(*Ed. note:* This paper reports the results of research only, and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities.)

Literature Cited

1. Benson, D.M. and D.L. Strider. 1986. Powdery mildew and blackspot control on roses with fungicides. Fungic. Nematic. Tests 41:177.

2. Coyier, D.L. and J.J. Gallian. 1982. Control of powdery mildew on greenhouse-grown roses by volatilization of fungicides. Plant Dis. 66:842–844.

3. Englehard, A.W. 1969. Fungicidal efficacy of three benzimidazole compounds and Dithane M-45 against *Diplocarpon rosae* on two rose cultivars. (Abstr.) Phytopathology 59:113.

4. Glenn, W.K., L.W. Baxter, and W. Witcher. 1972. Studies on the fungicidal control of black spot on roses after severe disease development. (Abstr.) Phytopathology 62:803.

5. Kaul, J.L. 1984. A note on the efficacy of Saprol against rose diseases. Pesticides 18:27.

6. Kolb, W. and T. Schwarz. 1985. Cultivation of roses without fungicides. Deutsche Baumschule 37:196–197.

7. Lyle, E.W. 1978. Black Spot of Roses: A Continuing Handicap. Pages 95–98 in: 1978 American Rose Annual. H.S. Goldstein, ed., Kingsport Press, Kingsport, Tennessee. 219 pp.

8. Meeus, P. 1980. Use of fungicides in the control of rose powdery mildew (*Sphaerotheca pannosa*) and secondary effects on black spot (*Diplocarpon rosae*). Revue de l'Agriculture 33:99–104.

9. Morrison, L.S. and C.C. Russell. 1976. Timing of fungicide-adjuvant mixtures for control of rose blackspot. Plant Dis. Rep. 60:634–636.

10. Paulus, A., J. Nelson, and S. Besemer. 1986. Fungicides for the control of rose powdery mildew (*Sphaerotheca pannosa* var. *rosae*) and rust (*Phragmidium mucronatum*). Phytopathology (Abstr.) 76:1071.

Comparison of Rootability of Stem Cuttings from Seedlings of *Aesculus* sp. and Mature *Aesculus* × *arnoldiana* 'Autumn Splendor'[1]

B.A. Bergmann, W.P. Hackett and H. Pellett[2]
Department of Horticultural Science and Landscape Architecture
University of Minnesota, St. Paul, MN 55108

Abstract

Rootability was evaluated for stem cuttings taken at varying positions and developmental stages from seedlings of *Aesculus* and from the mature trees of *Aesculus* × *arnoldiana* 'Autumn Splendor'. Rooting was 100% for cuttings taken from 2-week-old seedlings and 0% for those obtained from the crown of the mature tree 2 months after commencement of spring growth flush. Intermediate rootability was found for cuttings taken from 1-month-old seedlings and from the 2 week-old growth of suckers at the base of the mature tree. Rooting of cuttings with intermediate rooting potential was increased by a quick dip treatment with 2500 ppm indole-3-butyric acid (IBA) or by using apical rather than basal stem segments. Commercially acceptable rooting was not achieved using cuttings from root suckers or the crown of *Aesculus* 'Augumn Splendor'.

Index words: phase change, juvenility, maturation, rooting, IBA, buckeye

Introduction

Rooting ability of shoot cuttings from woody plant species depends on many factors. High rooting potential is generally considered to be a juvenile characteristic which is often lost during maturation (4, 5, 6, 7, 9). Evidence indicates that both physiologic and ontogenetic development over time contribute to decreased rootability as a plant gets older (2). Rooting potential is influenced by the position on the parent tree from which cuttings are taken and by the stage of shoot development at the time of taking cuttings (1, 6, 8, 10). The stage for achieving successful rooting can be quite limited. In some cases shoots arising from roots have a greater propensity to root than do cuttings from any other location on the plant (3, 7).

Attempts to propagate the selection *Aesculus* × *arnoldiana* 'Autumn Splendor' via traditional vegetative means, including bench grafting. T-budding, and rooting of stem cuttings, have met with limited success or was economically impractical. In order to characterize rooting potential in a tree-type *Aesculus* species such as the selection 'Autumn Splendor' and develop a system for clonal propagation, this study was designed to compare the influence of maturation state, developmental stage, cutting position, and indole-3-butyric acid (IBA) treatment on the rooting of stem cuttings.

Materials and Methods

Cuttings were taken from seedlings and a mature 30-year-old tree of *Aesculus* × *arnoldiana* 'Autumn Splendor' tree. Seeds collected from 'Autumn Splendor' were germinated in 100% sharp river sand in a greenhouse maintained at a temperature of 18/24°C (64/75°F) day/night. Seedlings were fertilized periodically with 20N-6.6P-16.6K (20-16-20).

[1]Received for publication November 5, 1987; in revised form March 21, 1988.

[2]Research Assistant, Professor, and Professor, resp.

Cuttings from the mature specimen were taken during the natural growth flush in the field during spring. Six different cutting sources were used: the main stem of 2-week, 1-month, and 2-month-old seedlings, and 2-week-old root suckers and 1-month and 2-month-old crown shoots from the mature tree. Crown shoot cuttings were taken non-systematically from all sides and at varying heights of the tree. Cuttings were surface sterilized by a 20 min soak in a solution of 0.5% sodium hypochlorite containing 1 ppm Tween-20 followed by a single rinse with distilled water.

Shoots were cut such that apical and basal sections could be used and compared. An exception to this was 2-week-old seedling cuttings from which only one cutting could be obtained since only one pair of expanded leaves had developed. For comparison purposes these cuttings were designated as apical cuttings which included the apical meristem and basal cuttings with the apex removed. When 3 pair of leaves were present, the uppermost pair of leaves was used for the apical cutting and the second for the basal cutting. Cuts were made originally just above nodes, and cuttings were trimmed to 5 cm (2 in), leaving one pair of oppositely positioned compound leaves. Leaflets were clipped to reduce the leaf surface area by approximately one-half. Each cutting type was divided into 2 groups, one dipped into distilled water:ethanol (1:1) by vol) and the other into the same solvent mixture containing 2500 ppm IBA. Cuttings were dipped to a depth of 1.5 cm (0.65 in) for 5 sec and stuck to a depth of approximately 2 cm (0.75 in) in a sphagnum peat:coarse perlite (1:1 by vol) medium in plastic flats. Flats were placed under 50% shade cloth and misted for 15 sec at 15 min intervals during daylight hours. The greenhouse was maintained at a minimum temperature of 20°C (60°F) during night and day.

A randomized 6 × 2 × 2 (cutting source × apical/basal × IBA treatment) factorial design was employed. Each treatment combination included 20 cuttings as experimental units. After 6 weeks roots emerging directly from the stem were counted and measured. A visual rating was assigned to each cutting based on a descriptive scale (with pictorial standards) ranging from 1 to 10 with 1 indicating a dead stem without leaflets or petioles and 10 signifying an intact cutting with dark green leaves and many long, healthy roots. Data analysis was done using a one-way analysis of variance. Fischer's protected least significant difference test was performed to separate means at the 0.01 level. Transformations were performed prior to analysis: arcsin for visual ratings and Freeman-Tukey transformation ($\sqrt{y} + \sqrt{y+1}$) for number of roots.

Results and Discussion

Rootability varied significantly according to cutting source (Table 1). Root number and length, visual rating, and percent rooting showed 2-week-old seedling cuttings to be superior to other cutting sources. Relative rooting success was as follows: two-week-old seedling > one-month-old seedling > 2-week-old sucker > 2-month-old seedling = 1-month-old crown > 2-month-old crown (Table 1).

Cutting position (apical or basal) and treatment with IBA had significant influences on rooting (Table 2). IBA served to enhance rooting of cuttings only when a moderate potential already existed. IBA was not promotive when rooting frequencies were 100% or 8% or less, but it did promote rooting when overall rooting frequencies were 61% (2-month-old seedlings) and 31% (2-week-old suckers). One-month-old seedlings provided the only cuttings in which rooting was consistently promoted by IBA treatment in a highly significant manner (Table 2). Treatment with IBA increased root length and cutting visual rating in 2-week-old sucker and 1-month-old crown cuttings, respectively. When the cutting source was 2-week or 1-month-old seedlings or 2-week-old suckers, higher values for root number and length and visual rating were observed for apical cuttings (Table 2). A higher rooting frequency was found for apical as compared to basal cuttings from 1-month-old seedlings and 2-week-old suckers (Table 1). No signifiiant differences in rooting due to cutting position nor IBA treatment were found for cuttings from 2-month-old seedlings and 1-month and 2-month-old crown cuttings. Neither of these treatments positively influenced rooting potential once it had been lost.

This experiment demonstrated the rapidity with which rooting potential was lost in newly germinated seedlings.

Table 1. Influence of cutting source and position on percent rooting, root number and length, and visual rating (scale: 1-->10) 6 weeks after cuttings were inserted into the rooting medium.

Cutting source	Percent Rooting			Root[x] No.	Root length (cm)	Visual rating[y]
	Apical cuttings	Basal cuttings	Total cuttings			
2-wk-old seedling	100.0	100.0	100.0	4.96d[z]	8.40d	7.51e
1-mo-old seedling	77.5	47.5	61.25	2.60c	6.57c	5.48d
2-mo-old seedling	10.0	5.0	7.50	0.13a	0.38a	2.25b
2-wk-old sucker	62.5	0.0	31.25	1.23b	1.76b	3.58c
1-mo-old crown	10.0	2.5	7.50	0.08a	0.59ab	2.79b
2-mo-old crown	0.0	0.0	0.0	0a	0a	1.53a

[z]Mean values within columns not followed by the same letter are significantly different at the 0.01 level.

[x,y]Statistical analyses are based on Freeman-Tukey and arcsin transformations, resp.

Table 2. Influence of cutting source, position, and IBA treatment on root number and length and visual rating (scale: 1-->10) 6 weeks after cuttings were inserted into the rooting medium.

	Treatment	Cutting Source					
		2-wk-old seedling	1-mo-old seedling	2-mo-old seedling	2-wk-old sucker	1-mo-old crown	2-mo-old crown
Root[x] Number	Apical	5.95**	3.73**	0.18	2.45**	0.10	0
	Basal	3.98	1.48	0.08	0.0	0.05	0
	2500 ppm IBA	4.80	3.70**	0.23	1.63	0.13	0
	0 ppm IBA	5.13	1.50	0.03	0.83	0.03	0
Root Length (cm)	Apical	9.57**	8.09*	0.49	3.51**	0.59	0
	Basal	7.24	5.04	0.28	0.0	0.58	0
	2500 ppm IBA	9.10	9.14**	0.59	2.35*	0.97	0
	0 ppm IBA	7.70	3.99	0.20	1.17	0.20	0
Visual[y] Rating	Apical	8.38**	6.48**	2.32	4.55**	3.08*	1.70
	Basal	6.65	4.48	2.18	2.60	2.50	1.35
	2500 ppm IBA	7.60	6.75**	2.48	3.65	3.28**	1.65
	0 ppm IBA	7.43	4.20	2.03	3.50	2.30	1.49

*,**Significant differences at the 0.05 and 0.01 level, resp.

x,yStatistical analyses are based on Freeman-Tukey and arscin transformations, resp.

Rooting decreased from 100% with 2-week-old seedling cuttings to 61% for cuttings from 1-month-old seedlings and more drastically to 8% for cuttings from 2-month-old seedlings. A visual rating below 5 indicated no roots, and only 2-week-old and 1-month-old seedling cuttings were suitable for effective rooting (Table 1). All 3 cutting sources from the mature tree had unacceptable rootability. However, not all stages of growth and only one IBA concentration was tested. Perhaps with an alteration in one of these factors higher rooting success could be obtained with the cuttings derived from root suckers. Those sucker cuttings which rooted are being maintained to evaluate their trueness-to-type.

This experiment clearly illustrated that rooting of stem cuttings from the crown is completely unsatisfactory as a commercial method of propagation of *Aesculus* × *arnoldiana* 'Autumn Splendor'. However, cuttings from root suckers have a moderate rooting capacity and hold some promise as a source of propagation material for conventional cuttings.

Significance to the Industry

'Autumn Splendor' buckeye would be a valuable addition to the nursery industry because of its highly desirable landscape characteristics. These include glossy green summer foliage, leaf scorch resistance, reliable cold hardiness in U.S.D.A. zone 4a, desirable form as a medium-sized tree, and deep red fall color. Therefore, it would be valuable to find a successful clonal propagation system for this selection. Based on results reported here, cuttings from root suckers have a moderate rooting capacity and hold some promise as a source of propagation material. Manipulation of other parameters such as auxin concentration or stage of development might lead to a commercially acceptable method of propagation using this type of cutting. This work also illustrates the importance of maturation state, developmental stage, and stem position in the rootability of stem cuttings.

Literature Cited

1. Chapman, D.J. and S. Hoover. 1981. Propagation of shade trees by softwood cuttings. Proc. Intern. Plant. Prop. Soc. 31:507–511.

2. Hackett, W.P. 1985. Juvenility, maturation, and rejuvenation in woody plants. Hort. Rev. 7:109–155.

3. Heybroek, H.M. and T. Visser. 1976. Juvenility in fruit growing and forestry. Acta Hort. 56:71–80.

4. Lepisto, M. 1974. Successful propagation by cuttings of *Picea abies* in Finland. New Zealand J. For. Sci. 4:367–370.

5. Paton, D.M., R.R. Willing, W. Nicholls and L.D. Pryor. 1970. Rooting of stem cuttings of *Eucalyptus*: a rooting inhibitor in adult tissue. Austral. J. Bot. 18:175–183.

6. Porlingis, I.C. and I. Therios. 1976. Rooting response of juvenile and adult leafy olive cuttings to various factors. J. Hort. Sci. 51:31–39.

7. Robinson, J.C. and W.W. Schwabe. 1977. Studies on the regeneration of apple cultivars from root cuttings. I. Propagation aspects. J. Hort. Sci. 52:205–220.

8. Smith, I.E., B.N. Wolstenholme and P. Allan. 1974. Rooting and establishment of pecan [*Carva illinoensis* (Wang.) K. Koch] stem cuttings. Agroplantae 6:21–28.

9. Vieitez, E. and A.M. Vieitez. 1976. Juvenility factors related to the rootability of chestnut cuttings. Acta Hort. 56:269–274.

10. Wally, Y.A., M.M. El-Hamady, S.T. Boulos and M.A. Salama. 1980. Physiological and anatomical studies on pecan hardwood cuttings. Egypt. J. Hort. 8:89–100.