superior trees to the trade by this method, among them the Cleveland Norway maple (*Acer platanoides* 'Cleveland') and the Chanticleer callery pear (*P. calleryana* 'Cleveland Select'). Horace Wester, who was the plant pathologist for the National Capital Parks, spent most of his professional life observing and treating street trees in Washington D.C. He made many selections including *Ulmus americana* 'Washington' and *Aesculus* ×*carnea* 'Fort McNair', a red-flowering horsechestnut with superior foliage retention. Such superior trees, which have been amply tested, under actual street conditions deserve introduction and propagation as named cultivars.

Even if the hypothetical perfect landscape tree were found, it would be a grave mistake to plant it exclusively in all street and park plantings. The advent of a new pest or fungus would play havoc with such a monoculture. For a great many cities the American elm was believed to be the ideal shade tree, and when the Dutch elm disease struck it was an aesthetic and financial catastrophe. This is not to say that the quest for the perfect landscape tree should not be vigorously pursued. Startling improvements in beauty and pest resistance lie ahead for the devoted tree breeder.

# Can I Use Municipal Waste Compost in My Propagation Media?©

**Calvin Chong**

University of Guelph, Department of Plant Agriculture — Vineland, Vineland Station, Ontario, L0R 2E0 Canada

**In unleached media consisting of between 15% and 75% by volume of municipal waste compost mixed with peat or perlite, cuttings from four of nine evergreen taxa were tolerant (rooting enhanced or unaffected) of salt levels up to 0.60 dS·m$^{-1}$ (0.2 dS·m$^{-1}$ desirable threshold). The other five evergreen taxa were intolerant (rooting adversely affected). In corresponding leached media, cuttings from most of seven deciduous taxa rooted as well as or better in the compost-amended media compared with 100% perlite or 100% peat. Best rooting occurred with between 45% and 75% compost in the rooting medium. A tendency for better rooting in compost with perlite than with peat was due largely to lower water and higher air porosities with perlite than with peat.**

## INTRODUCTION

Composts are commonly used in nursery potting mixes, but seldom in rooting mixes, indicated Gouin (1989), who successfully used sewage sludge compost in rooting media. Inconsistent quality, excessive soluble salts, high pH, and inexperience are major deterrents for using composts (de Bertoldi, 1993).

Since the mid-1980s, we have been investigating the use of wastes and composts as soil amendments and in nursery potting mixes (Chong, 1999a), and of selected wastes such as raw paper mill sludge as rooting medium amendments (Chong et al., 1998). Results of two rooting trials (Chong, 1999b; 2000), herein summarized, indicate that municipal waste compost has potential for use in propagation.

## EFFECT OF SALTS

During the winter, cuttings of nine evergreen taxa were rooted in media consisting of 100% sphagnum peat or 100% perlite, or peat or perlite mixed with 15%, 30%, 45%, 60%, or 75% by vol of a municipal leaf and yard waste compost (5-mm sieve size, Metro Toronto Keele Valley Landfill, Vaughan, Ont.). The basal portion of each cutting was quick-dipped in a rooting hormone solution consisting of 10,000 ppm IBA dissolved in commercial automobile windshield washer fluid containing 47.5% methyl alcohol (Chong and Hamersma, 1995). The taxa were: *Buxus* 'Green Gem', *Juniperus virginiana* 'Hetzii', *J.* ×*pfitzeriana* 'Mint Julep', *J.* 'Pfitzeriana Aurea', *J. horizontalis* 'Bar Harbor', *J. horizontalis* 'Blue Chip', *J. sabina* 'Blaue Donau' (syn. 'Blue Danube'), *Taxus* ×*media* 'Densiformis', and *Thuja occidentalis*.

Rooting occurred under greenhouse conditions in hot-water, bottom-heated benches, 16°/10°C day/night air temperature, and >85% relative humidity by fog. We recorded the percentage of cuttings with roots longer 1 mm, root number per rooted cutting, and length of the longest root per cutting. Under these conditions, little water was applied and there was little or no leaching of salts from the rooting media.

Chemical analysis (Table 1) indicated that the compost contained an excess of soluble salts (2.1 $dS \cdot m^{-1}$) due primarily to elevated levels of Cl (1013 mg $liter^{-1}$), K (1220 mg $liter^{-1}$), and Na (130 mg $liter^{-1}$). This soluble salt level was twice the desirable threshold of 1.0 $dS \cdot m^{-1}$ for general nursery use and 10 times the desirable threshold of 0.2 $dS \cdot m^{-1}$ for rooting of nursery cuttings (Chong et al. 1998). The pH of 8.0 was higher than the recommended range of 5.5-7.0. The salt readings increased with compost level and were similar in compost with peat or with perlite (range, 0.05-0.60 $dS \cdot m^{-1}$ with 0% to 75% compost).

With few exceptions, cuttings rooted similarly in compost with peat or with perlite. Depending on taxa, increasing salt levels had various degrees of diminutive, neutral, and enhancing effect on rooting responses. Four taxa (*J. horizontalis* 'Bar Harbor' and 'Blue Chip', *J. sabina* 'Blaue Donau', and *T. occidentalis*) were tolerant of salts (rooting positively influenced or unaffected), at least up to the highest level tested (0.6 $dS \cdot m^{-1}$ with 75% compost). The other five taxa were intolerant (adversely affected).

While there is some information on the relative tolerance of ornamental plants (whole) to salt levels (Skimina, 1980), there is little or no similar definitive information for cuttings *per se* during propagation (Hartmann et al., 1997).

## LEACHED COMPOST

In the summer, current season stem cuttings from seven deciduous taxa were quick-dipped in 5000 ppm IBA, and rooted under outdoor lath and mist in flats filled with similar media described above, but which were leached by watering the flats several times before the cuttings were stuck. The taxa were: coralberry (*Symphoricarpos* ×*chenaultii* 'Hancock'), snowberry (*S. albus*), European cranberry bush (*Viburnum opulus*), lilac [*Syringa pubescens* subsp. *palula* (syn. *S. velutina*)], purple osier (*Salix purpurea* 'Nana'), purple-leaf sandcherry (*Prunus* ×*cistena*), and winged spindle-tree (*Euonymus alatus* 'Compactus').

For each species, the best percent rooting, root number or root length in compost media with perlite or with peat is compared with response in 100% perlite (perlite control) or 100% peat (peat control) (Table 2). There was no significant adverse effect of the compost-amended media on rooting, except for decreases in percent rooting

**Table 1.** Chemical analysis of the municipal compost before mixing.

| Variable | Recommended values | Unmixed compost |
|---|---|---|
| pH[z] | 5.5-7.0 | 8.0 |
| Soluble salts ($dS \cdot m^{-1}$) | 1.0 | 2.1 |
| $NO_3$-N[y] | 100-200 | 8 |
| P | 6-9 | 2 |
| K | 150-200 | 1220 |
| Ca | 200-300 | 177 |
| Mg | 70-200 | 59 |
| Na | 0-50 | 130 |
| Cl | 0-50 | 1013 |
| Fe | 0.3-3.0 | 0.3 |
| Mn | 0.3-3.0 | 0.1 |
| Zn | 0.3-3.0 | 0.1 |
| Cu | 0.3-3.0 | 0.1 |

[z]pH and EC measured in medium : water (1 : 2, v/v) extracts; mean of three samples.
[y]Concentration of all nutrients expressed in terms of ppm; saturated medium extraction (greenhouse) procedure; mean of three samples.

of winged spindle-tree (38% with peat vs 82% in control) and purple-leaf sandcherry (68% with peat vs 88% in control), and in root length of winged spindle-tree (1.2 cm with perlite vs 1.8 cm in control). In fact, the compost often enhanced rooting (beneficial effect), occurring optimally with between 45% and 75% of compost (data not shown). When there were differences due to the presence of peat or perlite, more species rooted better in compost with perlite than in compost with peat (Table 2) due primarily to more favorable air (higher) and water (lower) porosities with perlite than with peat (Table 3).

## EFFECT OF pH

The pH varied substantially more in compost media with peat than with perlite, and changed little or not at all with or without leaching. Except for an adverse effect (abrupt decrease) in the rooting parameters of some taxa due to low pH (4.0 to 4.4) in the 100% peat medium, there were no other perceptible effects on rooting attributable to pH variation in other treatments with peat (5.6 to 8.2 with 15% to 75% compost) or with perlite (7.5 to 8.9 with 0% to 75% compost). Interestingly, the deciduous taxa were more tolerant of the low pH of peat than were the evergreen taxa. Among the nine evergreen taxa, *J. virginiana* 'Hetzii' was unaffected by the low pH, *J. sabina* 'Blaue Donau', only percent rooting was adversely affected; *J.*

**Table 2.** Best rooting responses of cuttings in leached compost amended with perlite or with peat compared with responses in 100% perlite or 100% peat control, respectively.

| Species | | Rooting (%) Control$^z$ | Rooting (%) Compost-amended | No. roots per cutting Control | No. roots per cutting Compost-amended | Root length (cm) Control | Root length (cm) Compost-amended |
|---|---|---|---|---|---|---|---|
| Coralberry | with perlite | 84 | $99^+$ | 18 | $18^n$ | 2.9 | $6.2^+$ |
| | with peat | 84 | $99^+$ | 18 | $18^n$ | 2.9 | $6.2^+$ |
| Snowberry | with perlite | 100 | $100^n$ | 21 | $26^+$ | 1.9 | $4.8^+$ |
| | with peat | 86 | $100^+$ | 8 | $20^+$ | 1.9 | $4.8^+$ |
| Cranberry bush | with perlite | 52 | $73^+$ | 12 | $16^+$ | 1.0 | $1.0^n$ |
| | with peat | 77 | $77^n$ | 12 | $21^+$ | 1.0 | $1.3^+$ |
| Lilac | with perlite | 99 | $99^n$ | 26 | $26^n$ | 3.7 | $4.5^+$ |
| | with peat | 40 | $99^+$ | 9 | $15^+$ | 1.0 | $4.5^+$ |
| Purple osier | with perlite | 100 | $100^n$ | 30 | $30^n$ | 8.2 | $11.0^+$ |
| | with peat | 92 | $100^+$ | 13 | $30^+$ | 8.2 | $11.0^+$ |
| Purple-leaf sandcherry | with perlite | 88 | $88^n$ | 14 | $14^n$ | 3.2 | $3.2^n$ |
| | with peat | 88 | $68^-$ | 14 | $14^n$ | 3.2 | $3.2^n$ |
| Winged spindle-tree | with perlite | 82 | $82^n$ | 29 | $29^n$ | 1.8 | $1.2^-$ |
| | with peat | 82 | $38^-$ | 13 | $13^n$ | 0.7 | $0.7^n$ |

$^z$ Control with no compost, i.e 100% perlite or 100% peat.
$^{+,n,-}$ Indicates positive, neutral or negative effects, respectively, of compost-amended compost with control medium.

**Table 3.** Physical properties[z] of perlite- and peat-amended municipal compost rooting media.

| | Bulk density | Pore space (%) | |
|---|---|---|---|
| Compost | (g $cm^{-3}$) | Air | Water |
| With perlite | 0.14-0.44 | 16-26 | 36-50 |
| With peat | 0.09-0.39 | 12-15 | 60-60 |

[z]Data represent range in values over level of compost from 0 (100% perlite or 100% peat) to 60% by vol.

*horizontalis* 'Bar Harbor', both percent rooting and root length were adversely affected; the other six taxa, all rooting parameters were adversely affected. Only three of the seven deciduous taxa were negatively affected: coralberry and purple osier, root number only; and lilac, all rooting parameters. Hitchcock (1928) and Paul and Smith (1966) reported low-pH root inhibition in peat and peat-based mixes.

## CONCLUSION AND RECOMMENDATION

The results, although limited in scope, should assist nursery propagators to make more favorable and better use of municipal waste compost as an alternative rooting medium amendment. While volumes of up to 75% were found to be satisfactory in physical properties such as air pore space and water retention, generally better with perlite than with peat, relatively low salt levels above 0.2 $dS \cdot m^{-1}$ can be damaging to cuttings. In these studies, I tested levels of compost that were very high or excessive to account for the "worst case" scenarios. In current nursery practices, composts are typically used in amounts less than one-third, thereby mitigating potential risks from salts.

Since different sources of municipal compost, or even batches from the same source, may differ, we recommend that you check the salts reading of the compost and/or prepared medium before use. If the reading is higher than 0.2$dS \cdot m^{-1}$ (1 medium : 2 water by volume extract), leach it and use only when the reading is below or very close to this value, or if you have prior knowledge that cuttings are tolerant of higher salt level. Salts leach very quickly from propagating medium in shallow flats or plugs. Often, just leaving the media in flats under mist for a day or two will result in leaching sufficient to lower salts to acceptable levels.

**Acknowledgments**. This project was conducted with the cooperation of Caesar J. Corvinelli, Engineer, Solid Waste Management Division, Metropolitan Works Department, The Municipality of Metropolitan Toronto, Ontario. Unrooted plant material was donated by Willowbrook Nursery, Fenwick, Ontario. Technical assistance was provided by Bob Hamersma, Linda Oulevey, and Sarah Wheeler.

## LITERATURE CITED

**Chong, C.** 1999a. Experiences with the utilization of wastes in nursery potting mixes and as field soil amendments. Can. J. Plant Sci. 79:139-148.

**Chong, C.** 1999b. Rooting of deciduous woody stem cuttings in peat- and perlite-amended MSW compost media. Compost Sci. Util. 7:6-14.

**Chong, C.** 2000. Relationship of soluble salts concentration in MSW compost media and rooting of evergreen cuttings. Compost Sci. Util. 8:29-35.

**Chong, C.** and **B. Hamersma.** 1995. Inexpensive IBA root-promoting solutions. Comb. Proc. Intl. Plant Prop. Soc. 45:483-587.

**Chong, C., B. Hamersma,** and **K.L. Bellamy.** 1998. Comparative rooting of deciduous landscape shrub cuttings in media amended with paper mill biosolids from four different sources. Can. J. Plant Sci. 78:519-526.

**de Bertoldi, D.** 1993. MSW composting challenges in Europe. Biocycle 34(10):75-76.

**Gouin, F.R.** 1989. Composted sewage sludge: An aid in propagation. Comb. Proc. Intl. Plant Prop. Soc. 39:489-493.

**Hartmann, H.T., D.E. Kester, F.T. Davies,** and **R.L. Geneve.** 1997. Plant propagation principles and practices. 6th ed. Prentice-Hall, Englewood Cliffs, New Jersey.

**Hitchcock, A.E.** 1928. Effect of peat moss and sand on rooting response of cuttings. Bot. Gaz., 86:121-148.

**Paul, J.L.** and **L.V. Smith.** 1966. Rooting of chrysanthemum cuttings in peat as influenced by calcium. Proc. Amer. Soc. Hort. Sci. 89:626-630.

**Skimina, C.A.** 1980. Salt tolerance of ornamentals. Comb. Proc. Intl. Plant Prop. Soc. 30:113-118.

# Tissue Proliferation on Rhododendron: A Current Perspective©

**Mark H. Brand**

Department of Plant Science, U-4067, University of Connecticut, 1376 Storrs Rd., Storrs, Connecticut 06269-4067 U.S.A

## INTRODUCTION

Tissue proliferation (TP) was first found in the mid-1980s and became a significant topic for propagators and growers by the early 1990s. The disorder is characterized by the development of callus-like tissue, often accompanied by adventitious buds and/or shoots, typically produced at the crown of rhododendron plants. TP has been observed on large-leaf and small-leaf rhododendrons, azaleas, and *Kalmia latifolia*. The superficial similarity in appearance of the gall-like growths or tumors of TP to crown gall caused considerable concern and problems for growers and nursery inspectors.

No evidence has been generated demonstrating that TP is caused by *Agrobacterium tumefaciens* or any other pathogenic organism. Today, it is generally believed that TP is not crown gall of rhododendron. The occurrence of TP mostly on micropropagated plants, or those with a history of tissue culture, has focused attention on the tissue culture process as a trigger for the development of TP in rhododendrons. As a result, TP has made many growers unwilling to grow micropropagated rhododendrons due to a fear of TP development.

## OBJECTIVES

Our research has focused on answering two grower questions: (1) Can TP symptoms be transferred to new plants via stem cutting propagation? and (2) can tissue culture trigger development of TP? Moreover, can high-quality rhododendron plants be micropropagated that won't develop TP?