Mist Water Quality, Rooting Hormone, Collection Time, and Medium Effect on Propagation of *Pittosporum Tobira* (Thunb.) Ait.[1]

Yin-Tung Wang[2]
Texas A&M University Agricultural Research and Extension Center, 2415 East Highway 83, Weslaco, TX 78596

Abstract

Cuttings of Japanese pittosporum (*Pittosporum Tobira* (Thunb.) Ait.) were collected in February, April, June, October and December 1987 and rooted in a mist propagation bed with 0, 1250, 2500, 5000 or 10000 mg/l (ppm) IBA in 50% ethanol under a mist of low-salt (EC $\leq$ 0.03 dS/m) or saline (EC = 0.96 to 1.50 dS/m) water. Regardless of collection time, IBA either did not improve or adversely affected rooting. Rooting percentages of all cuttings were acceptable with no response to water salinity, except those collected in June which had poor performance when misted with saline water. In another test, *P. Tobira* cuttings rooted in fine grade vermiculite and equal volumes of perlite and coarse grade vermiculite had superior performance to perlite.

Index words: cutting, propagation

Species used in this study: Japanese pittosporum (*Pittosporum Tobira*)

Chemicals used in this study: IBA (3-indolebutyric acid).

Significance to the Nursery Industry

Pittosporum Tobira is a species relatively easy to propagate by rooting cuttings. However, rooting success of cuttings collected in the summer may be low when water that is high in dissolved salts is used for misting. Use of water with a low salt content to mist cuttings during summer improves rooting success and root quality. The selection of a medium containing only vermiculite or half vermiculite may ensure more successful rooting.

Introduction

Pittosporum tobira, which tolerates temperatures to −17°C (0°F) (6), is an important evergreen landscape species most often used as hedges. It is commercially propagated by rooting shoot tip cuttings. Rooting success in commercial nurseries, however, is not always satisfactory.

Poor rooting success could be caused by several factors. During propagation, water containing high levels of total dissolved salts has been suspected to have resulted in low rooting success in chrysanthemum (12) and may inhibit root formation in cuttings of Japanese pittosporum. Rooting medium composition may affect rooting performance. A medium high in cation exchange capacity (CEC) may retain more salts to adversely affect rooting performance than a medium having a low CEC (10). However, Paul (9) reported that, when water containing 10 to 50 milliequivalent/liter sodium was used for misting, chrysanthemum cuttings had better rooting in peat than in sand.

Auxins have been known to facilitate root formation on cuttings of species which are otherwise hard to propagate from cuttings (5, 15). Cuttings of some species taken at different seasons of the year were shown to have different rooting capacities and optimum auxin concentrations for best root formation (16, 17). This study was conducted to determine the effect of season, IBA level, saline mist water and medium on the rooting response of *Pittosporum Tobira* cuttings.

Materials and Methods

Shoot tip cuttings with about 5 cm (2 in) stem were taken from young, healthy plants grown in bark medium in 2.8 l (one gal) containers under 70% of full sunlight (1680 $\mu mol/s/m^2$ or 11750 ft-c maximum) at a commercial nursery. Sierrablen 17N-3P-8.6K (17-7-10) slow release fertilizer was used at the manufacturer's recommended rate. Source plants were irrigated in the late afternoon and cuttings were taken the following morning between 0830 and 1030 HR. Cuttings were collected on February 11, April 13, June 17, October 22 and December 30, 1987, and placed in plastic bags immediately after severing from stock plants.

Pure IBA was dissolved in 50% ethanol at 0, 1250, 2500, 5000, or 10000 mg/l (ppm). The lower 2 cm (0.8 in) of each cutting was dipped in an IBA solution for 5 sec and placed in a mist propagation bed for rooting. Cuttings received between 220 (February, about 1550 ft-c) and 330 (June, about 2300 ft-c) $\mu mol/s/m^2$ of photosynthetic photon flux. The misting interval was 5 sec every 5 min during daylight hours and was controlled by a Model DE8PR2 controller (Davis Engineering, Canoga Park, CA.). The saline water used for misting was from the local municipal water supply and had an electrical conductivity (EC) between 0.96 and 1.50 dS/m and often exceeded 30 meq/liter of cations and anions (17). The low salt water, having an EC of 0.03 dS/m or less, was from a reverse osmosis system. The mist nozzles were the low-volume, oil burner type (E.C. Geiger Co., Harleysville, PA) placed 60 cm (2 ft) apart. Water pressure was maintained at about 2.8 kg/cm^2 (40 psi). During the first and last hour of daylight, the mist interval was doubled. Rooting medium was three parts perlite and one part peat moss (by vol) except for cuttings taken in April, which were rooted in perlite. Perlite was used in April because of the large amount of time needed to separate

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[2]Associate Professor.

peat moss from the roots. However, due to less satisfactory root systems in perlite, the peat-perlite medium was used again afterwards. There were five cuttings per treatment and each treatment was replicated five times in a randomized complete block design. After nine weeks of rooting, percentage success, root grade, number of roots, length of the longest root and root fresh weight (when applicable) were recorded. Treatment means of the last three variables were computed from rooted cuttings only. Regression analysis was performed on all data except percentage rooting success which was analyzed after arc sine transformation.

Shoot tip cuttings taken on March 26, 1990 from plants in a hedge grown under full sun were rooted in a mist propagation bed. Mist consisted of two water sources as described above. The eight medium treatments were:

1 = Peat moss + perlite (1:3 by vol);
2 = treatment 1 + 500 ml of 500 ppm $CaCl_2$ drench biweekly;
3 = treatment 1 + 5 kg/m^3 (8 lb/yd^3) Dolomite;
4 = perlite;
5 = perlite + 5 kg/m^3 (8 lb/yd^3) Osmocote 14N-6.1P-11.6K (14-14-14);
6 = fine vermiculite;
7 = coarse vermiculite; and
8 = volumes of perlite and coarse vermiculite.

Media were placed in 2 1 (6-1/2 in) pots and watered thoroughly with their respective saline or low-salt water before five cuttings were stuck. Data were recorded after 14 weeks and analyzed as stated above.

Results and Discussion

Increasing concentrations of IBA did not favorably promote rooting (Tables 1, 2, 3, 4 and 5). Percentage rooting was either unaffected by IBA or was reduced by increasing concentrations of IBA (Tables 1, 2, and 5), indicating that IBA may not be needed for propagation of Japanese pittosporum. This is in agreement with Conover and Joiner (3) who reported that IBA treatment is not necessary to root *Pittosporum Tobira variegatum* shoot tip cuttings. Rooting percentages of all cuttings except those collected in June were satisfactory (Tables 1, 2, 4, and 5). Pittosporum cuttings collected in June had poor rooting performance under mist of saline water (Table 3). Rooting success of June cuttings was significantly improved with mist of low-salt water. For example, June cuttings had rooting percentages ranging between 32% and 56% under saline water mist, whereas rooting success was between 72% and 92% under low-salt mist. Rooting of cuttings collected in other months was not affected by the high salinity of the city water, contrary to results in another study where poor rooting of *Buxus microphylla* cuttings occurred when rooted under high saline mist at low IBA concentrations (17).

Overall root grade was either unchanged by IBA (Tables 2, 3, 4, and 5) or was lower as IBA concentration increased (Tables 1 and 2). Water quality had little effect on root grade except for the April cuttings where saline water resulted in higher root grade (Table 2). This anomaly may have resulted from the use of pure perlite rooting medium in April as opposed to a medium consisting of peat moss and perlite used for other months. A medium containing peat moss may have assured better medium to cutting contact resulting in less water stress. Perlite contains hardly any major nutrients to meet plant growth requirements. The saline water may have provided some nutrients required for

Table 1. Effect of mist water quality and IBA concentration on rooting performance of *Pittosporum Tobira* terminal cuttings taken on February 18, 1987 and rooted under mist for 9 weeks.

Water salinity	IBA (ppm)	% Rooting	Root grade (0–5)^z	Root length (cm)	Number of roots	Root fresh wt (g)
Saline	0	100	3.4	8.7	10.0	0.65
	1250	92	3.1	7.5	10.2	0.72
	2500	96	3.2	7.8	9.6	0.52
	5000	92	2.7	5.5	8.2	0.40
	10000	88	2.6	4.5	6.4	0.24
Significance						
Linear		*	*	**	**	*
Quadratic		NS	NS	NS	NS	NS
Low-salt	0	96	3.3	8.0	12.0	0.56
	1250	88	2.9	6.4	9.1	0.41
	2500	100	3.2	7.3	11.5	0.62
	5000	88	2.5	5.1	7.8	0.29
	10000	76	2.4	3.9	8.0	0.26
Significance						
Linear		NS	**	**	**	*
Quadratic		NS	**	NS	NS	NS
Saline vs low-salt		NS	NS	NS	NS	NS

^{z}0 = no callus; 1 = callused; 2 = few or short roots; 3 = good rooting; 4 = abundant roots; 5 = excellent.

NS, *, and ** represent non-significant, significant at 5% and 1% level, respectively.

Table 2. Effect of mist water quality and IBA concentration on rooting performance of *Pittosporum Tobira* terminal cuttings taken on April 13, 1987 and rooted for 9 weeks in pure perlite.

Water salinity	IBA (ppm)	% Rooting	Root grade (0–5)^z	Root length (cm)	Number of roots	Root fresh wt (g)
Saline	0	96	4.0	10.9	18.6	1.06
	1250	96	4.1	11.0	23.1	1.57
	2500	100	3.8	9.0	26.9	1.35
	5000	84	3.3	7.7	26.0	1.00
	10000	88	2.8	7.2	26.6	0.97
Significance						
Linear		*	**	**	*	*
Quadratic		NS	NS	NS	*	NS
Low-salt	0	92	2.2	3.3	20.0	0.45
	1250	96	2.1	2.9	23.4	0.35
	2500	96	2.0	2.1	32.5	0.34
	5000	88	2.1	2.5	34.0	0.30
	10000	96	2.0	12.6	16.7	0.52
Significance						
Linear		NS	NS	NS	**	*
Quadratic		NS	NS	NS	NS	NS
Saline vs low-salt		NS	**	**	**	NS

^{z}0 = no callus; 1 = callused; 2 = few or short roots; 3 = good rooting; 4 = abundant roots; 5 = excellent.

NS, *, and ** represent non-significant, significant at 5% and 1% level, respectively.

Table 3. Effect of mist water quality and IBA concentration on rooting performance of *Pittosporum Tobira* terminal cuttings taken on June 17, 1987 and rooted under mist for 9 weeks.

Water salinity	IBA (ppm)	% rooting	Root grade (0–5)[z]	Root length (cm)	Number of roots
Saline	0	32	2.4	3.7	12.0
	1250	40	2.1	2.3	6.8
	2500	36	2.1	2.9	7.8
	5000	56	2.4	3.9	11.1
	10000	40	2.1	2.4	13.0
Significance					
Linear		NS	NS	NS	NS
Quadratic		NS	*	NS	NS
Low-salt	0	80	2.1	3.2	8.9
	1250	92	2.4	3.8	11.6
	2500	80	2.2	3.5	12.0
	5000	88	2.4	3.9	12.5
	10000	72	2.4	3.6	20.0
Significance					
Linear		NS	NS	NS	**
Quadratic		NS	NS	NS	NS
Saline vs low-salt		**	**	NS	NS

[z]0 = no callus; 1 = callused; 2 = few or short roots; 3 = good rooting; 4 = abundant roots: 5 = excellent.

NS, *, and ** represent non-significant, significant at 5% and 1% level, respectively.

Table 4. Effect of mist water salinity and IBA concentration on rooting performance of *Pittosporum Tobira* terminal cuttings taken on October 22, 1987 and rooted under mist for 9 weeks.

Water salinity	IBA (ppm)	% rooting	Root grade (0–5)[z]	Root length (cm)	Number of roots	Root fresh wt (g)
Saline	0	100	3.1	9.6	14.8	1.10
	1250	88	3.9	10.8	18.1	1.51
	2500	92	3.9	11.4	20.7	1.74
	5000	88	3.6	12.6	22.4	1.50
	10000	100	3.3	10.0	20.3	1.31
Significance						
Linear		NS	NS	NS	*	NS
Quadratic		NS	NS	NS	*	NS
Low-salt	0	100	4.2	11.7	16.3	2.01
	1250	96	3.8	8.9	23.2	1.81
	2500	96	3.6	9.6	23.8	2.06
	5000	100	3.8	9.3	27.4	2.03
	10000	92	3.5	8.5	26.1	1.61
Significance						
Linear		NS	NS	*	*	NS
Quadratic		NS	NS	NS	**	NS
Saline vs low-salt		NS	*	NS	**	**

[z]0 = no callus; 1 = callused; 2 = few or short roots; 3 = good rooting; 4 = abundant roots; 5 = excellent.

NS, *, and ** represent non-significant, significant at 5% and 1% level, respectively.

Table 5. Effect of mist water quality and IBA concentration on rooting performance of *Pittosporum Tobira* terminal cuttings taken on December 30, 1987 and rooted for 9 weeks.

Water salinity	IBA (ppm)	% Rooting	Root grade (0–5)[z]	Root length (cm)	Number of roots	Root fresh wt (g)
Saline	0	76	3.1	9.1	19.9	1.18
	1250	84	3.6	14.4	22.6	1.69
	2500	76	3.2	11.7	28.0	1.49
	5000	84	3.5	12.0	35.0	1.69
	10000	96	3.3	12.2	38.4	1.65
Significance						
Linear		NS	NS	NS	**	NS
Quadratic		NS	NS	NS	NS	NS
Low-salt	0	84	3.0	9.3	16.7	1.48
	1250	88	3.2	10.5	21.1	1.63
	2500	88	3.4	12.1	32.6	1.86
	5000	76	3.7	9.7	32.8	2.05
	10000	80	4.4	9.9	52.5	2.43
Significance						
Linear		*	NS	NS	**	**
Quadratic		NS	NS	NS	NS	NS
Saline vs low-salt		NS	NS	*	NS	NS

[z]0 = no callus; 1 = callused; 2 = few or short roots; 3 = good rooting; 4 = abundant roots; 5 = excellent.

NS, *, and ** represent non-significant, significant at 5% and 1% level, respectively.

root elongation after rooting had occurred in perlite medium while retaining little salts since there was no difference in percentage rooting between the two types of water. The saline municipal water contained over 10 meq/liter (> 230 ppm) Na which could have resulted in even higher Na levels in the peat-perlite medium over the 9 weeks rooting period. Peat moss was found to adsorb a large amount of extractable Na accumulated from the mist water and result in poor root grade of chrysanthemum cuttings (10).

Root length in most cases was little affected by IBA or water salinity. Cuttings collected in February had decreasing root lengths with increasing IBA concentrations (Table 1). The same was true for April cuttings rooted under saline mist (Table 2) and October cuttings rooted under low-salt water.

There was no particular pattern of root number as a function of IBA treatments. Collection time apparently had an impact on root number, with cuttings collected in December producing the most roots. Rooting performance of *Prunus salicina* (14), *Prunus domestica* (14) and *Epacris impressa* (16) cuttings was reported to be dependent upon the time of collection. Root number decreased as the result of IBA treatment in February cuttings (Table 1), whereas it was greatly increased with IBA in December cuttings (Table 5). Root fresh weight correlated with root number and length and was the greatest in cuttings collected in Oct. and December.

The composition of medium had a profound effect on rooting performance. The fine grade vermiculite and a medium consisting of equal volumes of coarse grade vermiculite and perlite (treatments 6 and 8) resulted in higher rooting percentages than pure perlite (treatment 4, Table 6). The lower percentage rooting, compared to cuttings collected at a similar time in the first experiment, could have been the result of cuttings developing under full sun and having not been fertilized as much. Overall root grade and root length, number and fresh weight were superior when cuttings were rooted in media containing vermiculite relative to the other media. All the above parameters showed little or no difference among other media. However, Thompson (16) reported that pure vermiculite resulted in poor rooting in *Epacris impressa* cuttings relative to perlite, sand or peat. Conover and Joiner (3) reported that terminal cuttings of *Pittosporum Tobira variegatum* rooted poorly in No. 2 resin coated vermiculite than in a medium consisted of 50% perlite and 50% peat. A recent study showed that high moisture content in the rooting media enhanced rooting (Rein et al., 1991). In this current study, pots filled with vermiculite or vermiculite and perlite were heavier than the others. Therefore, higher moisture content in vermiculite medium might have enhanced root initiation and root development. Coating vermiculite with resin may have affected its water retention and changed its physical properties needed to provide good rooting.

The pH of rooting media could have an effect on rooting success (1), with a medium pH close to 5.1 resulting in the best rooting for *Epacris impressa* (16) and a pH near neutrality for *Gypsophila paniculata* (7). Since perlite and vermiculite have a similar pH, between 7 and 7.5, better rooting of pittosporum cuttings in media containing vermiculite may be the result of less water stress by having better medium contact with the base of cuttings, providing better water potential to promote rooting (13).

Paul and Thornhill (11) reported that mist water containing a high Mg to Ca ratio resulted in shorter root length in chrysanthemum cuttings. The saline water used in this study had a 2:1 Ca to Mg ratio (17). The high Mg content in the water and accumulation of Mg in the rooting medium over time might have impaired rooting performance.

Increasing medium Ca by adding dolomitic lime or $CaCl_2$ to peat-perlite medium to decrease the Na percentage or increasing nutrient level by adding Osmocote slow release fertilizer to perlite did not result in improved rooting percentage (Table 6). Addition of calcium carbonate or gypsum to rooting medium was reported to have enhanced root grade of chrysanthemum cuttings (1). The dolomitic lime used in this study might have also elevated Mg levels in the medium to impair rooting. Cuttings of some species have been reported to have improved root grade by the addition of nutrients to rooting media, while others did not respond to this cultural practice (2, 4, 8). Carney and Whitcomb (2) reported that cuttings of three woody plant species did not respond to fertilizers in rooting medium, however, cuttings rooted in the fertilizer-amended medium had improved growth after transplanting relative to that in the base medium. Water salinity did not affect rooting (Table 6).

Results from these experiments suggest that treating Japanese pittosporum cutting with IBA is not required in order to get satisfactory rooting. Water salinity up to 1.50 dS/m did not adversely affect rooting except on cuttings collected in June and rooted during summer. It is apparent from these results that selection of a medium containing vermiculite has a significant impact on the success of rooting Japanese pittosporum cuttings.

Table 6. Performance of *Pittosporum Tobira* cuttings rooted in eight media and under mist from high- or low-salt water for 14 weeks. There was no significant interaction between water source and medium composition.

Treatment	Rooting success (%)	Root grade[z] (0–5)	Root length (cm)	Root no.	Root fresh wt (g)
Medium[y]					
1	70 bc[x]	2.3 d	7.2 cd	17.1 c	1.2 c
2	68 bc	2.1 d	7.1 cd	14.8 c	1.2 c
3	80 abc	2.6 d	8.9 c	15.4 c	1.6 c
4	64 c	2.1 d	5.9 d	16.2 c	1.6 c
5	70 bc	2.3 d	6.2 d	16.3 c	1.6 c
6	100 a	4.9 a	15.4 a	26.0 a	4.3 a
7	68 bc	3.2 c	14.2 ab	21.2 b	3.5 b
8	90 ab	4.1 b	13.0 b	22.1 b	3.4 b
Water salinity					
Low	79 NS	3.0 NS	10.5 NS	18.3 NS	2.5 NS
High	74	2.9	9.8	20.0	2.4

[z]0 = no rooting; 1 = callused; 2 = a few short roots; 3 = acceptable; 4 = good; 5 = excellent.

[y]Medium: 1 = 1 peat moss : 3 perlite; 2 = treatment 1 + 500 mg/l $CaCl_2$ biweekly; 3 = treatment 1 + 5 $kg{\cdot}m^{-3}$ Dolomite; 4 = perlite; 5 = perlite + 5 $kg{\cdot}m^{-3}$ Osmocote 14-14-14; 6 = fine vermiculite; 7 = coarse vermiculite; 8 = 1 perlite : 1 coarse vermiculite.

[x]Mean separation among medium within columns by the same letter or letters are not significantly different at the 5% level by Duncan's multiple range test.

NS represents non-significant at the 5% level by F test.

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Production and Postproduction Performance of Uniconazole-Treated Bedding Plants[1]

Gary J. Keever[2] and William J. Foster[3]
Department of Horticulture
Alabama Agricultural Experiment Station
Auburn University, AL 36849

Abstract

Growth and flowering responses of *Pelargonium* × *hortorum* L. H. Bailey 'Ringo Deep Scarlet', *Tagetes erecta* L. 'Inca Orange', *Viola* × *wittrockiana* Gams. 'Blue Shades', *Impatiens* × 'Zenith' and *Salvia farinacea* Benth. 'Victoria Blue' to uniconazole applied at the seedling stage were evaluated at the end of production and 5 to 7 weeks after transplanting into the landscape (geranium, impatiens and salvia only). A drought stress evaluation was also conducted. Response to uniconazole varied with species, sampling date and uniconazole concentration. Growth of all species was suppressed when measured 4½ to 8½ weeks after treatment (WAT), and stress tolerance of all species except marigold increased with increasing concentrations of uniconazole. Flowering generally was delayed with uniconazole. Impatiens and geranium treated with 10 ppm or less of uniconazole were similar in height to nontreated plants 5 to 7 weeks after being transplanted; at this time, uniconazole had no effect on plant height or shoot dry weight of salvia. Daminozide applied once as a 5000 ppm foliar spray was not effective in suppressing vegetative growth of any of the tested species.

Index words: growth retardant, uniconazole, Sumagic, daminozide, B-nine

Growth regulators used in this study: Sumagic (uniconazole), (E)-1-(p-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-penten-3-ol; B-nine (daminozide), butanedioic acid mono (2,2-dimethylhydrazide).

Species used in this study: 'Ringo Deep Scarlet' geranium (*Pelargonium* × *hortorum* L. H. Bailey 'Ringo Deep Scarlet'); 'Inca Orange' marigold (*Tagetes erecta* L. 'Inca Orange'); 'Blue Shades' pansy (*Viola* × *wittrockiana* Gams. 'Blue Shades'); 'Zenith' New Guinea impatiens (*Impatiens* × 'Zenith'); 'Victoria Blue' salvia (*Salvia farinacea* Benth. 'Victoria Blue').

Significance to the Nursery Industry

Chemical growth retardants commonly are applied to bedding plants to promote compactness and to extend the marketing period. Sumagic (uniconazole) is an effective retardant in suppressing internode elongation and increasing a plant's tolerance to water stress, both of which should enhance and extend marketability; however, optimum rates are specific to a given species. Growth suppression may continue after plants are transplanted into the landscape, but plants may exhibit an accelerated growth rate after the growth-retarding effect dissipates. Sumagic (uniconazole) applied at too high a concentration will suppress growth excessively and delay flowering. The effects may persist for 5 or more weeks after plants are transplanted into the landscape, depending upon the bedding plant species and the concentration of uniconazole applied.

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[2]Associate Professor of Horticulture.

[3]Former Superintendent, Ornamental Horticulture Substation, Mobile, AL 36608-0276.

Introduction

Chemical growth retardants, such as B-nine (daminozide), Cycocel (chlormequat chloride), and A-rest (ancymidol), are applied to bedding plants to promote compactness and uniformity and to extend marketability (9). Such growth retardants also may improve transplant survival by maintaining favorable root to shoot ratios and reduce water use, hence increasing a plant's tolerance to drought stress (10). Triazole inhibitors, a group of plant bioregulants represented by Sumagic (uniconazole) and Bonzi (paclobutrazol), suppress stem elongation by interfering with gibberellin biosynthesis (7). Studies indicate that both compounds are active on a variety of bedding plants (2, 4, 5, 8, 10), including species which are unaffected by other commercially available growth retardants (1).

Compared to other retardants, triazole inhibitors are active in low dosages and are persistent (6), characteristics that could result in undesirable growth inhibition after plants are transplanted into the landscape. Limited information is available on postproduction growth and performance of triazole-treated bedding plants (5, 8). Our study was conducted to determine the influence of various dosages of Sumagic