Comparative Rooting of Stem Cuttings of Selected Woody Landscape Shrub and Tree Taxa to Varying Concentrations of IBA in Talc, Ethanol and Glycol Carriers[1]

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Abstract

Stem cuttings of five evergreen and vie deciduous taxa were rooted after treatment with 0, 0.1, 0.3 or 0.8% indolebutyric acid (IBA) in talc, or with 0, 0.25, 0.5, 1.0 or 2.0% IBA in 95% ethanol or in 45% propylene glycol. Despite large differences in the rooting response of taxa to carriers and (or) IBA concentrations, propylene glycol-IBA treatments produced rooting in most taxa comparable to those of ethanol-IBA. Root numbers of the 14 taxa increased linearly or curvilinearly with increasing concentrations of IBA dissolved in ethanol or propylene glycol, as did percent rooting of six of the nine evergreen and four of the five deciduous taxa. Talc formulations were generally less effective than IBA in solution at comparable concentrations.

Index words: Nursery species, propagation, auxin, growth regulator

Species used in this study: 'Mint Julep' juniper (*Juniperus chinensis* L. 'Mint Julep'); 'Wiltonii juniper (*Juniperus horizontalis* Moench 'Wiltonii'); 'Blue Danube' juniper (*Juniperus sabina* L. 'Blue Danube'); 'Tamariscifolia' juniper (*Juniperus sabina* L. 'Tamariscifolia'); 'Capitata' yew (*Taxus cuspidata* Siebold & Zucc. 'Capitata'); 'Densiformis' yew (*Taxus* × *media* Rehd. 'Densiformis'); 'Hicksii' yew (*Taxus* × *media* Rehd. 'Hicksii'); 'Little Champion' arborvitae (*Thuja occidentalis* L. 'Little Champion'); 'Nigra' arborvitae (*Thuja occidentalis* L. 'Nigra'); serviceberry (*Amelanchier alnifolia* Nutt.); Katsura tree (*Cercidiphyllum japonicum* Siebold & Zucc.); Russian olive (*Elaeagnus angustifolia* L.); 'Lynwood' forsythia (*Forsythia* × *intermedia* Zab. 'Lynwood'); and higan cherry (*Prunus subhirtella* Miq.).

Significance to the Nursery Industry

This study demonstrated that propylene glycol (potable water system antifreeze) can be effectively used as a solvent when preparing IBA solutions. Propylene glycol-IBA preparations were at least as effective as those of traditional ethanol-IBA up to 2% (20,000 ppm). Cuttings of relatively few of the 14 taxa studied showed differences in percent rooting, root number, and (or) root length due to the two solvents. Propylene glycol is an economic and easily obtained alternative solvent that should be used by more propagators.

Introduction

Rooting powders consisting of varying amounts of IBA dispensed in talc are commonly used in nursery propagation, but propagators are increasingly using liquid preparations (2, 3). Research has shown that solutions with high concentrations of IBA between 10,000 and 40,000 ppm (1 and 4%) stimulate rooting of many difficult-to-root species (4, 6, 8). Other advantages of auxin solutions have been summarized (11).

Although alcohols are the most common solvents for the free acid of IBA and other auxins, polyethylene glycol has also been used (11). Limited research by Barnes (1) demonstrated that IBA, dissolved in ethylene glycol or propylene glycol, promoted rooting of 'Snowdrift' crabapple (*Malus* Mill. 'Snowdrift', 1000 ppm IBA) and Japanese flowering cherry (*Prunus serrulata* Lindl. 'Kwanzan', 800 ppm IBA). However, before these glycol solvents can be widely used by nursery propagators, their efficacy with other taxa must be demonstrated. Because of limited information on the effects of these solvents (10), this study compared the rooting of woody ornamental taxa treated with IBA in talc, ethanol or propylene glycol carriers, or with the carriers alone, at different concentrations.

Materials and Methods

IBA treatments. The basal 3–4 cm (1.2–1.6 in) of terminal, 10–12 cm (4–5 in) stem cuttings of nine evergreen and five deciduous taxa (Figs. 1–3) were stripped of foliage. Leaves of deciduous cuttings were reduced by 50%. Cuttings of each taxa were treated as follows: basal (1.0 cm; 0.4 in) dusting in talc or in Stim-Root 1, 2, and 3 commercially-prepared rooting powder containing 0.1, 0.3, and 0.8% IBA in talc; quick dip (5-sec) in 95% ethanol (no IBA) or in 0.25, 0.5, 1.0, and 2.0% IBA dissolved in ethanol; quick dip in a parallel series of 0, 0.25, 0.5, 1.0, and 2.0% IBA dissolved in undiluted Cryo-tek potable water system antifreeze, consisting of 45% propylene glycol, 54% water, and 1% dipotassium phosphate. The 2% IBA in Cryo-

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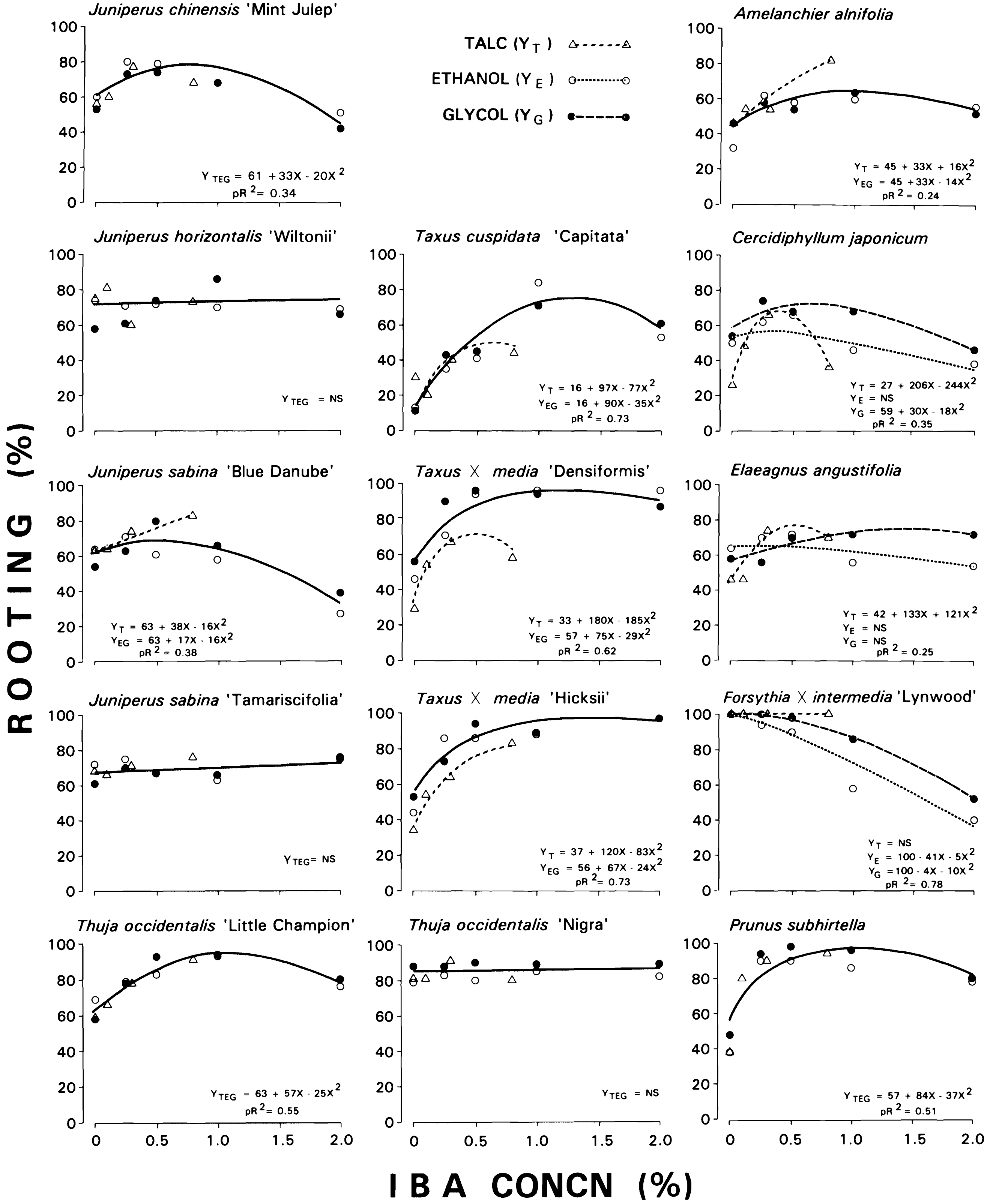

Fig. 1. Mean percent rooting of 14 woody landscape plant taxa in response to varying concentrations of IBA in talc, ethanol, or propylene glycol carriers. The regression for each carrier is represented by Y_T (talc), Y_E (ethanol), and Y_G (glycol). Y_{EG} and Y_{TEG} indicate no significant difference at $P \leq 0.05$ among the regressions for the two liquid carriers and for the three carriers, respectively. NS indicates the slope was nonsignificant at $P \leq 0.05$. pR^2 represents the partial R^2 value.

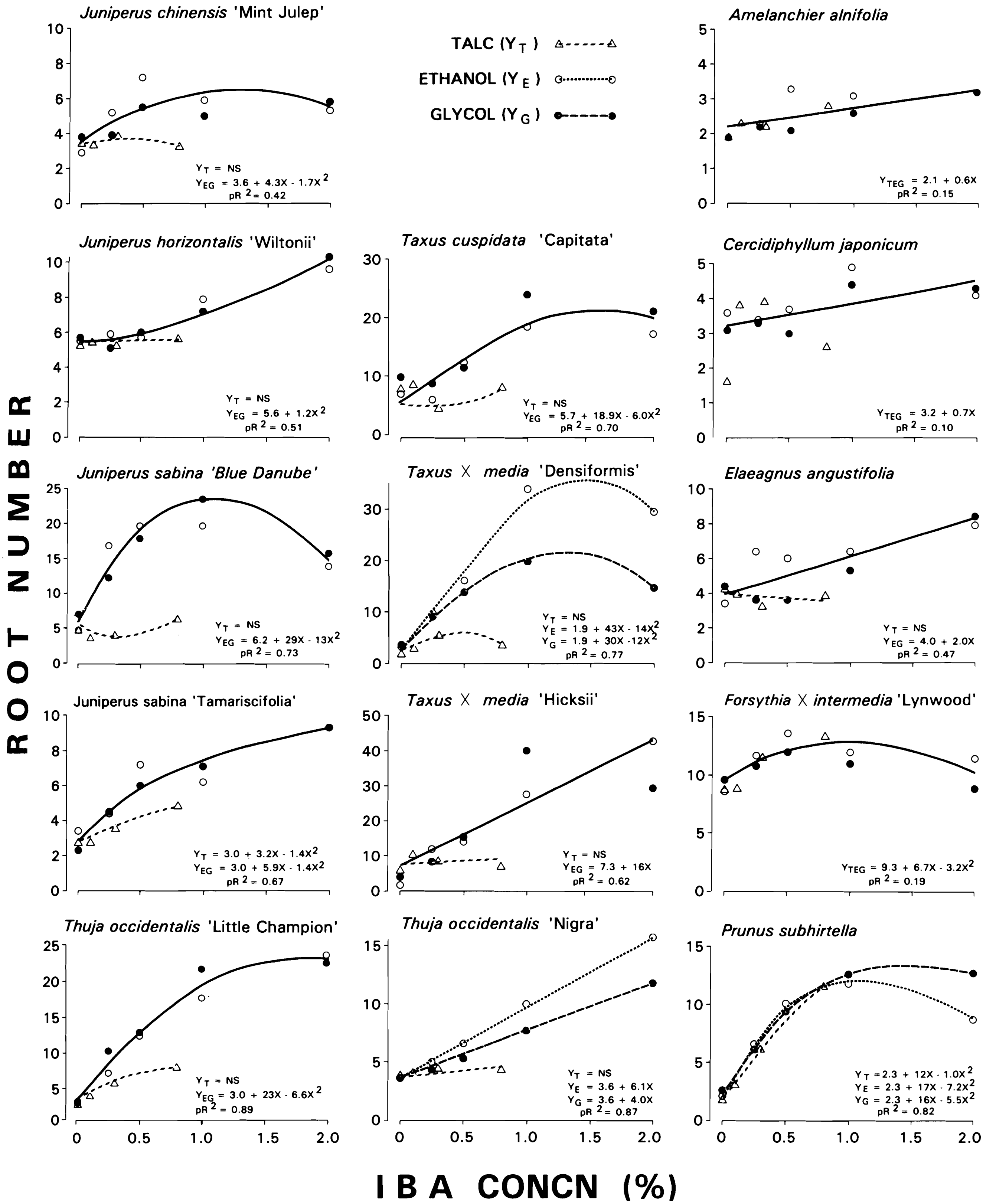

Fig. 2. **Mean root number (based on cuttings which rooted) of 14 woody ornamental taxa in response to varying concentrations of IBA in talc, ethanol, or propylene glycol carriers. The regression for each carrier is represented by Y_T (talc), Y_E (ethanol), and Y_G (glycol). Y_{EG} and Y_{TEG} indicate no significant difference at $P \leq 0.05$ among the regressions for the two liquid carriers and for the three carriers, respectively. NS indicates the slope was nonsignificant at $P \leq 0.05$. pR^2 represents the partial R^2 value.**

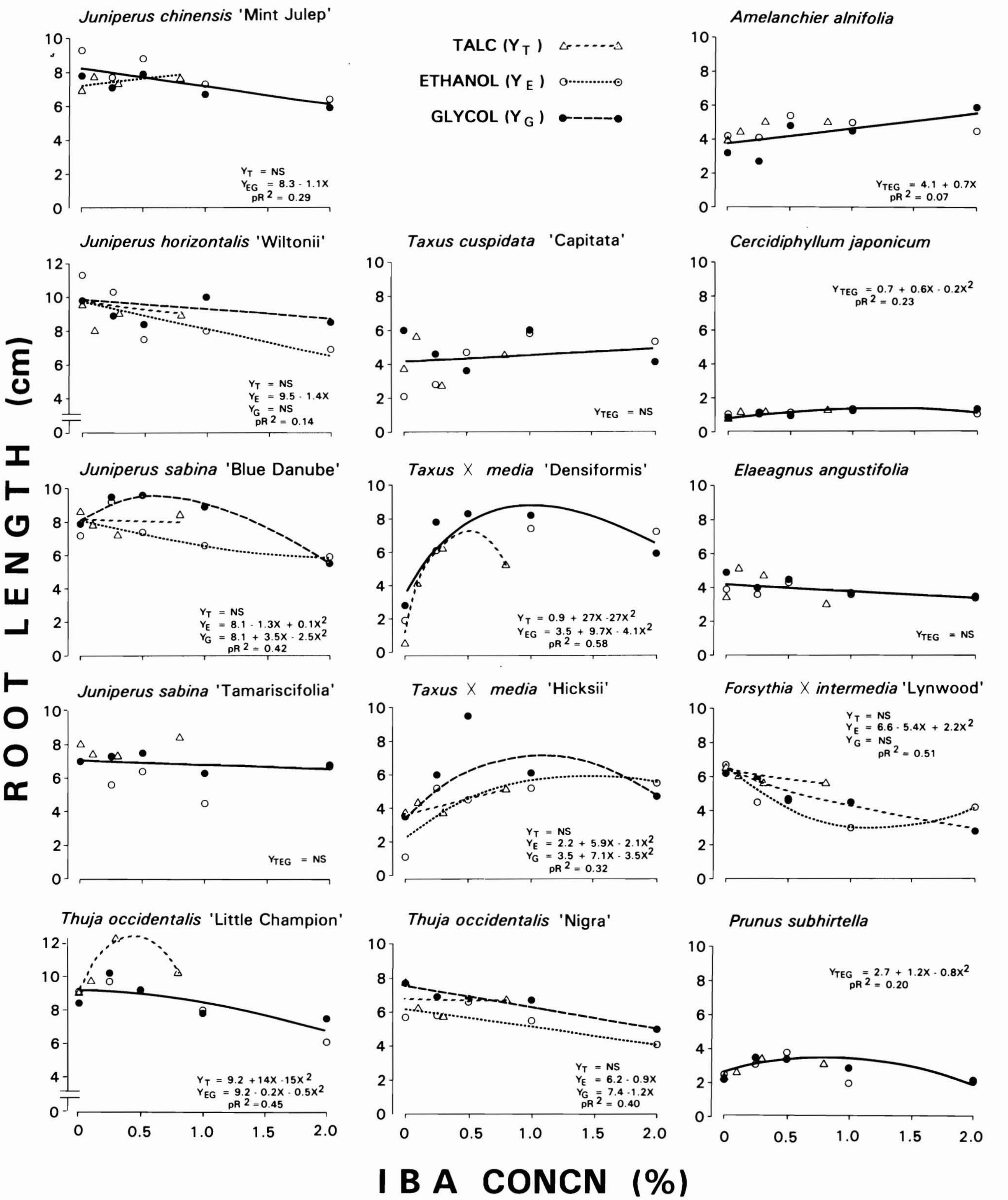

Fig. 3. Mean root length (based on the longest root) of 14 woody landscape plant taxa in response to varying concentrations of IBA in talc, ethanol, or propylene glycol carriers. The regression for each carrier is represented by Y_T (talc), Y_E (ethanol), and Y_G (glycol). Y_{EG} and Y_{TEG} indicate no significant difference at $P \leq 0.05$ among the regressions for the two liquid carriers and for the three carriers, respectively. NS indicates the slope was nonsignificant at $P \leq 0.05$. pR^2 represents the partial R^2 value.

tek was dissolved with gentle stirring over low heat provided by a hot plate due to difficulty in dissolving IBA at room temperature.

Rooting conditions. In January 1990 or 1991, evergreen cuttings were inserted in perlite and peat medium (3:2 by vol) and rooted in four adjacent double-layer, plastic-covered (SDP-16) greenhouse compartments, each 5.5 m (18 ft) wide × 6.0 m (20 ft) long. In each compartment (replicate), the ambient day/night cycle was 16°/10°C (61°/50°F). Bottom heat of 21 ± 2°C (70° ± 4°F) was provided by Root Zone®. Relative humidity ≥ 85% was maintained by a fog system. In mid-June 1991, deciduous cuttings were inserted in 100% perlite and rooted under lath in outdoor frames provided with intermittent mist between 0600 and 2000 h (4 to 8 sec/8 min) until August 31 and with 21°C (70°F) bottom heat after August 15.

Cuttings of each taxon were arranged in a separate randomized complete-block design with four (evergreen) or five (deciduous) replicates and 25 cuttings per plot. Rooting performance was based on mean percent rooting of cuttings, mean root number (based on cuttings which rooted), and mean root length (based on the longest root).

Statistical analysis. Data were analyzed separately by taxa. Transformations of the data were considered but did not appear to be necessary, or to have much effect on data interpretation. Thus, each nontransformed rooting response (Figs. 1–3) was regressed on percent IBA by carrier, using a previously described regression model (7). Graphically, the model represents a series of curves, one for each carrier, radiating from a common intercept or from separate intercepts when significantly different. Quadratic polynomials were fitted when necessary to account for a curved relationship. Preliminary tests to determine whether or not to use the quadratic relationship were done at the 15% level. When the two regressions with liquid carriers were not significantly different at the 5% level, a common regression was fitted to the two carriers. A similar procedure was followed when the three regressions were not significantly different. The coefficient of determination for each response was expressed in terms of partial R^2 (pR^2), which measured the strength of the response relationship after removing replication effects (9).

Results and Discussion

Percent rooting. Three of the nine evergreens (*Juniperus horizontalis* 'Wiltonii', *Juniperus sabina* 'Tamariscifolia', and *Thuja occidentalis* 'Nigra') showed no difference in percent rooting due to IBA treatments (Fig. 1). In contrast, the other six responded curvilinearly to increasing concentrations of IBA in solution, with ethanol (E) and glycol (G) producing similar responses (Y_{EG}). Rooting of *Juniperus chinensis* 'Mint Julep' and *Thuja occidentalis* 'Little Champion' in talc-IBA was similar to the two solvents at comparable concentrations, but was generally lower in the three *Taxus* taxa (Fig. 1). However, *Juniperus sabina* 'Blue Danube' rooted better (83%) with optimum IBA-talc (0.8%) than with corresponding optimum IBA solution (68% rooting at 0.5% IBA).

Among the five deciduous species (Fig. 1), three (*Cercidiphyllum japonicum, Elaeagnus angustifolia*, and *Forsythia* × *intermedia* 'Lynwood') differed in percent rooting between the two solvents. 'Lynwood' forsythia rooted 100% in all talc-IBA treatments and in both solvents without IBA. Rooting decreased as IBA increased in the solvents; however, the negative response to increased auxin was less with glycol. With *Cercidiphyllum japonicum*, percent rooting also was higher with glycol. With *Elaeagnus angustifolia*, the ethanol and glycol curves were statistically different from one another but both were nonsignificant when regressed over IBA concentration.

Root number. Root numbers of all taxa (Fig. 2) increased linearly or curvilinearly with increasing concentrations of IBA in a solution. In contrast, talc IBA induced less (all evergreens) or a similar number of roots (most deciduous species) compared with IBA in solution, at the same concentration. Root number differences between the two solvents were observed in only three of the 14 taxa: *Taxus* × *media* 'Densiformis' and *Thuja occidentalis* 'Nigra', ethanol > glycol; and *Prunus subhirtella*, glycol > ethanol with >1% IBA.

Root length. Similar to percent rooting (Fig. 1), root length of the two cultivars of *Taxus* × *media* (Fig. 3) increased curvilinearly with increasing concentrations of IBA solution. There were small linear or curvilinear root length increases also with *Amelanchier alnifolia, Cercidiphyllum japonicum*, and *Prunus subhirtella*. In contrast, root length of the other taxa tended to decrease with increasing concentrations of IBA solution.

In the four taxa with root length differences between the two solvents (*Thuja occidentalis* 'Nigra', *Juniperus horizontalis* 'Wiltonii', *Taxus* × *media* 'Hicksii', and *Forsythia* × *intermedia* 'Lynwood'), glycol tended to be less inhibitory than ethanol (Fig. 3). Except for *Taxus* × *media* 'Densiformis' and *Thuja occidentalis* 'Little Champion', which yielded the longest roots (12.2 cm; 4.8 in) with 0.5% talc-IBA, talc-IBA treatments had little or no effect on root length in other taxa.

There were large differences in the rooting of taxa to carriers and (or) IBA concentrations (Figs. 1–3). Propylene glycol IBA treatments produced rooting in most taxa comparable to those of ethanol IBA. In several deciduous species, propylene glycol-IBA solutions were more effective than ethanol-IBA solutions, with the reverse occurring in certain evergreen species.

In this and other studies (4, 8), basal necrosis occurred on cuttings treated with high concentrations of IBA dissolved in a solvent, particularly with the 2% IBA; the incidence of necrosis was comparable for both solvents. In a study by Barnes (1), which was limited to relatively low concentrations of IBA between 800 and 2,000 ppm (0.08 and 0.2%), no necrosis was reported. Taxa, such as *Taxus* (Figs. 1–3) and others that tolerated relatively high concentrations of IBA (6, 8), rooted profusely above the basal necrosis. The roots tended to be shorter than those produced with lower concentrations.

Of four solvents, including ethanol and polyethylene glycol, tested by Dirr (10), 95% ethanol was the only solvent which *per se* stimulated rooting to any significant degree. In the present study, both ethanol and propylene glycol stimulated rooting to a limited extent in some taxa [*Taxus* × *media* 'Densiformis' and 'Hicksii', % rooting and(or) root length; *Thuja occidentalis* 'Nigra', root length only; *Elaeagnus angustifolia*, % rooting only], as evidenced by the significantly higher or different intercepts in these cases compared to talc (Figs. 1 and 3). Ethanol inhibited root length of *Taxus* × *media* 'Hicksii' and *Thuja occidentalis* 'Nigra' compared with propylene glycol and talc (Fig. 3).

Dirr (10) reported no phytotoxicity (basal necrosis) or latent growth effects in stem cuttings of Fraser photinia (*Photinia* × *fraseri* Dress), treated with polyethylene glycol alone or with IBA. IBA in polyethylene glycol produced comparable percent rooting to IBA in alcohol but increased the number of roots and total length of roots per rooted cutting (10). The choice of polyethylene glycol as a solvent would be a good one but the commercial availability of this chemical is very limited. Conversely, propylene glycol has many of the beneficial qualities of polyetheylene glycol and is much easier to obtain.

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