained with softwood cuttings treated with 20,000 ppm (2.0%) K-IBA. However, softwood and semi-hardwood cuttings treated with ≥10,000 ppm (1.0%) K-IBA produced well developed root systems.

Results herein demonstrate that asexual propagation of ‘Emerald Prairie’ lacebark elm by stem cuttings is rapid and efficient. Although rooting was poor for hardwood cuttings, high percentages can be attained throughout the growing season, reducing the importance of timing as a factor in successful rooting. In addition, results suggest that successful rooting occurs among trees of varying ages (Table 1). Stem cuttings from trees 7 or 18 years of age (late semi-hardwood or early semi-hardwood, respectively) rooted in high percentages when treated with K-IBA. Although greatest rooting percentage and mean root number were achieved with softwood cuttings, many leaves had abscised by the end of the 6 week rooting period. In contrast, most of the leaves on early and late semi-hardwood cuttings were retained throughout the experiment, even on nonrooted cuttings. Whether this leaf retention improves over-wintering and subsequent growth requires further investigation. Softwood cuttings treated with IBA in talc formulations ranging from 1000 ppm (0.1%) to 8000 ppm (0.8%) failed to root. While results may vary with different propagators, these results suggest liquid formulations of IBA should be used for optimum rooting of stem cuttings of ‘Emerald Prairie’ lacebark elm.

Literature Cited

1. Croxton, D.S. 1976. Elm cuttings for bonsai training. Proc. Intern. Plant. Prop. Soc. 26:37–38.

2. 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.

3. Griffin, J.J., H. Khatamian, J.C. Pair, and M. Shelton. 2004. ‘Emerald Prairie’ lacebark elm. HortScience 39:181–182.

4. Hartmann, H.T., D.E. Kester, F.T. Davies, Jr., and R.L. Geneve. 2002. Hartmann and Kester’s Plant Propagation: Principles and Practices. 7th ed. Prentice Hall, Inc., Upper Saddle River, NJ.

5. Pair, J.C. 1992. Evaluation and propagation of lacebark elm selections by hardwood and softwood cuttings. Proc. Intern. Plant Prop. Soc. 42:431–435.