Container Nursery Plant Culture in Waxed Corrugated Cardboard Media

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Media containing 25% or 50% by volume of uncomposted waxed corrugated cardboard mixed with 25% or 50% of spent mushroom compost and(or) sawdust were evaluated for container culture of four woody shrubs. The shrubs used were: dogwood (*Cornus stolonifera* 'Flaviramea'); forsythia (*Forsythia* x *intermedia* 'Lynwood'); ninebark (*Physocarpus opulifolius*); and weigela (*Weigela florida* 'Aureovariegata'). There were two fertilizer regimes: liquid (20-20-20); slow-release (Sierra 17-6-12 plus minors, 3-4 month release time). Shoot growth data showed that all four shrubs supplied with liquid fertilizer grew better than those with slow-release fertilizer. Among the media tested, certain waxed cardboard blends supported growth of dogwood, forsythia, and ninebark equal to a bark control medium and a commercial nursery mix.

INTRODUCTION

With many urban landfill sites approaching capacity and with scarcity of new sites, it is becoming more difficult to dispose of organic and industrial wastes (Davie, 1993). Landfills are now more selective of the wastes they will accept, while at the same time increasing their tipping fees. In Ontario, a tipping fee of over $100 per tonne is not uncommon. In Toronto the fee is even higher.

The Ornamental Nursery Research Programme at Vineland has been evaluating the use of organic waste by-products as growing media or as substitutes for traditional organic products such as peat and bark. At the 1991 International Plant Propagator's Society Eastern Region meeting, I described the successful recycling and reutilization of spent mushroom compost, papermill sludge, and composted municipal waste as amendments in container culture of several nursery crops (Chong et al., 1991a). My presentation generated significant interest from members attending the meeting, and from others that contacted me later.

Ontario discards annually about 70,000, 350,000, and 500,000 tonnes of waxed corrugated, non-waxed corrugated, and non-corrugated (post-consumer) cardboard, respectively (Anonymous, 1992; Ciepiela, E.J., personal communication). In addition, other cardboard products are brought in via shipping, but tonnage is unknown. As an introduction to the recycling of cardboard, this investigation was conducted to determine the suitability of uncomposted, waxed, corrugated cardboard wastes as amendment in container culture of selected nursery crops.

MATERIALS AND METHODS

In early June 1992, plug-rooted cuttings of dogwood (*Cornus stolonifera* 'Flaviramea'), forsythia (*Forsythia* × *intermedia* 'Lynwood'), ninebark (*Physocarpus opulifolius*), and weigela (*Weigela florida* 'Aureovariegata') were planted in #2 (6 liter) nursery containers filled with eight experimental media (Table 1). The media were:

1) Composted pine bark (control)

2) 16 bark : 3 peat : 1 soil (by volume) (a commonly used nursery mix)

3) 1 spent mushroom compost : 1 sawdust (v/v)

4 to 6) 50% uncomposted waxed corrugated cardboard plus sawdust and(or) spent mushroom compost

7 and 8) 25% cardboard plus sawdust and spent mushroom compost. Before blending with other ingredients, the cardboard was shredded through a hammermill producing pieces that were generally 10 cm x 4 cm.

Containers were arranged by species in separate split-plot designs: main plot, 8 media x 5 replications; subplot, 2 fertilizer treatments, i.e., liquid (200 ppm N) supplied as 20-20-20 with micronutrients 3 times weekly through drip irrigation, and slow-release (6 kg/m^3 Sierra 17-6-12 plus minors, 3-4 month release) incorporated before potting. Each subplot treatment consisted of four plants. Plants received 1 litre of water/container/day during the growing season. All media were sampled at planting and analyzed for selected macro- and micro-nutrients (duplicate samples) and physical (triplicate samples, air dry weight basis) properties (Table 1). Mid-August leaf samples were analyzed for N, P, K, Ca, Mg, Fe, Mn, and Zn. Top dry weight of all plants was determined in late September (Table 1).

RESULTS AND DISCUSSION

Compared to medium #1, all other media had pH of 7.0 or above at planting (Table 1). The 1 cardboard : 1 spent mushroom compost : 2 sawdust (by volume) (medium #7) and all cardboard-based media with 50% spent mushroom compost (media #3, 5, 8) had salt levels that were substantially higher than the 3.5 dS/m optimum threshold value and were due primarily to the presence of K, Ca, SO_4, Cl, and to a lesser degree, NO_3 in media #3 and 8 (Table 1).

Notwithstanding the above results, there was no apparent abnormal or detrimental symptoms observed on plants that could be attributed to initially high salts in the media. Unlike weigela which had lower top dry weight in all media compared with the 100% bark control medium #1, dogwood, forsythia, and ninebark grew equally well in control medium #1, nursery medium #2, and all the cardboard media, except the 1 waste cardboard : 1 sawdust (v/v) medium #4 (Table 1). Previous studies indicated that high or potentially toxic initial salt levels are quickly leached to low levels under these cultural conditions (Chong et al., 1991b). Similarly, media with initial pH up to 8.2 showed no negative effect on plant growth. Medium #4 consistently yielded the poorest growth in all species and was the medium with the highest (40%) aeration porosity (pores filled with air) and, conversely with the lowest (23%) moisture retention capacity (pores filled with water) (Table 1). All other cardboard media had aeration porosities (17% to 32%) and moisture retention (34% to 40%) in more acceptable ranges (OMAF, 1992).

Except for weigela, all species grew significantly better with liquid than with slow-release-fertilizer (data not presented) and, the leaves of slow-released fertilized plants tended to be slightly yellow. Chemical analysis revealed significantly lower contents of N, P, K, and Mn in leaves of all four species grown with slow-release fertilizer (data not presented). The unusually cool temperatures which prevailed during the summer of 1992 apparently resulted in inadequate nutrient release, which is temperature dependent.

Table 1. Chemical and physical properties of waxed cardboard and other media at planting and end-of-season top dry weight of four nursery crops grown in these media.

	Medium (by volume)							
	1 (Control)	2	3	4	5	6	7	8
Ingredient								
Bark	1	8						
Cardboard				1	1	2	1	1
Peat		1.5						
Sawdust			1	1		1	2	1
SMC[z]			1		1	1	1	2
Soil		.5						
Chemical Properties								
pH	5.2	7.0	7.7	7.6	7.7	7.8	7.8	7.5
Soluble salts(dS/m)[y]	0.6	3.0	7.2	3.7	7.0	3.4	5.9	9.3
NO_3[x]	3	3	122	8	9	2	5	96
P	14	2	2	2	1	2	2	3
K	138	587	1585	762	1638	817	1410	2058
Ca	15	206	401	207	348	221	283	455
Mg	12	65	172	80	159	84	118	216
SO_4	20	300	800	800	800	550	800	800
Na	18	109	272	213	277	155	252	391
Cl	27	428	784	384	786	380	837	1204
Fe	0.2	<0.1	0.5	0.3	0.4	0.2	0.5	0.1
Mn	1.9	0.5	<0.1	<0.1	<0.1	0	0.1	0
Zn	<0.1	0.6	0	0.8	0	<0.1	<0.1	0
B	0.2	0.1	0.4	0.4	0.6	0.3	0.7	0.4
Physical Properties								
Bulk density(g/liter)	330	239	497	216	352	372	287	352
Total porosity (%)	60	55	63	63	62	64	66	63
Aeration porosity (%)	14	22	17	40	22	23	32	22
Moisture retention(%)	46	33	46	23	40	41	34	40
Top dry wt (g/plant)								
Dogwood	99	107	89	52*	98	70*	98	75*
Forsythia	92	101	100	55*	109	91	99	91
Ninebark	101	106	105	56*	112	98	110	92
Weigela	30	20*	20*	15*	18*	17*	23*	18*

[z] SMC = spent mushroom compost.
[y] Low 0-0.75; acceptable 0.76-2.0; optimum 2.1-3.5; high 3.6-5.0; very high 5+, saturated paste procedure.
* Significantly different at $\underline{P} = 0.05$ from the 100% bark control (medium #1) according to LSD test within row (species).
[x] All macro- and micro-nutrients are expressed in ppm.

CONCLUSIONS

In this study, the cardboard was not composted before mixing with other medium ingredients. Also, the cardboard pieces were relatively large due to lack of availability of smaller-sized material. Despite this "worst-case scenario", the results showed that certain blends of waxed corrugated cardboard media supported growth of three of the nursery species equal to the control and(or) the nursery mix.

There were high levels of certain nutrients in some of the media at the start of the experiment, but no visual symptoms of nutrient toxicity was observed in any of the plants during the growing season. Analysis further confirmed no abnormally high buildup of any elements in the leaves.

While this experiment was in progress, it was brought to my attention that Cu and B may be present in high quantities in waxed corrugated cardboard (Anonymous, 1992; Davie, 1993; Ciepiela, E.J., personal communication). Analysis of selected leaf samples from all media indicated low (3 to 6 ppm) and average (36 to 48 ppm) contents of copper and boron, respectively. There was only a very low level of boron in the cardboard media (0.1 to 0.7 ppm) (Table 1). Copper was not analyzed in the media.

Presently, studies have been initiated to investigate the composting of various blends of waxed cardboard media using smaller-sized material. The comparative response of nursery crops grown in these composts will be evaluated.

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