INFLUENCE OF CHEMICAL SANITATION TREATMENTS ON PROPAGATION OF *BUXUS MICROPHYLLA* AND *PEPEROMIA CAPERATA*

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Abstract. Rooting of Japanese boxwood and peperomia shoot cuttings was used to determine the influence of chemical treatment procedures on propagation efficiency of two widely planted nursery and greenhouse crops. In the first experiment 10 commercial fungicides and a disinfectant[1] were applied as drench and cutting soak treatments to boxwood, *Buxus microphylla* var. *japonica*, cuttings which were rooted in a steam sterilized mist bench. Lesan© 70W applied as a soak was the only treatment that inhibited rooting of boxwood cuttings when compared to cuttings not receiving chemical treatment. Cuttings treated with drench or soaks using Terraclor© 75W or drenches using Banrot© 40W produced more roots than control, but in root length, number of roots, and root weight, the treatments could not be separated from results with untreated cuttings. Root numbers of cuttings treated with drench applications of Lesan 70W, Subdue© 2E, Banrot 40W, and Terraclor 75W were greater than with soak treatments using the fungicides. In a second study the influence of soil fungicide treatments on rooting of *Peperomia caperata* 'Blackie' leaf cuttings was determined in a peat/perlite growing medium receiving periodic manual watering. Rooting percentage of untreated leaf cuttings was equal to or better than that of cuttings receiving chemical treatment application. Root development of cuttings receiving Agrimycin© 21W, Benlate© 50@, Subdue 2E, and combinations of Subdue 5W + Benlate 50W, and Truban© 5G + Benlate 50W Agrimycin 21W, was greater than control. In general, however, rooting percentage and root development was restricted when combinations of chemicals were applied to cuttings. Treatments using the fungicides Terraclor 75W and Captan© 50W gave consistently poor results, suggesting phytotoxicity.

REVIEW OF LITERATURE

Diseases occurring on propagative units are a common source of soil-borne pathogens at the initiation of the growing cycle. This situation can largely be attributed to inadequate use of sanitary production practices during propagation (1).

Regardless of the growing medium used for vegetative propagation, disinfestation is highly desirable to eliminate weeds, insects, nematodes, and disease organisms (1,3). Aerated steam sterilization was developed in an attempt to reduce the problem of pathogen re-entry (2); however, the treatment has little effect on pathogens introduced on shoot cuttings. For this reason, chemical disinfectants are frequently employed as

[1] Trade names and company names are included for the benefit of the reader and do not imply endorsement or preferential treatment of the products listed by Texas A&M University.

an additional tool for controlling diseases in the propagation bench (1). Cuttings of woody ornamental plants in a mist bench are susceptible to attack by several species of *Pythium*, *Phytophthora*, *Rhizoctonia*, (12), *Fusarium* (10), *Botrytis* (5), *Alternaria*, *Cylindrocladium*, *Gloesporium*, *Pestalotia* (11), and other pathogenic fungi. Several of the more popular fungicide formulations, including Benlate© (4), thiram (6), captan (7), Difolatan© (11), Subdue and Truban© (9), have been cited as phytotoxic to cuttings in mist propagation. Other reports indicate enhanced rooting of cuttings treated with Ferbam© (8, 13), thiram (8), and combinations of fungicides and growth regulators (8). A wide range of chemical disinfectants is available for prevention of soil-borne problems, yet few studies have been conducted to determine the influence of chemical sanitation programs on propagation efficiency.

MATERIALS AND METHODS

Experiment I — Influence of Chemical Disinfectants on Boxwood Propagation Efficiency

Studies were designed to determine the effects of several disinfectant treatments on rooting efficiency of Japanese boxwood, propagated under mist. We evaluated 10 commercially available fungicides and a disinfectant (commercial bleach) for phytotoxicity, both as a dip and drench application during the propagation cycle.

Uniform 10 cm length stem tip cuttings bearing six leaves were collected from a single Japanese boxwood hedge in July, 1981. Basal tips of the cuttings were dipped for 5 seconds in an aqueous solution of 10 g/l 3-indolebutyric acid (potassium salt), and allowed to dry for approximately one minute. Chemical disinfectants were then applied directly to cuttings as a 3-min. soak prior to planting or to the propagation medium as a drench, at rates and frequency of application suggested by the manufacturer (Table 1). The cuttings were placed at a depth of 5 cm in a steam-sterilized propagation medium consisting of perlite-peat moss 3:1 (v/v) under intermittent mist. Cuttings were arranged in a randomized complete block design with three replications of 10 cuttings per replication. Data were collected after 43 days, at which time the untreated control cuttings had rooted. Parameters measured were: (1) percentage rooting of cuttings, (2) total number of roots per cutting, (3) root weights per cutting, and (4) root lengths as determined by the means of lengths of the three longest roots per cutting. All data were subjected to square root transformation after which they were analyzed using an analysis of variance and Duncan's multiple range test. Means reported in Table 3 were computed from untransformed values.

Table 1. Fungicides, methods of use, and frequency of application to cuttings of *Buxus microphylla* var. *japonica*[a].

Chemical formulation	Rate (oz/100 gal.)	Method of applicaton[b]	Application Frequency
Control, not treated			
Truban 5G	10 oz/yd^3	Medium incorporation	Preplant
Truban 30W	8 oz	Soak	Preplant
Truban 30W	8 oz	Drench	1, 34 days
Truban 25E	8 oz	Soak	Preplant
Truban 25E	8 oz	Drench	1, 34 days
Lesan 70W	8 oz	Soak	Preplant
Lesan 70W	8 oz	Drench	1,12,22,34 days
Captan 50W	24 oz	Soak	Preplant
Captan 50W	24 oz	Drench	1,12,22,34 days
Subdue 2E	0.8 oz	Soak	Preplant
Subdue 2E	0.8 oz	Drench	1,34 days
Benlate 50W	8 oz	Soak	Preplant
Benlate 50W	8 oz	Drench	1,12,22,34 days
Banrot 40W	12 oz	Soak	Preplant
Banrot 40W	12 oz	Drench	1, 34 days
Dithane M-45 80W	32 oz	Soak	Preplant
Dithane M-45 80W	32 oz	Drench	1, 34 days
Terraclor 75W	4 oz	Soak	Preplant
Terraclor 75W	4 oz	Drench	1st day only
Clorox	10%	Soak	Preplant
Clorox	10%	Drench	1,12,22,34 days

[a] Preplant soak of cuttings was for 3 min. Drenches were applied to cuttings and medium at a volume of 1.5 pints/ft^2 of bench space.

[b] Chemical names of these fungicides are:

Truban:	5-ethoxy-3-trichloromethyl-1,2,4-thiodiazole
Lesan:	sodium (4-dimethylamino) phenyl) diazene sulfonate
Subdue:	N-(2,6-dimethylphenyl)-N-(methoxyacetyl)-alanine methyl ester
Benlate:	methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate
Banrot:	5-ethoxy-3-trichloromethyl-1,2,4-thiodiazole, 15%, dimethyl 4,4-0-phenylenebis (3-thioallophanate), 25%; and inert ingredients, 60%
Captan:	cis-N-(trichloromethyl) thio)-4-cyclohexene-1,2-dicarboximide
Dithane M-45:	manganese ethylenebisdithiocarbamate
Terraclor:	pentachloronitrobenzene

Experiment II — Influence of Chemical Treatment on Propagation Efficiency of *Peperomia caperata.*

Leaf cuttings of *Peperomia caperata* 'Blackie' were placed in a peat moss-perlite growing medium (1:1 v/v) adjusted to pH 6.7 with hydrated lime. Fungicides used in the study were applied as a drench following planting, or incorporated into the growing medium prior to planting at use rates suggested by the manufacturer (Table 2). The volume of application used for drench treatments was 709 ml (1.5 pints)/sq ft. Following planting and application of chemical treatments, the cuttings

received watering and fertilizer with solutions containing Peters 20-19-18 (20N-8.2P-14.9K) three times per week. After 44 days, 10 cuttings from each treatment were washed in running water to remove growing medium from the root system. Percentage rooting of the cuttings and visual assessments of root development using a root index are reported.

Table 2. Chemical products, use rate, and method of application for rooting studies with *Peperomia caperata* 'Blackie'

Chemical formulation	Rate of applicaton (oz/100 gal)*	Method of application**
Truban 5G	10 oz/yd^3	Medium Incorporation
Truban 30W	8 oz	Soil drench
Truban 25E	8 oz	Soil drench
Banrot 40W	12 oz	Soil drench
Subdue 5W	2.5 oz	Soil drench
Agrimycin 21W	16 oz	Soil drench
Lesan 70W	8 oz	Soil drench
Benlate 50W	8 oz	Soil drench
Terraclor 75W	4 oz	Soil drench
Captan 50W	24 oz	Soil drench

* Chemical combinations were used at rates indicated for each.
** Chemical drench applications were applied after planting at a volume of 1.5 pints/ft^2 of propagation medium.

RESULTS

Experiment I — Boxwood Propagation Efficiency

General comments: Lesan 70W, used as a preplant cutting soak, was the only treatment tested that inhibited rooting as compared with the untreated control (Table 3). In all parameters evaluated, cuttings treated with Lesan 70W drench developed better roots than did cuttings treated with similar rates of Lesan 70W soak, yet the effects of Lesan drench on rooting (all parameters) could not be separated from control.

Cuttings treated with Terraclor 75W consistently provided roots equal to or greater than nontreated cuttings. Cuttings treated wtih commercial bleach, in both drench and soak applications, rooted equal to control. Applications of Benlate and captan, which in other reports (5, 7) inhibited rooting or ornamental plants of several species, did not inhibit rooting in boxwood, compared with control, as either drench or soak.

Ferbam (ferric dimethyldithiodicarbamate) reportedly stimulated rooting in cuttings of *Hevea brasiliensis* (13) and *Hebe diosmilofia* (8), due possibly to its auxin-like activity, but Manzate 200, also a dithiodicarbamate fungicide, did not enhance rooting of *Buxus* cuttings. No particular class of compounds appeared to be more or less phytotoxic than any other.

Table 3. Rooting under mist of *Buxus microphylla* var. *japonica* treated with fungicides[1].

Treatment	No. roots	Root length (mm)	Percent rooting	Root wt/cutting (g)
Control	13.4 bcdef	18.5 abcd	87 ab	0.16 ab
Truban 30W				
drench	16.1 ab	13.5 cd	93 a	0.14 ab
soak	14.4 bcde	14.0	83 ab	0.19 ab
Truban 5G				
in medium	8.4 efg	14.2 de	76 ab	0.11 ab
Truban 25E				
drench	13.3 bcdef	13.6 cde	87 ab	0.15 ab
soak	9.7	23.4 abc	83 ab	0.16 ab
Lesan 70W				
drench	14.7 abc	16.1 bcd	93 a	0.19 a
soak	7.4 g	1.00 e	57 b	0.08 b
Subdue 2E				
drench	15.5 abc	25.0 ab	97 a	0.20 a
soak	7.8 efg	19.2 bcd	80 ab	0.11 ab
Benlate 50W				
drench	9.2 defg	20.2 bcd	80 ab	0.12 ab
soak	10.4 bcdefg	19.6 abcd	90 ab	0.12 ab
Banrot 40W				
drench	15.1 ab	22.5 ab	100 a	0.20 a
soak	7.2 fg	19.4 abcd	80 ab	0.11 ab
Captan 50W				
drench	10.6 bcdefg	19.8 abcd	90 ab	0.15 ab
soak	10.8 bcdefg	22.5 abc	90 ab	0.17 ab
Manzate 200				
drench	11.8 bcdef	20.4 abc	93 a	0.17 ab
soak	11.3 bcdefg	19.6 bcd	73 ab	0.18 ab
Terraclor 75W				
drench	20.9 a	25.7 a	100 a	0.21 a
soak	10.5 bcdefg	25.7 a	100 a	0.16 ab
Clorox 1:10				
drench	14.5 bcd	15.7 bcd	87 ab	0.14
soak	10.5 bcdefg	22.0 abc	87 ab	0.19 ab

[1] Mean separation within columns by Duncan's multiple range test, 5% level.

Greater numbers of roots developed on cuttings drenched with Lesan, Subdue, Banrot, and Terraclor than appeared on cuttings soaked in those materials. This might be attributable to accumulative effects of multiple applications of the treatment as opposed to single soil applications, except with Terraclor which was drenched only once at the beginning of the experiment (Table 1).

Number of roots: Terraclor 75W drenching enhanced rooting, and Lesan 70W soak had an inhibitory effect, compared with control. None of the other treatments could be separated from control. Lesan 70W, Subdue 42E, Banrot 40W, and Terraclor 75W applied as drench applications resulted in greater

rooting than did these fungicides when applied as soak applications.

Root length: Use of Lesan 70W as a soak resulted in shorter roots than untreated control cuttings and cuttings receiving 18 other treatments, including Lesan 70W drench. None of the other treatments could be separated from control, although greater root lengths occured in cuttings treated with both Terraclor 75W drench and soak than with 10 other fungicide treatments.

Root weight and percent rooting: Treatments did not significantly influence root weight or percent rooting, when compared to the control.

Experiment II — *Peperomia caperata 'Blackie'* Propagation Efficiency

Of 34 chemical sanitation measures used for rooting of *Peperomia* 'Blackie' leaf cuttings, reductions in percent rooting of leaves were observed for 13 treatments tested (Table 4). Rooting percent was equal to untreated leaves (100%) in 21 sanitation treatments used in the study. Percent rooting of treated leaves did not appear to be influenced by the use of singly applied or combinations of chemicals used for treatment; however, Captan 50W, Terraclor 75W, Banrot 40W, and Truban 25E when applied singly resulted in a reduction in rooted leaf cuttings compared to control. Use of Agrimycin© 21W, Lesan 70W, Benlate© 50W, Subdue 5W, Truban 30W, or Truban 5G gave rooting percentages equal to untreated control leaves. Root development of leaf cuttings 44 days after planting appeared to be influenced by both type and number of chemicals used for sanitation during propagation. Only 6 of 24 combination treatments tested resulted in root development indices greater than untreated leaf cuttings while 8 of 10 singularly applied chemical treatments gave a root development rating greater than untreated leaves. Four single chemical treatments including Agrimycin 21W, Lesan 70W, Benlate 50W, and Subdue 5W had root development indices significantly greater than untreated control values. Combination chemical treatments using Subdue 5W + Benlate 50W and Truban 5G + Benlate 50W + Agrimycin 21W also gave significantly greater root development than untreated cuttings.

DISCUSSION

In the present investigation, use of four parameters for measuring rooting activity of boxwood cuttings exposed to 22 chemical treatments gave statistical differences in only one parameter (root number/cutting) for two of the treatments

tested. With the exception of Lesan 70W used as a 10 min soak, where root length and number on boxwood cuttings were significantly reduced, there appears to be no deleterious effect of the chemical treatments tested.

Table 4. Influence of single-application soil fungicide treatments on rooting of *Peperomia caperata* 'Blackie' leaf cuttings*.

Fungicide treatment	Mean percent rooting	Mean root** development (Index 0-5)
Subdue 5W + Benlate 50W	100	4.30 a
Agrimycin 21W	100	4.10 ab
Lesan 70W	100	3.90 abc
Truban 5G + Benlate 50W + Agrimycin 21W	100	3.80 abc
Benlate 50W	100	3.80 abc
Subdue 5W	100	3.60 abcd
Truban 30W + Benlate 50W + Agrimycin 21W	100	3.05 bcde
Truban 30W	100	3.00 bcde
Truban 25E + Benlate 50W	90	2.95 cde
Truban 25E + Benlate 50W + Agrimycin 21W	100	2.83 cde
Banrot 40W	90	2.80 cde
Truban 5G	100	2.60 de
Truban 25E	90	2.55 de
Truban 5G + Benlate 50W	100	2.30 ef
Not Treated, Control	100	2.20 ef
Subdue 5W + Benlate 50W + Agrimycin 21W	100	2.20 f
Truban 25E + Terraclor 75W + Agrimycin 21W	100	1.38 fg
Truban 30W + Benlate 50W	100	1.35 fg
Truban 5G + Terraclor 75W	100	1.35 fg
Subdue 5W + Terraclor 75W	100	1.30 fg
Subdue 5W + Terraclor 75W + Agrimycin 21W	90	1.20 fg
Truban 5G + Terraclor 75W + Agrimycin 21W	100	1.05 g
Lesan 70W + Terraclor 75W	100	1.00 g
Truban 30 + Terraclor 75W + Agrimycin 21W	80	1.00 g
Lesan 70W + Benlate 50W + Agrimycin 21W	90	0.90 g
Terraclor 75W + Captan 50W + Agrimycin 21W	70	0.65 g
Lesan 70W + Benlate 50W	50	0.65 g
Truban 30W + Terraclor 75W	80	0.60 g
Terraclor 75W + Captan 50W	90	0.55 g
Captan 50W	80	0.53 g
Lesan 40W + Terraclor 75W + Agrimycin 21W	100	0.50 g
Benlate 50W + Captan 50W	100	0.50 g
Truban 25E + Benlate 50W + Agrimycin 21W	100	0.45 g
Terraclor 75W	90	0.45 g
Benlate 50W + Captan 50W + Agrimycin 21W	60	0.30 g

* Leaf cuttings were propagated 44 days in a peat:perlite growing medium.
** Root Development Index where 0 = no root development and 5 = maximum root development.

Rooting activity and root development of *Peperomia caperata* 'Blackie' leaf cuttings were significantly influenced by the number and type of chemicals used for sanitation. Poor results obtained wtih once-applied chemical drench treatments such as captan 50W and Terraclor 75W suggest a higher potential

for phytotoxicity on tropical plant species than on woody cuttings such as boxwood. Rooting and root development on peperomia leaves were also reduced by the use of most of the combination drenches used for sanitation during propagation. Only the broad spectrum chemical treatments Subdue 5E + Benlate 50W, and Truban 5G + Benlate 50W + Agrimycin 21W, resulted in greater root development on cuttings and appeared to be well suited for disease protection during propagation of *Peperomia caperata* 'Blackie'.

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