RAY MALEIKE: We had a grower who had a problem with high pH water and the accummulation of white deposits. He cured it simply by putting magnets around his intake. I don't know what it does but it sure cleared up the problem. I will be glad to send you the info if you want it.

MIKE DODGE: We had a problem with salts and high pH during our propagation. Dr. Paul Read in an article on the rooting of 'Northern Lights' azaleas suggested either injecting a small quantity of acid or rooting in a poly tent. Since we went to a poly tent for rooting our Exbury azaleas we do not have that problem.

INFLUENCE OF WILLOW AND POPLAR EXTRACTS ON ROOTING CUTTINGS[1,2]

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Abstract. Crude water extracts were prepared from shoots (1 g freeze-dried powder/25 ml H_2O) of weeping willow (*Salix alba* var. *tristis*) or of lombardy poplar (*Populus nigra* 'Italica') collected at intervals during the year. Extracts from both species or combinations of extracts + 5,000 or 20,000 mg/liter IBA inhibited rooting of *Cotoneaster acutifolius* cuttings. In comparison with water-treated (control) cuttings, cuttings of both *Philadelphus coronarius* 'Aureus' and *Ribes alpinum* (but not *Cornus alba* 'Argenteo-marginata') showed consistently better rooting after treatment with seasonal willow extracts.

INTRODUCTION

Plant extracts of diverse species have been known to influence rooting of cuttings. Went (24) observed that *Acalypha* leaf extract induced rooting in *Carica* cuttings. Bouillenne and Went (2) found in cotyledons, leaves, and buds substance(s), given the name "rhizocaline", which stimulated rooting. Nelson (20) showed that alfalfa extract contained an unknown active ingredient which increased the speed and rooting percentage of juniper cuttings. Girouard and Hess (7) suggested the presence of four root-promoting substances in extracts from stem cuttings of juvenile *Hedera helix*. In addition, other

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[2] Contribution No. J948.

plant-derived rooting substances have been reported (10, 11, 12, 13). Kawase (14) found strong root-promoting substances extracted from softwood cuttings of *Salix alba* by centrifuging them with water or by shaking ground, freeze-dried stem tissue with water. As an alternative to synthetic growth regulators, the use of similar plant extracts as abundant and easily prepared, natural rooting stimulants show promise for practical application.

It is well established that time of year cuttings are taken influences rooting and large differences in rooting ability occur among species (1, 6, 9). Thus differences in the potency of plant extracts due to environmental and related effects can be expected, but there is no information with regard to the time of year when material used for making rooting promoting extracts should be harvested for best results. This study, therefore, investigated seasonal variation in potency of crude water extracts from shoots of weeping willow (*Salix alba* var. *tristis*), or of closely related lombardy poplar (*Populus nigra* 'Italica') collected at intervals during the year by testing the rooting response of certain shrub cuttings treated with these extracts.

MATERIALS AND METHODS

On November 10, 1980, and on January 12, March 30, May 1, June 13, and August 7, 1981, 20 to 45 cm terminal shoots were harvested from a 21-year-old weeping willow tree and a 45-year-old lombardy poplar tree on the campus at Macdonald College. A single tree of each species was sampled to eliminate inter-tree variation (16). Shoots were stripped of foliage (during the growing season), cut into 5 to 7 mm pieces, immediately stored in a freezer for 15 h. at −15°C in tightly-covered plastic containers, then freeze-dried. These were ground to pass through a 40-mesh wire screen and kept in tightly capped 225 g square bottles at −15°C. An aqueous slurry (crude extracts) was prepared immediately before each experiment by adding distilled water to the freeze-dried powder, as described below, and the mixture shaken (275 strokes per min) for 1 h at 4°C to reduce possible enzymatic reactions.

On June 29, 1981, the basal ends of 10 to 15 cm stem cuttings from 11-year-old *Cotoneaster acutifolius* plants were dipped for 3 min in all combinations of the following treatments: seasonal willow and poplar extracts (1 g powder/25 ml H_2O) from the 5 collection dates between November 10 and June 13, inclusive; indolebutyric acid (IBA) treatments of 0, 5,000, or 20,000 mg/liter; and all combinations of extracts and IBA treatments. The extract + IBA treatment combinations were obtained by mixing (v/v) 1 part extract (2 g/25 ml H_2O)

to 1 part of 10,000 or 40,000 mg/liter IBA dissolved in 50% ethanol. Cuttings, arranged as a 3 × 11 factorial in a randomized complete block design with 7 replications and 10 cuttings per experimental factor combination, were rooted under intermittent mist in a medium of 1 peat moss: 1 perlite (v/v) in fiber flats (18 cm long × 13 cm wide × 7 cm deep) in outdoor frames with bottom heat thermostatically set at 21°C. Factor A was IBA treatments and factor B, plant extract treatments. Data for percent rooting of cuttings, evaluated in early August, was transformed to log (percent rooting + 0.5/100.5 − percent rooting) before analysis of variance.

On August 20, 1981, 9 to 11 cm stem cuttings from 10-year-old *Philadelphus coronarius* 'Aureus', *Ribes alpinum*, and *Cornus alba* 'Argenteo-marginata' were treated similarly with willow extracts from all six collection dates or with water (control treatment), and rooted under conditions described above. The experiment was a randomized complete block design with six replications and 15 cuttings per experimental treatment. Rooting response in terms of percent rooting and root number per rooted cutting was evaluated in early October; data were not transformed before analysis of variance.

RESULTS

Increase in the rooting response of *Cotoneaster* cuttings was associated with increasing IBA concentrations, i.e. 25, 50, and 70% after treatment with 0, 5,000 and 20,000 mg/liter IBA, respectively (Figure 1). However, rooting in this species was markedly suppressed by both willow and poplar extracts (five collection dates between November and June) regardless of IBA treatment; the effect of plant extracts due to date of collection was variable (Figure 1).

Cuttings of *Philadelphus* (Figure 2) and *Ribes* (Figure 3) showed somewhat similar rooting response, but *Cornus* (Figure 4) responded differently. Rooting percentage and root number per rooted cutting of *Philadelphus* and *Ribes* cuttings treated with crude willow extracts from all six collection dates between November 1980 to August 1981 was markedly higher than those of water-treated control cuttings (Figures 2 and 3); coresponding data for extract-treated cuttings of *Cornus* were not significantly different or were lower than those of control cuttings depending on collection date (Figure 4).

Unlike rooting percentage, root number for all three species showed significant effects due to collection date of the willow extracts (Figures 2, 3, 4). Although variation due to collection date differed among species, the greatest stimulation

in root numbers in cuttings of *Philadelphus* and *Ribes* notably occurred in extracts collected between November and January and between November and May, respectively.

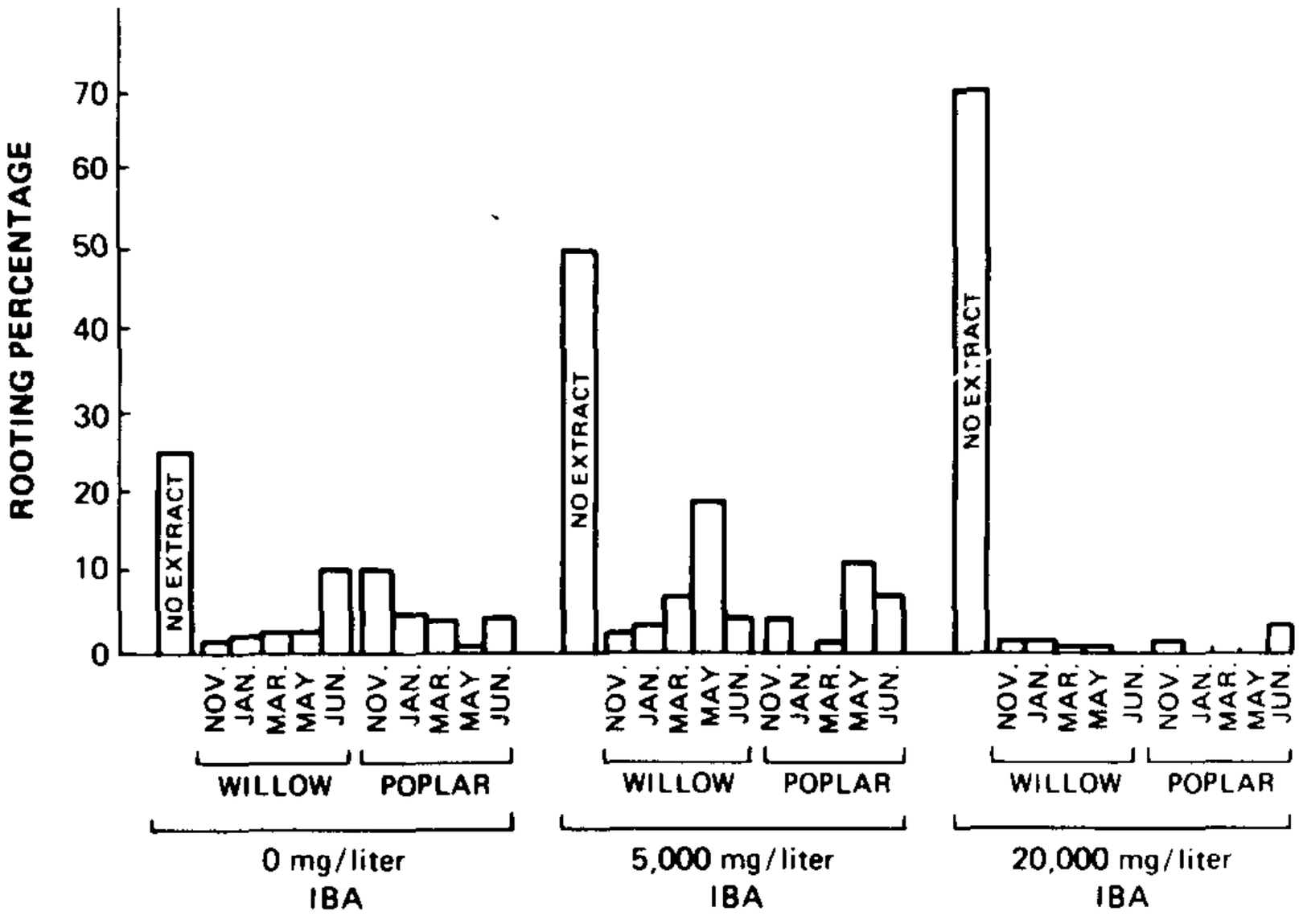

Figure 1. Rooting percentage of *Cotoneaster acutifolius* cuttings in response to seasonal willow and poplar extracts with or without IBA.

DISCUSSION

Philadelphus, *Ribes*, and *Cornus* are genera that usually root from cuttings with relative ease, especially during the early growing season. In this study, started in later summer, when rooting may be more difficult, the use of willow extracts resulted in markedly enhanced rooting of *Philadelphus* and *Ribes* cuttings but had little effect on cuttings of *Cornus*; the seasonal influence of the extracts was small. On the contrary, rooting of *Cotoneaster* was suppressed by seasonal extracts of both willow and poplar. This evidence suggests interactive and(or) complex action of plant extracts on rooting response. The similarity of influence on rooting of extracts from willow and poplar suggests that the rooting substance(s) present in both species are of similar identity.

Evidence suggests that, like other growth processes, each step of the rooting process is influenced by a delicate balance of growth regulators or other rooting substances, rather than by a single substance (17, 23). This, in part, may explain the more favorable rooting response of *Philadelphus* and *Ribes* from extracts collected in fall and winter when plant tissues have a greater amount of growth inhibitors (10). Perhaps the extracts did not contain the specific cofactors to promote root-

ing in Cornus or, possibly, the appropriate hormonal balance for root promotion was disturbed. Root inhibition of easy-to-root *Salix babylonica*, *Amorpha fruticosa*, and *Robinia pseudoacacia*, after treatments with water extracts from difficult-to-root *Castanea crenata*, *Pinus densiflora*, *Myrica rubra* and *Cryptomeria japonica*, was apparently due to the presence of growth inhibitors in the aqueous extracts (5).

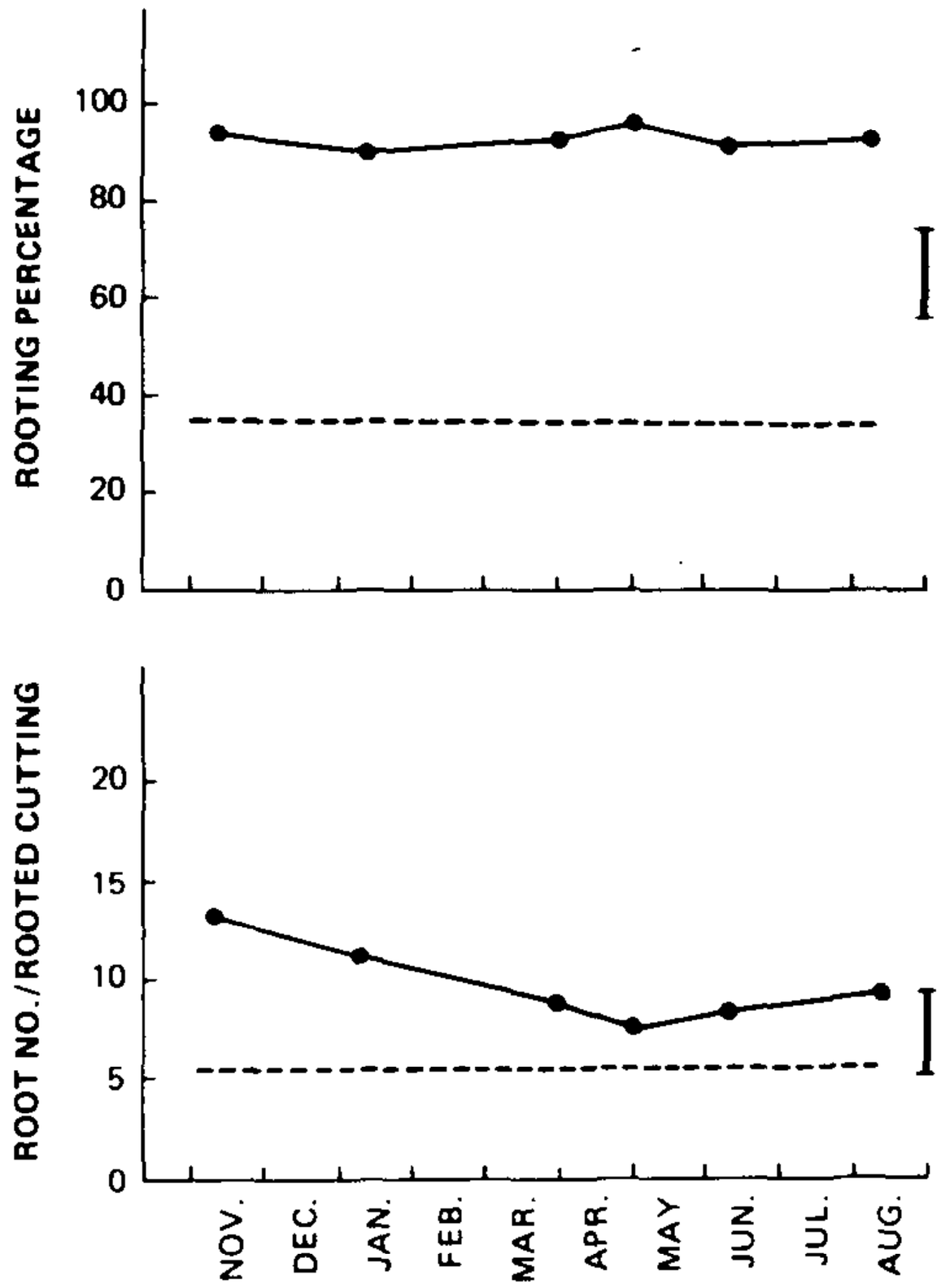

Figure 2. Rooting performance of *Philadelphus coronarius* 'Aureus' in response to seasonal willow extracts. ----- represents water-treated *cuttings*; ——— *represents extract-treated cuttings*. Vertical bars represents LSD ($P = 0.05$).

High IBA concentrations between 10,000 and 40,000 mg/liter have been shown to be a significant factor in the successful rooting of certain difficult species (3, 4). In some of these species, including *Cotoneaster acutifolius*, the base of cuttings tended to be injured by treatments with 20,000 and 40,000 mg/liter IBA although very prolific rooting occurred above the injured portion (4). In the present study, it is noteworthy that the percentage of dead *Cotoneaster* cuttings (ranging from 23 to 100%) was very high for those treated with all plant extracts + IBA combinations, compared with those treated with either plant extract, or with IBA alone (ranging from 0 to 1.7%). Thimann (22) indicated that crude plant extracts were frequently toxic.

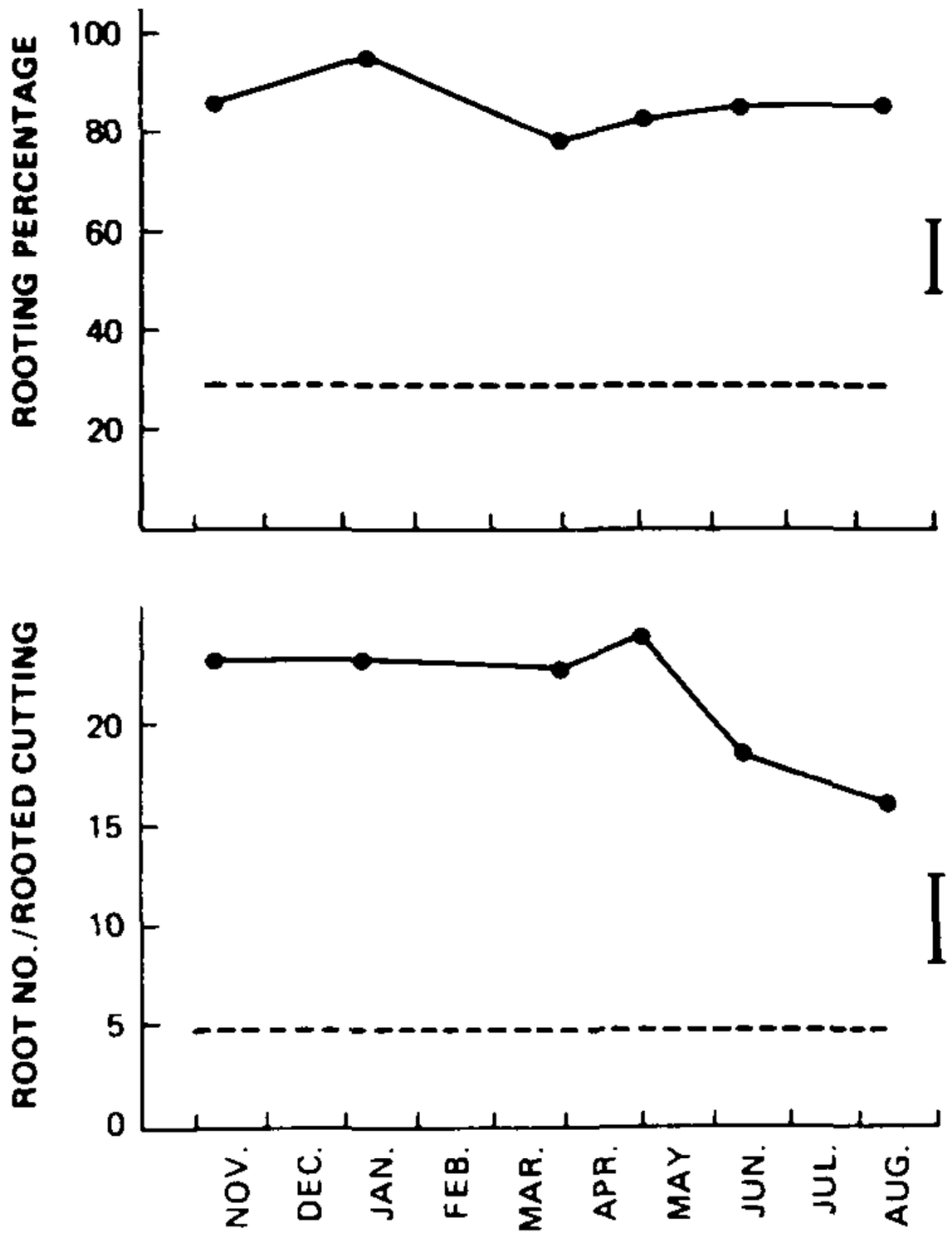

Figure. 3. Rooting performance of *Ribes alpinum* in response to seasonal willow extracts. ----- represents water-treated cuttings; ——— represents extract-treated cuttings. Vertical bars represent LSD ($P = 0.05$).

In preliminary attempts to gain a better understanding of the nature of these plant extracts, the seasonal willow samples were analysed for their carbohydrate and phenol contents. Although these substances are known to influence rooting (8, 18, 19) results of correlation of the amounts of these constituents with rooting response in *Philadelphus*, *Ribes*, and *Cornus* were inconclusive. Ouellet (21) found that boiled water extracts of barley and oat seeds and of ground pieces of *Ulmus* twigs promoted rooting of *Ulmus americana* cuttings, but these extracts were less effective than IBA. Kawase (15) reported that the centrifugal diffusate or water extract of willow showed a strong synergistic effect with indoleacetic acid in the rooting of mung beans, and contained at least four rooting fractions, the most active being very soluble in water but insoluble in chloroform or ethyl ether. Apparently similar rooting substances have been found in a variety of other woody species, including *Cotoneaster racemiflorus* var. *soongoricus*, *Euonymus fortunei* 'Carrierei', *Symplocos paniculata*,

Lonicera maackii, *Ilex opaca*, *Physocarpus amurensis*, *Taxus cuspidata*, and *Viburnum* × *burkwoodii* (16). Although the rooting substance(s) in willow was thought to be similar in effect to "rhizocaline" (15), the identity of these substances is still unknown.

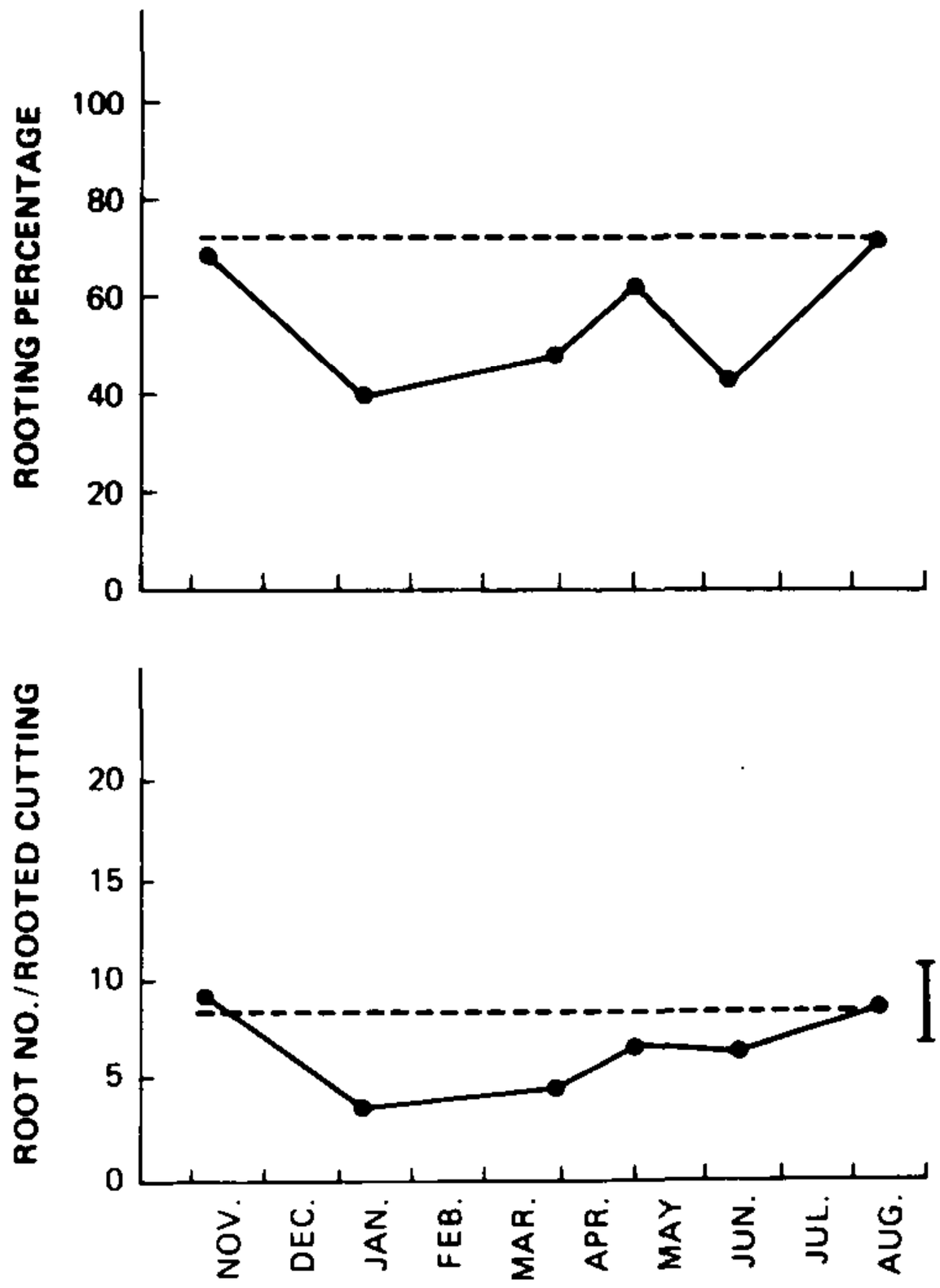

Figure 4. Rooting performance of *Cornus alba* 'Argenteo-marginata' in response to seasonal willow extracts. ----- represents water-treated cuttings; ———— represents extract-treated cuttings. Vertical bars for rooted number per rooted cutting represents LSD (P = 0.05); data for rooting percentage was not significant.

The evidence of this study confirms the favorable use of plant extracts, such as willow, for stimulating rooting of certain species and indicates that extracts from material collected in fall and winter may be slightly more effective in inducing rooting in cuttings of two species. However, under certain circumstances these extracts may inhibit or have little or no influence on rooting and can even be detrimental to cuttings. Studies to elucidate the identity of the rooting substance(s) in these extracts should greatly enhance their value as rooting aids.

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VOICE: Have you tried saligin, which is found in willows? If not, you should try it.

CALVIN CHONG: No, we have not.

COMPARATIVE EFFECTS OF SELECTED ROOTING COMPOUNDS ON THE ROOTING OF *PHOTINIA* × *FRASERI*

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Athens, Georgia 30602

Many commercial root promoting compounds have been offered to the nursery industry since the introduction of indolebutyric acid (IBA) and naphthaleneacetic acid (NAA) in 1935 (7). IBA and NAA form the chemical bases for these commercial preparations which are offered as talc, organic or water-based formulations (3). Many nurserymen make their own preparation by purchasing pure IBA or NAA crystals and dissolving them in an appropriate solvent (usually alcohol). Dip 'N Grow and Wood's Rooting Compound are liquid-based commercial formulations that are becoming more common in commercial propagation. Dip 'N Grow contains 1.00% IBA and 0.5% NAA plus an anti-pathogen agent in an alcohol solvent. Wood's contains approximately the same IBA and NAA but uses a solvent-carrier (20% dimethylformamide) and 80% ethyl alcohol.

This study compared the relative effectiveness of Dip 'N Grow, Wood's, and Hormodin #2 against the pure chemicals using *Photinia* × *fraseri* as the test plant. *Photinia* × *fraseri* is an excellent test plant for rooting studies because without an exogenous root promoting agent it shows limited propensity to root (1,2,4).

MATERIALS AND METHODS

Four to six-inch long terminal cuttings of *Photinia* × *fraseri* were collected from 6 to 8-year-old plants growing on the