BILL LIBBY: Do you find mycorrhiza on the eucalyptus?

BARRIE COATE: I wish I knew the answer. It is a field that has been neglected. I think it is important, perhaps more for some species than others. I do believe eucalyptus is one of the genera that would respond better if we had the right mycorrhiza provided for them. I don't have the feeling that we are doing that. We hope the mushroom compost is providing a few of the things of that nature but, frankly, I can't give you any scientific answers.

BILL LIBBY: How are you doing on rooting eucalyptus?

BARRIE COATE: Zero. I have tried it, I have tried grafting, various kinds, and frankly we are not large enough to provide research of that depth. I wish we could. There is a wide open market for cutting-grown *Eucalyptus ficifolia*, for example, The closest we can come is being very careful about our seed source.

ROOT PROMOTION ON STEM CUTTINGS OF SEVERAL ORNAMENTAL PLANT SPECIES BY ACID OR BASE PRETREATMENT

C.I. LEE, J.L. PAUL and W.P. HACKETT

Department of Environmental Horticulture
University of California
Davis, California 95616

Abstract. Rooting of stem cuttings of *Bouganvillea*, *Ceratonia siliqua*, *Chrysanthemum morifolium*, *Euonymus japonica*, *Euphorbia pulcherrima*, *Hedera helix*, *Trachelospermum jasminoides*, sp., *Juglans hindsii*, *Pistacia chinensis* and *Salix laevigata* is greatly promoted by dipping in H_2SO_4 prior to applying indolebutyric acid. On the other hand, NaOH treatment results in considerable increase of rooting of cuttings of azalea, *Bougainvillea* sp., *Liquidambar styraciflua*, *Osmanthus heterophyllus* and *Pinus radiata*.

Auxin has varying degrees of effectiveness in promoting adventitious root formation in stem cuttings of many plant species. It has been suggested that auxin in the promotion of growth of *Avena* coleoptile is via induction of hydrogen ion secretion and cell wall acidification (2, 4). Acidification of the cell wall enhances its extensibility either by cell wall-loosening enzymes (3) or by breaking acid-labile links non-enzymatically (4). Media of low pH also show effects similar to that of auxin on the growth of *Avena* coleoptile (1). If at least part of the effect of auxin is cell wall loosening due to enhanced acidity, then pretreatment of cuttings in acid may further stimulate rooting ability. The purpose of this study was to determine the influence of acid or base pretreatment of stem cuttings upon the rooting ability of several ornamental plants.

Sulfuric acid and sodium hydroxide were used as acid and base respectively. For determination of optimum concn of H_2SO_4, a preliminary experiment was conducted with the cuttings of *Phaseolus aureus*, *Chrysanthemum* 'Golden Anne' and *Salix laevigata*. Treatment with 2N H_2SO_4 for 15 sec dipping without IBA treatment was found to be most promotive in the rooting of all three plants and Fig. 1 shows the rooting response of chrysanthemum cuttings as a function of dipping time in 2N H_2SO_4. Similarly, NaOH solution of pH 10.5 for 10 min soaking gave the best result in the rooting of *Bougainvillea* 'San Diego Red'. Therefore, the concn of acid or base mentioned above was used in this study, although optimum dosage was not determined in other plant species.

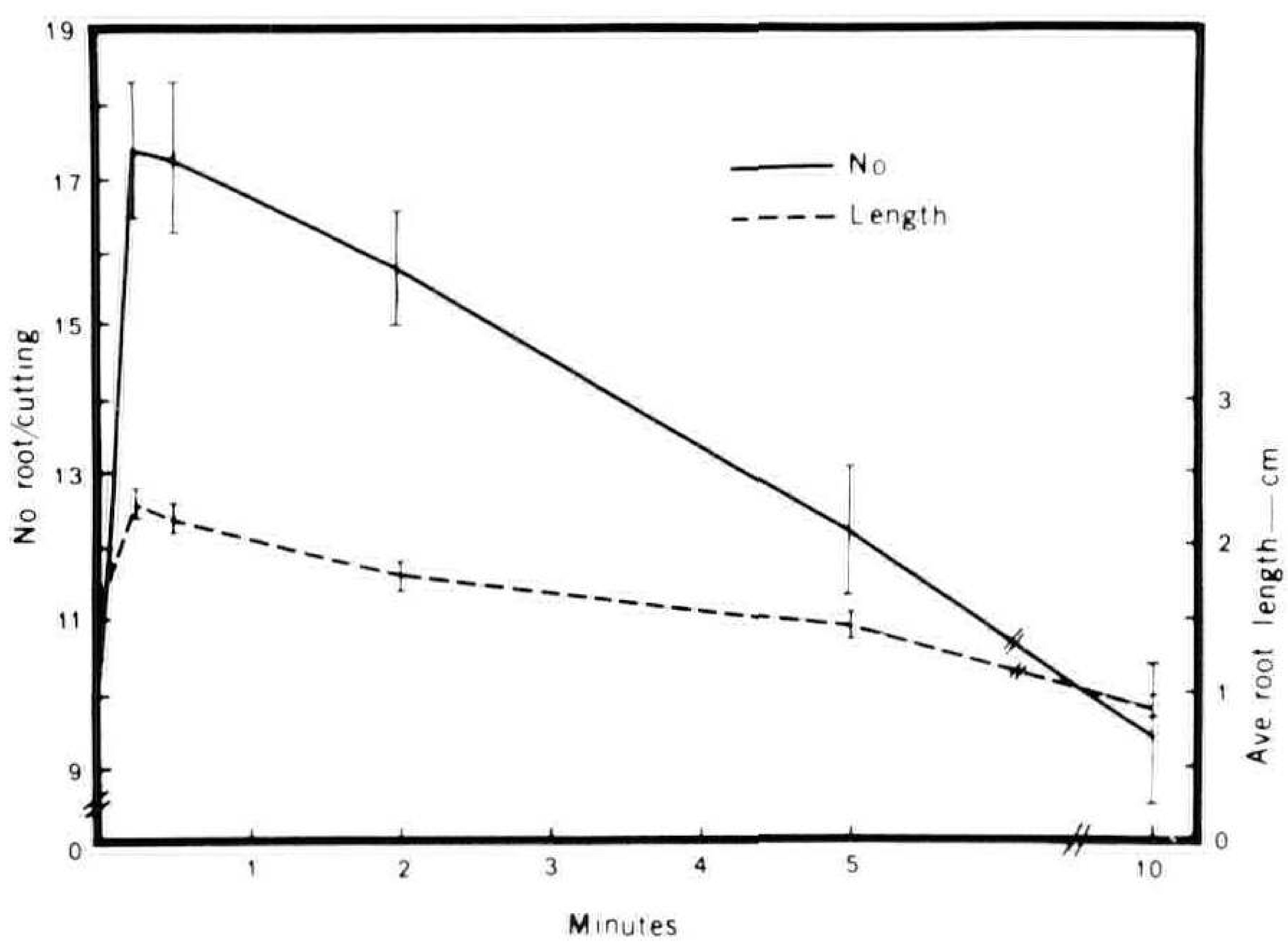

Figure 1. Rooting of *Chrysanthemum* 'Golden Anne' cuttings dipped in 2N H_2SO_4 as a function of time.

Thirty cuttings of each plant species listed in Table 1 and 2 were treated with the acid or base, washed with distilled water and then dipped in a 3000 ppm aqueous solution of the K-salt of indolebutyric acid (K-IBA) for 10 sec for herbaceous cuttings and 20 sec for hardwood cuttings. Thirty cuttings treated with K-IBA alone served as controls. Cuttings of azalea, *Bougainvillea*, *Euphorbia*, *Liquidambar*, *Osmanthus* and *Pinus* were placed in acid rooting medium (unlimed sphagnum peat + perlite 1:1 v/v) and cuttings of other species were placed in neutral medium (perlite + vermiculite 1:1 v/v). Previous work indicated that these species root best in these rooting media. All cuttings were rooted under intermittent mist with a 16 hr photoperiod.

Table 1. Promotion of rooting in certain ornamental plants by acid pretreatment.

Species	No. days to harvest	Treatment: IBA Percent rooting	IBA No.[z]	IBA Length[y]	Treatment: H_2SO_4 + IBA Percent rooting	H_2SO_4 + IBA No.	H_2SO_4 + IBA Length
Bougainvillea 'San Diego Red'	28	100	19.1 ± 2.8[x]	-	100	27.1 ± 4.4	-
Ceratonia siliqua (Jan.)[w]	28	93	13.9 ± 2.5	2.5 ± 0.2	100	18.1 ± 3.1	3.5 ± 0.2
Ceratonia siliqua (June)[w]	28	20	2.0 ± 1.0	3.9 ± 1.7	75	4.7 ± 0.9	3.8 ± 0.7
Chrysanthemum 'Golden Anne'	12	100	87.2 ± 4.2	1.6 ± 0.1	100	105.5 ± 3.2	1.8 ± 0.1
Chrysanthemum 'Mandalay'	12	100	62.9 ± 3.5	-	100	77.3 ± 3.4	-
Euonymus japonica 'Yellow Edge'	47	85	11.7 ± 2.6	1.6 ± 0.2	100	27.2 ± 2.7	2.3 ± 0.2
Euphorbia pulcherrima 'Eckspoint C-1 Red'	21	100	29.5 ± 2.6	1.3 ± 0.1	100	39.0 ± 1.3	2.1 ± 0.2
Hedera helix (adult)	25	100	16.3 ± 2.1	0.9 ± 0.1	100	26.8 ± 2.3	1.1 ± 0.1
Trachelospermum jasminoides	42	53	23.5 ± 7.2	-	87	29.0 ± 6.6	-
Juglans hindsii	38	80	4.4 ± 0.8	4.7 ± 0.8	100	7.9 ± 1.2	7.3 ± 1.0
Pistacia chinensis	42	28	3.7 ± 0.6	-	70	3.2 ± 0.4	-
Salix laevigata	12	95	20.9 ± 2.4	3.4 ± 0.4	100	26.7 ± 2.9	3.9 ± 0.3

[z] No. of roots/rooted cutting.

[y] Ave. root length (cm).

[x] Mean and standard error of the mean.

[w] Jan. and June indicates month when cuttings were taken.

Table 2. Promotion of rooting in certain ornamental plants by base pretreatment.

Species	No. days to harvest	Treatment: IBA Percent rooting	IBA No.[z]	Treatment: NaOH ± IBA Percent rooting	NaOH ± IBA No.
Azalea 'Sweetheart Supreme'	42	90	9.6 ± 1.7[y]	90	20.8 ± 3.2
Bougainvillea 'San Diego Red'	28	100	19.1 ± 2.8	100	33.1 ± 3.5
Liquidambar styraciflua	42	100	34.7 ± 1.5	100	42.6 ± 2.0
Osmanthus heterophyllus	33	75	5.4 ± 1.0	100	8.6 ± 0.6
Pinus radiata	90	60	4.0 ± 0.5	93	3.9 ± 0.3

[z] No. of roots/rooted cutting

[y] Mean and standard error of the mean.

Acid or base pretreatment significantly influenced the rooting ability of cuttings studied (Table 1 and 2). Stem cuttings of *Bougainvillea*, *Ceratonia*, *Chrysanthemum*, *Euonymus*, *Euphorbia*, *Hedera* (adult form), *Juglans* (cuttings from adventitious shoots of 5-yr-old tree) and *Salix* (softwood) had a significantly greater number of roots as a result of acid pretreatment. On the other hand, base pretreatment significantly increased the number of roots in cuttings of azalea (taken in Jan.), *Liquidambar* (semi-hardwood) and *Osmanthus* (semi-hardwood). Rooting of *Bougainvillea* was enhanced by both acid and base pretreatment. Rooting percentages of relatively difficult-to-root cuttings such as *Ceratonia* (taken in June), *Trachelospermum* (hardwood), *Osmanthus*, *Pistacia* (semi-hardwood cuttings from 2-yr-old seedlings), and *Pinus* (taken in Jan.) were increased by the pretreatment. Also, cuttings treated wth H_2SO_4 produced longer roots in *Ceratonia* (taken in Jan.), *Euonymus*, *Euphorbia*, and *Juglans*. The pretreatment, however, depressed rooting of *Cotoneaster* sp. and *Xylosma congestum* (data not shown). Concentrations of acid or base and time of pretreatment may result in toxic effects for these plants. Generally, acid pretreatment promoted rooting of plants native to near neutral or alkaline soil and base pretreated cuttings increased rooting ability of those native to acid soil.

Cuttings of azalea treated with base remained turgid and leaves did not show any visual water stress during the rooting period, whereas the control showed some wilting under the environmental conditions described (Fig. 2). Similar results were also observed in the cuttings of *Chrysanthemum* dipped in acid. The pretreatment also reduced loss of foliage of woody species in which root initiation takes more than 6 weeks.

Figure 2. Azalea 'Sweetheart Supreme' cuttings treated with NaOH (*right*) showing turgid leaves and stems after planting. Control (*left*) and acid-treated cuttings (*center*) showed some water stress.

In *Chrysanthemum* sulfuric acid treatment alone hastened root initiation and promoted rooting quality as well (Table 3). Protuberances on the stem were observed on the 4th day in acid treated cuttings but not in control cuttings. Acid treated cuttings rooted 100% on the 8th day but control cuttings rooted only 75%. At the time of harvest (12th day) total root length per cutting was 37.0 cm compared to 16.5 cm for the control.

These results lead us to suggest that a short exposure to acid may break acid-labile linkages (Ca bridge) in the cell walls of calciphilous plants. The base pretreatment may break base-labile linkages (ester bridge) in the cell walls of acid-loving or acid-tolerating plants. Such reactions may loosen cell walls, increase water permeability (5), facilitate absorption of applied auxin and/or emergence of root initials. The relation of acid or base promotion of root initiation to auxin-induced root initiation has not been studied in detail. It is clear (Fig. 1 and Table 3) that H_2SO_4 alone can promote root initiation. This could be a direct morphogenetic effect of acid or an interaction of the acid with endogenous morphogenetic factors such as auxin. At present the mode of action of acid or base treatment is being investigated.

Table 3. Rooting of *Chrysanthemum* 'Golden Anne' cuttings treated with or without 2N H_2SO_4 alone for 15 sec after 8 and 12 days.

No days after *planting*	*Treatment*	Percent *rooting*	No. roots/ *cutting*	Aver. root *length (mm)*	Total root length/ *cutting (mm)*
8	H_20	75	3.6 ± 0.6[z]	2.7 ± 0.4	15.5 ± 3.4
	H_2SO_4	100	5.9 ± 0.6	5.2 ± 0.5	37.5 ± 6.5
12	H_20	100	9.1 ± 0.7	16.1 ± 1.3	165.3 ± 22.5
	H_2SO_4	100	14.9 ± 0.8	23.3 ± 1.2	370.0 ± 34.7

[z] Mean and standard error of the mean.

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