INFLUENCE OF IBA CONCENTRATIONS ON ROOTING OF WOODY PERENNIAL NURSERY STOCK[1]

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Abstract. Cuttings of 20 woody genotypes belonging to various species were treated with 0 (control), 2,500, 5,000, 10,000, 20,000, and 40,000 ppm of indolebutyric acid (IBA) as a 5-second dip and rooted under intermittent mist. Except for two species (*Prunus serrulata* 'Kwanzan' and *Forsythia* × *intermedia* 'Lynwood Gold'), rooting of all plants was significantly greater than the control after treatment with one or more concentrations of IBA. Maximum rooting varied between 24 and 100% depending on the genotype. IBA-induced basal injury to cuttings occurred in all plants and increased with increasing IBA concentrations, especially between 20,000 and 40,000 ppm. In certain difficult-to-root genotypes, basal injury at these high IBA concentrations was associated with swelling and enhanced rooting above the injury.

It has long been known that high concentrations of certain growth regulators might promote rooting in hard-to-propagate species (3,10). In fact, IBA concentrations of between 10,000 and 40,000 ppm have been shown to stimulate rooting in some hard-to-root species, including various ornamental crabapples (3), *Tilia* spp. (11), *Quercus robur* 'Fastigiata' (7), *Cotoneaster acutifolius,* and *Taxus cuspidata* (5,6). In certain nursery propagation programs higher IBA concentrations are increasingly being used (1).

As part of a research program which aims to develop more effective methods and techniques for propagating nursery stocks (5,6), related investigations were conducted with a variety of other woody plants to determine their rooting response after treatment with different concentrations of IBA.

MATERIALS AND METHODS

Stem cuttings of current season's growth were rooted during the growing seasons between 1982 and 1985 from 20 woody species or cultivars, listed alphabetically with insertion dates and rooting period (weeks) in brackets:

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[1] Appreciation is extended to Joerg Leiss, Sheridan Nurseries Ltd., Oakville, Ontario for cuttings of several species, and to Bob Hamersma for technical assistance at the Horticultural Research Institute of Ontario, Vineland, Ontario.

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Acer platanoides 'Crimson King' (6/28/83 - 10)
Amelanchier laevis (6/23/83 - 5)
Betula pendula 'Gracilis' (6/25/82 - 13)
Chaenomeles speciosa 'Rubra' (7/10/85 - 4)
Elaeagnus angustifolia (7/30/85 - 6)
Euonymus alata 'Compacta' (6/27/85 - 5)
Forsythia × intermedia 'Lynwood Gold' (8/08/85 - 4)
Magnolia stellata (7/30/85 - 8)
Malus 'Bitenfolder' (8/11/83 - 7)
Malus 'Royalty' (6/25/82 - 5)
Prunus × *cistena* (8/09/85 - 4)
Prunus domestica 'Stanley' (7/18/85 - 7)
Prunus domestica 'Valor' (7/18/85 - 7)
Prunus domestica 'Verity' (7/18/85 - 7)
Prunus serrulata 'Kwanzan' (6/28/85 - 6)
Prunus triloba 'Multiplex' (7/19/85 - 5)
Quercus rubra (6/23/83 - 14)
Sorbus alnifolia (6/27/85 - 6)
Tilia cordata 'Glenleven' (6/29/83 - 4)
Tilia × *europaea* 'Pallida' (6/28/83 - 10).

Work was conducted at Macdonald College, McGill University, Ste-Anne-de-Bellevue, Quebec between 1982 and 1984. The study was completed at the Horticultural Research Institute of Ontario (HRIO), Vineland Station in 1985. Except for the three easy-rooting shrubs, *Euonymus alata* 'Compacta', *Prunus* × *cistena*, and *Forsythia* × *intermedia* 'Lynwood Gold', all other plants were difficult rooters.

Length of cuttings varied between 10 and 15 cm depending on genotype. The base of all cuttings were stripped of foliage. In cuttings with larger leaves, the leaves were cut in half to reduce the surface area and to facilitate closer spacing. Cuttings were treated (5-second dip) with 0 (control), 2,500, 5,000, 10,000, 20,000 and 40,000 ppm IBA dissolved in 95% ethanol. At Macdonald College, cuttings were inserted in a medium of 1 perlite: 1 vermiculite (v/v) and rooted in outdoor mist frames controlled by an electronic leaf. At HRIO, cuttings were inserted in a medium of 1 peat: 1 perlite (v/v), and rooted in outdoor frames under intermittent mist controlled during daylight hours by time clock (4 to 8 sec/8 min). At both locations, the mist frames were shaded with lath. Captan was applied as a drench at time of cutting insertion, followed by Captan or Benlate applied alternatively once per week.

The experimental design was a randomized complete block with four or five replications and 10, 12 or 15 cuttings per experimental treatment unit. Rooting performance of each genotype was based on percentage rooting and on a visual rooting index according to the scale: 0, no rooting; 1, callus but no roots; 2, poor rooting; 3, fair rooting; 4, good rooting; 5, excellent rooting.

RESULTS AND DISCUSSION

Data for percentage rooting of the 20 plants in response to varying levels of IBA are presented in Figures 1, 2, 3, and 4. Plants are shown in these figures in accordance with the peaking or plateauing of percentage rooting with low IBA concentration (2500 ppm, Figure 1); with intermediate IBA concentrations (5,000 to 10,000 ppm, Figure 2); with high IBA concentrations (20,000 to 40,000 ppm, Figure 3). Percentage rooting for the three easily-rooted shrubs are shown in Figure 4.

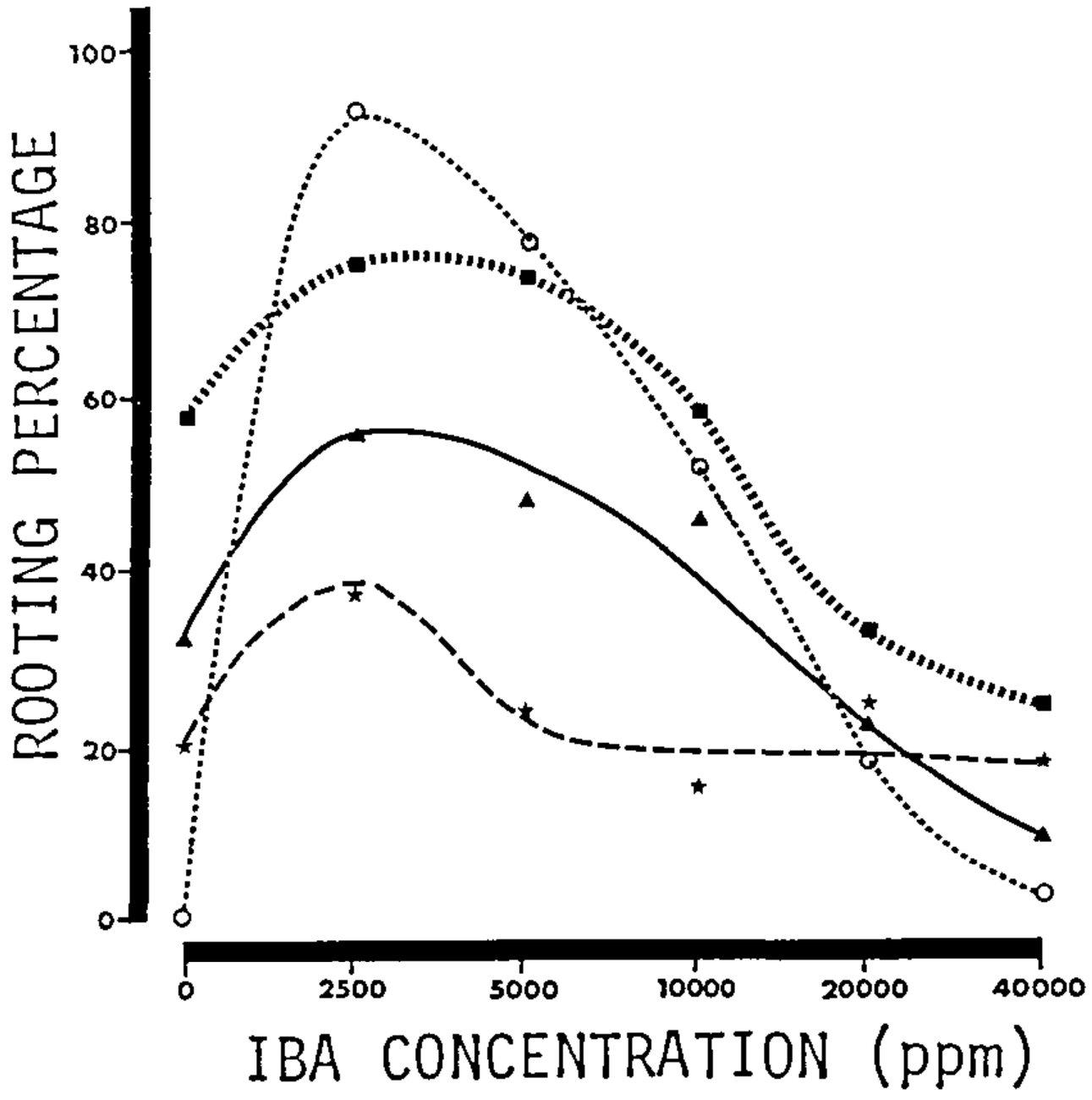

Figure 1. Plants with rooting percentage peaking at 2500 ppm IBA. LSD (P = 0.05): *Malus* 'Bitenfolder' (■), 22%; *Quercus rubra* (★), 13%; *Prunus serrulata* 'Kwanzan' (▲), 27%; *Tilia cordata* 'Glenleven' (○), 21%.

Except for *Prunus serrulata* 'Kwanzan' (Figure 1) and *Forsythia* × *intermedia* 'Lynwood Gold' (Figure 4), analysis of variance indicated that rooting of all other genotypes was significantly greater than the control after treatment with one or more concentrations of IBA. Maximum rooting varied between 99 and 100% in the easily-rooted shrubs (Figure 4) and between 24 and 91% in other genotypes (Figures 1–3).

The trend in data for percentage rooting in response to IBA concentrations and corresponding data for rooting indices (data not shown) varied similarly for all species. Chong (5,6) showed that, within a species, maximum rooting percentage, root length per cutting (RL), and root number per cutting (RN) may sometimes occur at different IBA concentrations. However, RL and RN were not evaluated in the present investigation.

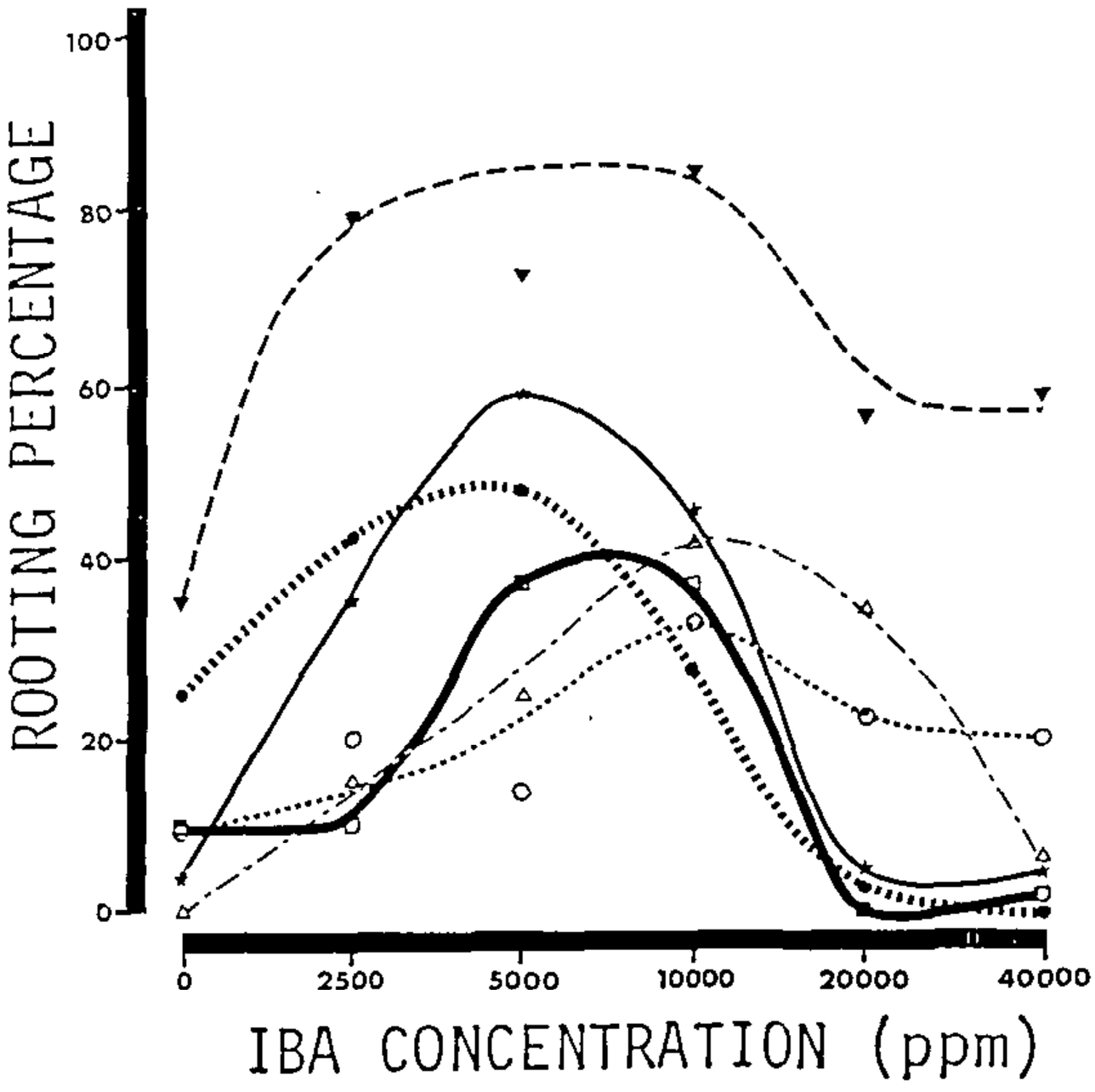

Figure 2. Plants with rooting percentage peaking or plateauing between 5,000 and 10,000 ppm IBA. LSD (P = 0.05): *Chaemomeles speciosa* 'Rubra' (▼), 19%; *Prunus domestica* 'Verity' (○), 20%; *Acer platanoides* 'Crimson King' (△), 18%; *Malus* 'Royalty' (★), 18%; *Tilia* × *europaea* 'Pallida' (□), 16%; *Betula pendula* 'Gracilis' (●), 19%.

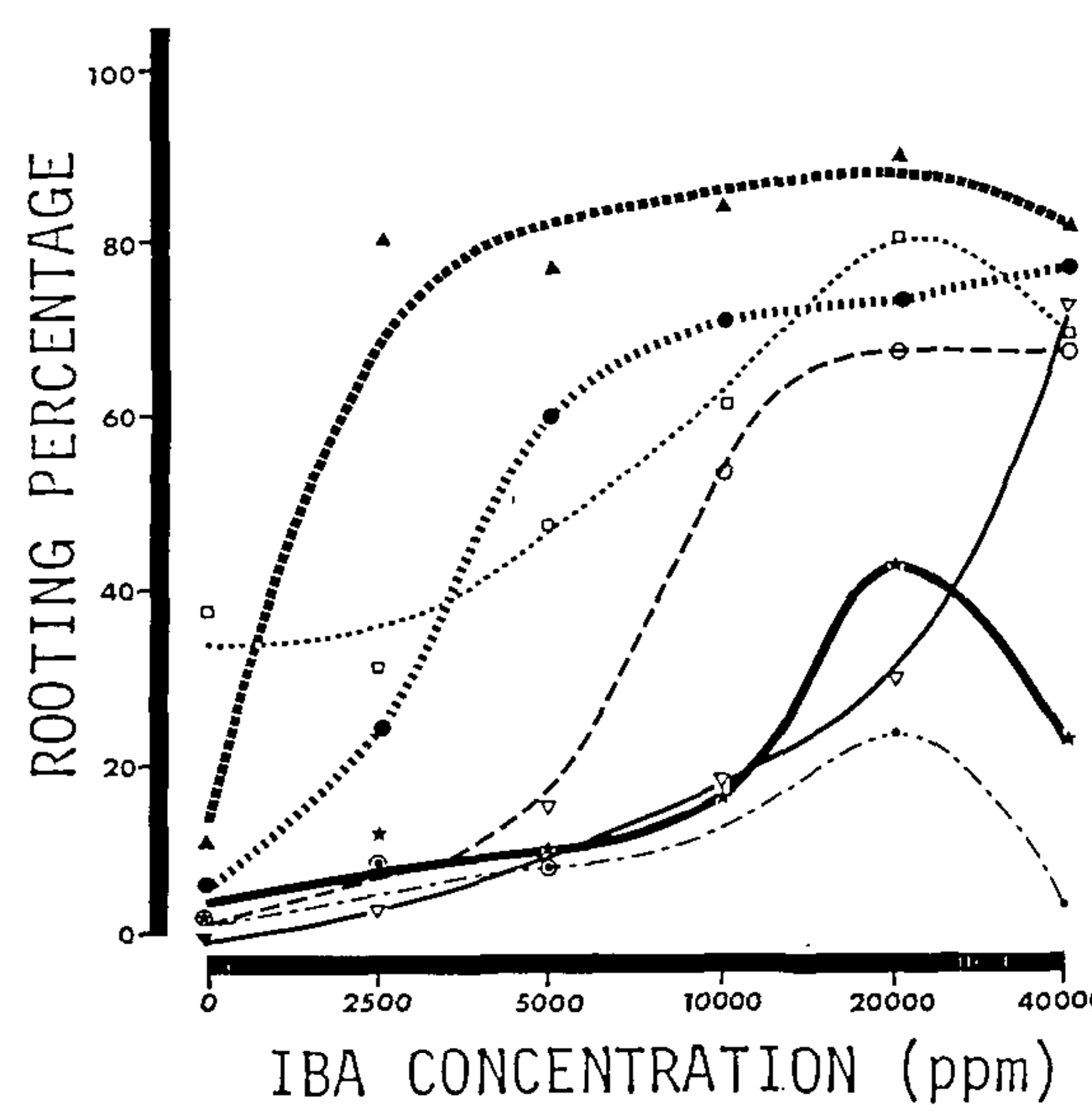

Figure 3. Plants with rooting percentage peaking or plateauing between 20,000 and 40,000 ppm IBA. LSD (P = 0.05): *Prunus triloba* 'Multiplex' (▲), 15%; *Magnolia stellata* (●), 25%; *Amelanchier laevis* (▽), 22%; *Elaeagnus angustifolia* (□), 18%; *Sorbus alnifolia* (○), 21%; Prunus domestica 'Stanley' (★), 17%; *Prunus domestica* 'Valor' (●), 11%.

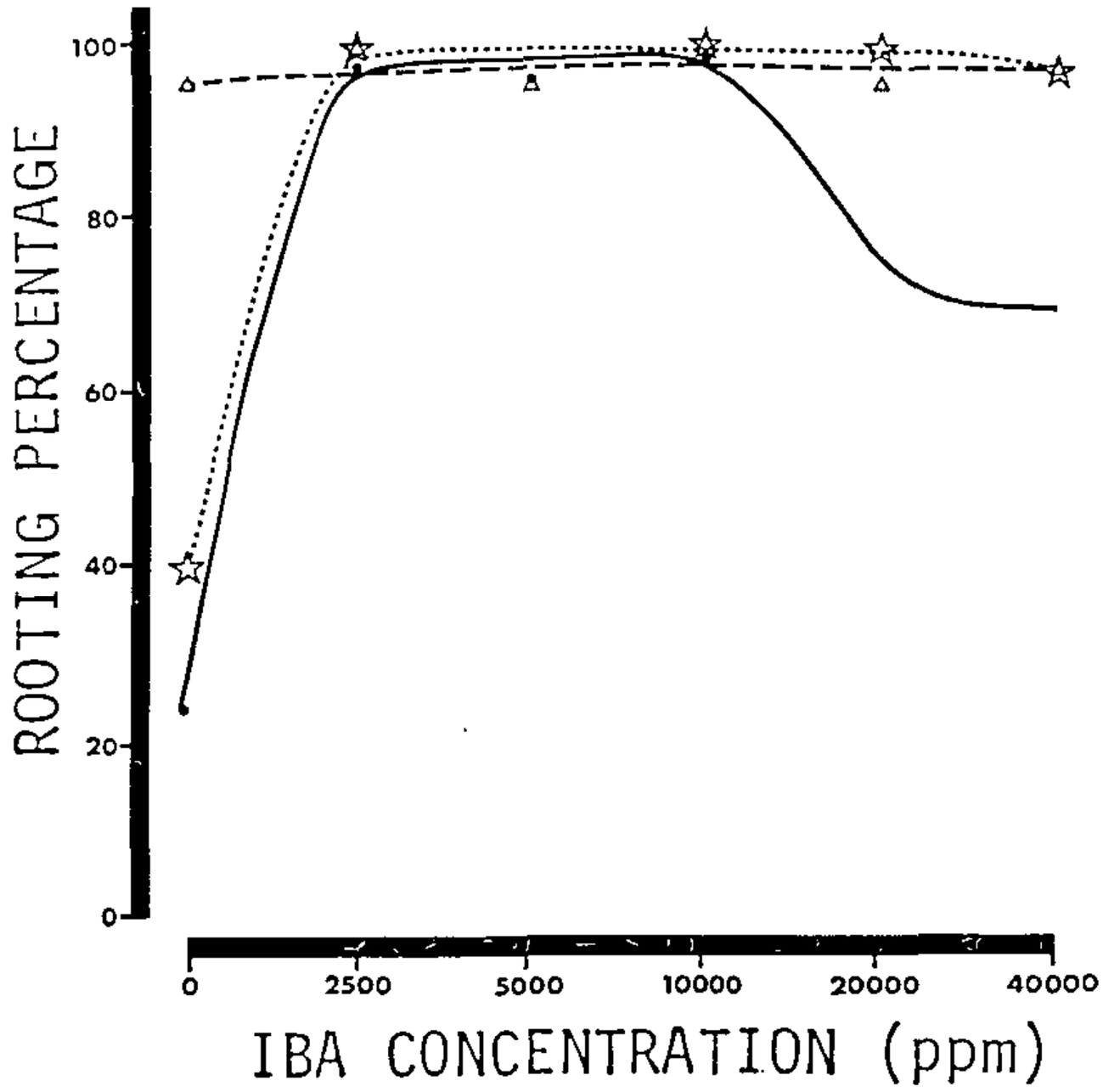

Figure 4. Rooting percentage of three easily-rooted shrubs in response to IBA concentrations. LSD (P = 0.05): *Prunus* × *cistena* (☆), 6%; *Forsythia* × *intermedia* 'Lynwood Gold' (△), not significant; *Euonymus alata* 'Compacta' (●), 16%.

While auxins have been distinctly beneficial for promoting rooting in many plant species, their effects also have been variable, inhibitory, and sometimes detrimental to certain species (5,7). Brown and Dirr (3) and Burd and Dirr (4) reported that high concentrations of IBA between 20,000 and 30,000 ppm often resulted in defoliation, significant injury or death in crabapple cuttings. Thus, the occurrence of significant defoliation in cuttings of the three cultivars of *Prunus domestica* (Figures 2 and 3), and also the relatively late date of cutting insertion of these cultivars, may account largely for their poor rooting. Low rooting response of other species such as *Quercus rubra* (Figure 1), *Betula pendula* 'Gracilis', *Tilia* × *europeae* 'Pallida', and *Acer platanoides* 'Crimson King' (Figure 2) also may have been associated with factors such as inappropriate time of cutting insertion (9), or to inherent difficulty in propagation (7,8,10,14).

Incidence of basal injury to cuttings as described by Chong (5,6) increased in all plants with increasing IBA concentrations, especially between 20,000 and 40,000 ppm. However, increasing basal injury to plants in Figure 3 was associated with increased swelling and enhanced rooting above the injured (untreated) portion with IBA treatments $\geq$ 20,000 ppm. In contrast, increasing basal damage to plants in Figures 1 and 2 was associated with increasing root inhibition with IBA treatments > 2,500 ppm and > 10,000 ppm,

respectively. While root inhibition of plants in Figures 1 and 2 seemed to be due to IBA phytotoxicity (7), in Figure 3 basal damage seemed to act like a girdle causing carbohydrates to accumulate, resulting in swelling and increased rooting (9).

Dirr (7) indicated that cuttings of some plants will root over a wide range of IBA concentrations. Notwithstanding the occurrence of IBA-induced basal damage also to cuttings of all three easily-rooted shrubs (Figure 4), very high rooting response occurred with IBA treatments between 2,500 and 10,000 ppm for *Euonymus alata* 'Compacta', and between 2,500 and 40,000 ppm for *Prunus* × *cistena* and *Forsythia* × *intermedia* 'Lynwood Gold'. In *Forsythia*, a similar response was observed even in the control treatment without IBA. *Chaenomeles speciosa* 'Rubra' (Figure 2) and *Prunus triloba* 'Multiplex' (Figure 3), the two species with the highest rooting percentages among the species shown in each figure, respectively, also exhibited this characteristic. This apparent association between tolerance to a relatively broad range of IBA-concentrations and high degree of rootability is noteworthy. It is interesting that Stoltz and Hess (12) reported that girdling caused a substantial increase in a rooting cofactor above the girdle in an easily-rooted hibiscus clone.

Evidence suggests that physiologically each step of the rooting process is controlled by a delicate balance of growth hormones, both promotor and inhibitor types, in conjunction with various rooting cofactors and complex enzymes (13,14). In view of the stimulative response of some of the species (Figures 1–4) using different amounts of IBA, it is difficult to conceive that rooting is always controlled by this "delicate" mechanism. Auxin application may be a dominant factor in rooting such species.

This study investigated the rooting of a selected number of deciduous woody species in response to varying IBA concentrations and, as an extension to previous studies (3,4,5,6,8,11), identified other species and their favorable response to high concentrations of IBA.

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VOICE: A question for Rick Wells. What time of year do you do your air-layering?

RICK WELLS: We can do it most anytime of the year in warm climates. We are concentrating on early spring and in the fall, so we are able to can the air layers in early summer before it gets hot, and in late fall before it gets too cold.

RALPH SHUGERT: To Steve Hottovy—you alluded several times in your talk to increasing the caliper of your Japanese maple plants. Could you tell us what you do to increase the caliper of the understock?

STEVE HOTTOVY: By leaving lower branches on the seedlings and by topping back at the beginning of the second season.

PHIL BARKER: Would you speculate as to what materials may be in incompatible species other than the ones you worked with?

CHARLES HEUSER: The cyanide compounds are limited in their distribution. The *Prunus* group has them, as does *Taxus*. You have to look at other compounds in other cases of incompatibility, which I have not done.

DALE KESTER: There are two types of almond cultivars—those that are compatible with Marianna plum rootstock and those that are not. We are in the process now in California of trying to screen these two types using field tests. This biochemical test could provide a great opportunity for speeding up this screening process.

RICHARD CRILEY: With regard to the system you describe, can you put both compatible and incompatible callus into the same culture?

CHARLES HEUSER: One of the problems with prunasin is that it is a secondary product and, in callus cultures, secondary products are not produced in high enough quantities, or not at all. That is one of the problems we would be running into.

FILIBERTO LORETI: A question for Dr. Chong. In your high concentrations of IBA on cuttings you would have a high concentration of alcohol also. Did you try the potassium salt of IBA, which is water soluble, and would not impose the side effect of high alcohol levels?

CALVIN CHONG: No, we did not use K-IBA, but in our water control we did use 95% alcohol, just as we did for the high IBA levels.

ED SHULTZ: Dr. Chong, in your work with IBA at high levels, you did not mention NAA once. In future work could you test combinations of NAA and IBA to see what synergistic effects may appear at high levels of each?

CALVIN CHONG: Yes, I agree, but this is a case of where there is so much work to be done that we need to take it a little at a time. I do plan to do more work with NAA. Right now I am working on studies of liquids and powders applied at the same time.

ANNE KYTE: Dr. Durzan, do I understand that your original explant material is after fertilization and, therefore, not true-to-type for your somatic embryogenesis?

DON DURZAN: There are several origins of this type of tissue that has the embryogenetic potential. There is no doubt that this material represents the new generation rather than the mother tree, but in the material we were working with, both parents were blister-rust resistant. After fertilization the process is enhanced quite a bit. You can get as many embryos as you want.