A New and Inexpensive Rooting Medium Amendment: Paper Mill Biosolids

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Paper mill waste (biosolids) was used as an alternative rooting medium amendment in various investigations. With few exceptions, cuttings from a wide assortment of deciduous shrub taxa rooted good to excellent in media consisting of perlite mixed with up to 60% by volume of biosolids in outdoor summer trials under mist. Despite differences in manufacturing processes and end-uses of four sources of biosolids, or in the rooting variability of woody taxa, there was no clear indication that any one of the sources was consistently or substantially better as a rooting medium amendment. Results from parallel winter trials with evergreen cuttings in fog-humidified greenhouses with bottom heat were contrastingly poor due to hardening and shrinking of the biosolids-amended media under these circumstances.

INTRODUCTION

Pulp and paper mills in Canada discard about 10% of the 10 million tonnes of paper mill biosolids generated across North America. Like other industrial wastes, the disposal of paper mill waste is a major concern. Landfilling has been banned or has become prohibitively expensive. Environmentally friendly and sustainable disposal alternatives are needed.

Paper mill biosolids have been used as soil amendment in land reclamation, forestry, and agriculture since the 1950s (Aitkin et al., 1995; Brockway, 1983; NCASI, 1959), and in potting mixes for growing container nursery crops since the 1980s (Bellamy et al., 1995; Chong and Cline, 1994; Tripepi et al., 1996). We have reported an alternate use of paper mill biosolids in rooting medium (Chong and Hamersma, 1996; Chong et al., 1998). This research is herein summarized.

EARLY TRIALS

In two trials conducted during the early 1990s, we attempted to root evergreen shrub cuttings in fog-humidified greenhouses with bottom heat. The media consisted of one source (QUNO, Table 1) of paper mill biosolids (0% to 100% by volume) mixed with peat, bark, or perlite. Few of a wide assortment of taxa rooted fair to acceptable but only in media with ≤30% of the biosolids. With higher proportions, rooting declined rapidly due to increasing hardening and shrinking of the amended media. This condition was apparently induced by the bottom heat and seemed to have restricted water penetration and/or air exchanges in the media.

In a third investigation conducted during summer outdoor under lath (50% shade) and mist, the amended rooting media remained friable and normal in appearance. Six of seven deciduous shrub taxa rooted good to excellent in media with perlite and paper mill biosolids up to 60%, the highest proportion used in this investigation.

DIFFERENT SOURCES

Since sources of biosolids differ in physical and chemical characteristics (Bellamy et al., 1995) and may elicit different rooting responses, a fourth trial under similar outdoor conditions compared rooting with four different sources of biosolids.

Despite differences in characteristics of the four sources due to different manufacturing processes and/or end-uses (Table 1), or to the wide variability in rooting response among six woody taxa, the overall results of the study were remarkably consistent. With few exceptions, there was little or no adverse effect of the four biosolids on rooting when present at levels ≤45%. In fact, as exemplified by data for two of the six species (Fig. 1), some yielded higher rooting percentage, root number, and/or root length with 60% of biosolids. Furthermore, there was no clear indication that any one of the sources was consistently or substantially better as a rooting medium amendment.

Table 1. Source and compositional properties of selected paper mill biosolids.

Atlantic (A)

- 100% recycled deinked newsprint and tissue.
- Combined primary and secondary biosolids; 40% to 60% organic solids (dry wt); ca. 1:1 organic to inorganic solids content.
- Major solid components include: fine cellulosic fibre, calcium carbonate, magnesium silicate (talc), clay (kaolin), ink solids, microbial biomass, and miscellaneous inorganic solids.

Domtar (D)

- Bleached kraft pulp and recycled fibre from old corrugated cartons.
- Combined primary and secondary biosolids; 1.2 : 1 dry wt ratio; 70% to 80% organic solids.
- Major solid components include: cellulosic fibre, calcium carbonate, microbial biomass, and miscellaneous inorganic solids.

QUNO (Q)

- 25% thermomechanical, soft-wood pulp and 75% deinked newsprint and magazines.
- Combined primary and secondary biosolids, 9 : 1 dry wt ratio; 70% organic solids.
- Major solid components include: fine cellulosic fibre, carbonate, talc, and clay (kaolin) filler/coating materials, ink solids, microbial biomass, and miscellaneous inorganic solids.

Thorold (T)

- 100% virgin, market pulp.
  Primary biosolids; 40% to 60% organic matter; ca., 1 : 1 organic matter to inorganic matter content.
- Major solids components include: cellulosic fibres and clay (kaolin) fillers and coatings.

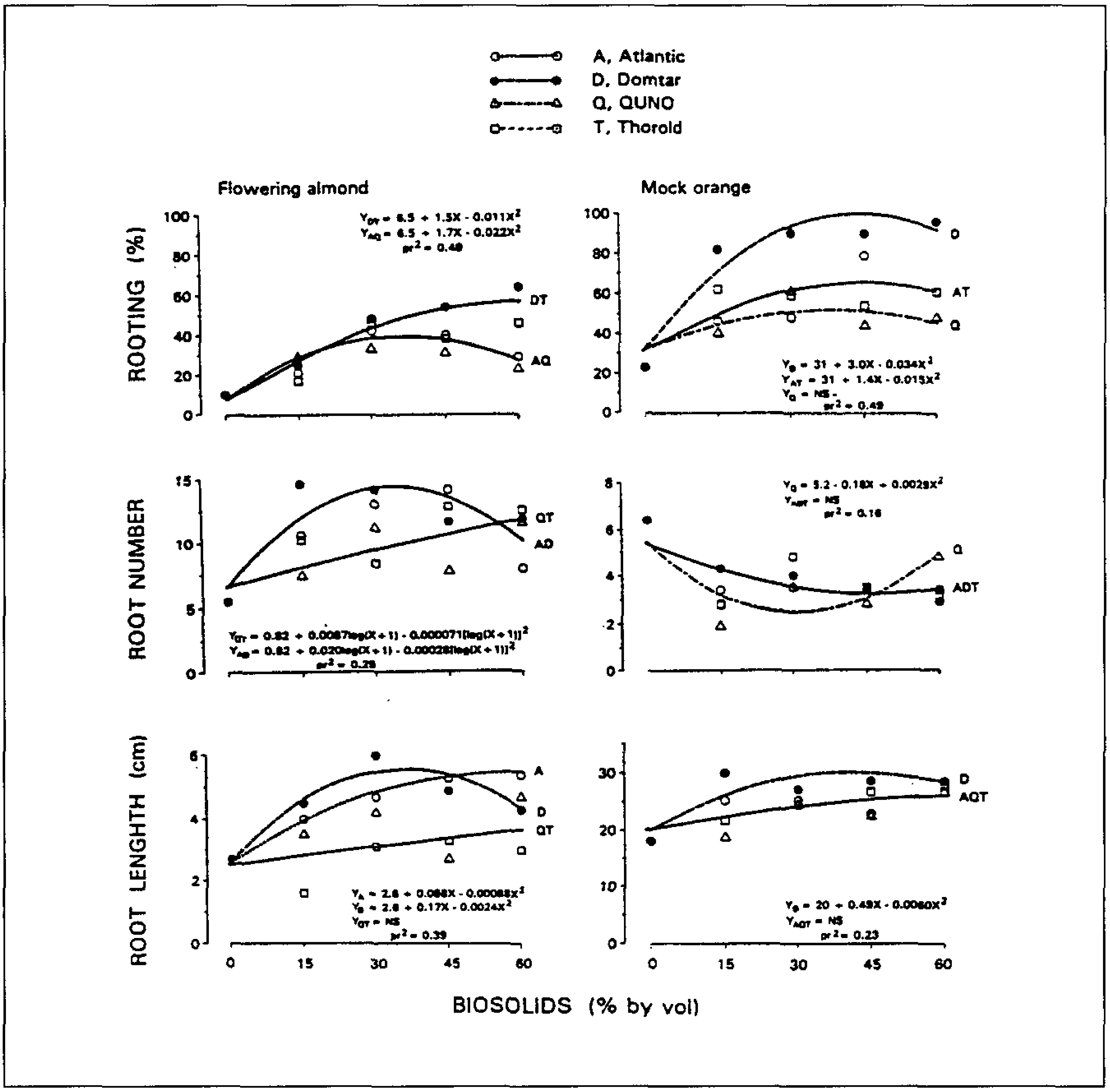

Fig. 1. Percent rooting, root number, and root length of two deciduous landscape shrubs in response to source and level of paper mill biosolids. The regression for each source is represented (broken lines) by Y_A (Atlantic), Y_D (Domtar), Y_Q (QUNO), and Y_T (Thorold). When any two (i.e., Y_{AD}) or more (i.e. Y_{ADT}) regressions were not significantly different at P<0.05, a common regression (solid line) was fitted. NS indicates that the slope, curvature, or both, were nonsignificant at P<0.05. pr^2 represents the coefficient of determination after removing replication effects.

Except for an excess of Cl^- concentration (136 ppm) with source D, all nutrients in the unamended biosolids were low and the values of EC (a measure of total soluble salts concentration) ranged from 0.2 to 0.7 dS m^{-1} (Table 2). However, the EC in all amended media measured 0.1 dS m^{-1} at the start of the experiment (just after preparation and initial watering in the flats), and ≤0.2 dS m^{-1} (the desirable threshold for rooting of cuttings, Chong et al., 1998) at the end, except for those with the Domtar biosolids (0.3 dS m^{-1}, all levels). The pH values of the amended media tended to be similar to those measured in the unamended biosolids (Table 2), changed little or not at all during the rooting period, and had no apparent effect on rooting.

Table 2. Chemical analysis of perlite and four paper mill biosolids before mixing.

Variable	Recommended values[z]	Perlite	Source of biosolids[y] A	D	Q	T
pH[x]	5.5-7.0	7.6	7.8	6.9	7.8	7.3
EC (dS m^{-1})	<1.0	<0.1	0.3	0.7	0.2	0.3
NO_3-N[v]	100-200	0.6	52	19	83	5
P	6-9	0.1	1	23	2	1
K	150-200	0.8	2	71	2	1
Ca	200-300	0.3	50	151	66	33
Mg	70-200	0.1	10	27	17	10
Cl	0-50	2.0	27	136	25	19
Fe	0.3-3.0	0.5	0.6	1.2	0.9	0.0
Mn	0.3-3.0	0.0	0.1	1.3	0.1	0.1
Zn	0.3-3.0	0.0	0.4	0.1	0.03	0.6
Cu	0.3-3.0	0.0	0.0	0.03	0.13	0.0

[z] According to recommendations for container growing media (OMAFRA, 1994).
[y] A, Atlantic; D, Domtar; Q, QUNO; and T, Thorold; see Table 1 for description.
[x] pH and EC (electrical conductivity) measured in 1 medium: 2 water (v/v) extracts; mean of three samples.
[v] Concentration of all nutrients expressed in terms of mg $liter^{-1}$; saturated medium extraction (greenhouse) procedure, mean of three samples.

While the bulk densities of the unamended biosolids were 1.3 to 1.8 times higher than that of perlite (0.12 g cm^{-3}), the porosity characteristics exceeded slightly (1.1-1.3 times), or were similar to those of perlite (total pore space, 56%; air pore space, 32%; water pore space, 24%).

CONCLUSIONS

These investigations demonstrated that paper mill biosolids in amounts ranging from 30% to 60% by volume can be used effectively as rooting medium amendment for propagating cuttings under mist. The four biosolids tested showed little adverse effects on rooting. The electrical conductivities of the biosolids-amended media were acceptable (0.1 to 0.3 dS m^{-1}) for rooting of woody cuttings and pore space characteristics were comparable to, or exceeded those of, perlite. As an organic waste product which may be obtained, where available, at little or no cost, raw paper mill biosolids could be more widely used in nursery propagation as an inexpensive rooting medium amendment.

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