Use of Waste and Compost in Propagation: Challenges and Constraints©

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INTRODUCTION

Organic wastes and composts have been gaining support for use as amendments in potting substrates (Chong, 1999a; Shiralipour et al., 1994; Warman and Taylor, 2000), but there has been little or no examination of these materials for use in propagation. This presentation compares the characteristics of selected wastes and composts and highlights the challenges and constraints in relationship to their potential for use in propagation.

HISTORICAL

The literature indicates some use of organic waste and compost in propagation: bark compost (Wisniewska-Grzeszkiewicz and Marcinkowski, 1976); sewage sludge compost (Atzmon et al., 1997; Gouin, 1989); peanut hull/sewage biosolids compost (Smith, 2002); raw paper mill sludge (Chong, 1998; Chong et al., 1998); and municipal waste compost (Chong, 2001). Major deterrents for use of these components in propagation include: inconsistent quality; potential phytotoxicity due to high salt levels or unsatisfactory pH; differences in species response; inexperience; and lack of scientific information. Furthermore, a proven by-product or compost may not always be more economical than traditional "tried-and-true" components such as sand, perlite, or peat, or may not be available within an affordable trucking distance.

Sand, perlite, and peat differ widely in physical properties and are commonly used to improve aeration, porosity, and water retention characteristics of rooting media. These components contain little nutrients or soluble salts (Table 1) and are renowned for their predictability and consistency when used in propagation. They are ideal rooting medium components. Sand (despite its high bulk density) and perlite (despite its higher cost) are often used alone as the rooting medium.

BIOLOGICAL PROPERTIES

Kostenberg (1995) reported the presence of IAA and IBA in anaerobically digested instant coffee waste. Atzmon et al. (1997) attributed enhanced rooting and shoot development of *Bougainvillea* cuttings in sewage sludge compost media (1.0% to 7.5% by volume mixed with peat and perlite) to the possible presence of auxins and cytokinins and/or biocatalysts such as enzymes, vitamins, and antibiotics. Considering that common plant species such as willows, poplars, and maples contain root-promoting substances (Daigneault and Chong, 1985; Kling et al., 1988), composts could conceivably contain these substances. However, the identification and efficacy of these naturally occurring substances in wastes and composts need to be elucidated. Composts are also rich in microflora that may produce antibacterial and antifungal substances. There seems to be no report on compost use in propagation specifically to exploit these biological properties. Demonstrations of disease-suppressing properties during propagation could make the use of drenches or steam sterilization of media obsolete.

PHYSICAL PROPERTIES

Bark and wood by-products are relatively light (about twice the bulk density of peat) while paper mill sludge and composts are three to five times heavier (Table 1). Organic wastes and composts tend to have porosity and aeration characteristics comparable to, or better than, those of peat and, thus, are ideal substitutes for peat in propagating media. In experiments, we have successfully used paper mill sludges and municipal waste composts in volume proportions up to 60% and 75%, respectively, for rooting of some species (Chong, 1999b). For general use, we recommend lower proportions. Results were generally better with perlite than with peat. When present in high proportions, sludges and composts, like peat, tend to make the media "too wet" due to their high water-retention capacities.

We routinely use a paper mill sludge and perlite (1 : 1, v/v) mixture for outdoor rooting under intermittent mist. We do not recommend its use for winter propagation in greenhouses with bottom heat. The sludge loses its friability and integrity under this condition. We also use mixtures of municipal leaf and yard waste compost and perlite (1 : 1 or 1 : 3, v/v). We like these sludge and compost mixtures because their contents of soluble salts are relatively low, the salts leach easily, and the waste products are readily and easily available in our area.

pH

The desirable pH range recommended for many potting and propagating media is 5.5 to 7.0. Except for barks, which are acidic (pH between 3.5 and 6.8), most organic wastes and composts we have encountered have pH above neutrality (Table 1). According to Maynard (2000), medium pH is still one of the least understood of factors that may affect rooting of cuttings. Medium pH may affect auxin uptake.

In perlite or peat media with between 0% and 75% by volume of municipal leaf and yard waste compost, we observed no apparent effect of pH between 5.0 and 8.9 on rooting of common deciduous and evergreen shrubs. However, rooting of some species was suppressed by 100% peat attributed primarily to its very low pH (4.0) (Chong, 1999b; 2000). This evidence suggests that many common shrub species are amphitolerant, i.e., tolerance to a wide range of pH (Maynard, 2000), and that variation in pH may not be a critical deterrent for using wastes and composts in propagation. Note that sand and perlite (pH 7.8 and 7.6, respectively, Table 1) are each often used as the sole rooting medium components. Peat (pH 4.0) is typically used in mixtures.

SALTS AND NUTRIENTS

Soluble Salts Are the Dissolved Inorganic Ions in Aqueous Solution. Their concentration is measured indirectly in terms of electrical conductivity (EC) and provides a measure of the nutrient or fertility status of a substrate.

Cuttings Are Sensitive to Salts. Our experience indicates no observable negative effect on rooting of a wide variety of cuttings under intermittent mist in media with salt level ≤ 0.2 dS · m^{-1}, as measured in substrate and water (1 : 2, v/v) extracts. This threshold is at least five times lower than that which we consider ideal for use in container growing media (1.0 dS · m^{-1}), although our experience indicates that components with higher salt values can be used successfully.

Salts leach very quickly from propagating medium especially in shallow flats or plugs. Often, one or several sprinklings of water, or just leaving the media in flats under mist for 1 or 2 days will result in leaching sufficient to lower salts to acceptable levels. While this practice may render waste-derived substrates usable for propagation, it will require extra labour, time, and expense for leaching and for monitoring the salt levels. For some propagators, this practice may be impractical, too much of a bother, or may not be worth the potential risk, and could be perceived as "unfriendly" if the leachates were simply allowed to flow into the ground water environment.

High salt content in wastes and composts is perhaps the single most important criteria that limits the potential for their widespread use in potting and propagating media (Skimina, 1980). The selected waste products and composts shown in Table 1 are arranged primarily according to increasing salt content (left to right) or, conversely, according to decreasing desirability or potential for use in propagation.

High Salt Level (EC ≥2.5 dS · m-1). Many, if not most, waste-derived byproducts and composts contain higher than desirable salt levels. Elevated levels in spent mushroom compost, turkey litter compost, and waste composts are due primarily to excessive amounts of nutrients such as K, Cl, Na, and SO_4 (Table 1). Usually present in small or trace amounts, are NO_3-N and NH_4-N, although there can be substantial amounts of NH_4-N in immature composts. The "typical" municipal solid waste compost (MSW compost), i.e., derived primarily from food and household waste, contains much more salts than municipal leaf and yard waste composts.

High salt materials are not recommended for rooting mixes. Even after allowing such materials or mixtures of these materials to be leached, the salts may leach incompletely or inconsistently, thus posing a high risk of burning the cuttings.

Intermediate Salt Level (EC 1.0-2.5 dS · m^{-1}). Some paper mill sludges and municipal leaf and yard waste composts are in this category. Using proportions less than 30% often by itself mitigates potential harm due to easy leaching of the salts.

Low Salt Level (EC 0.1-1.0 dS · m^{-1}). Finely-ground softwood bark is increasingly being used or considered by some nurseries. Barks, wood chips, hemp chips, and sawdust should fit in this category, although I have not yet tried most of these products in rooting media. Coir, a by-product derived from the husks of coconut is being increasingly used in greenhouse growing substrates as a substitute for peat for production of cut flowers and potted ornamentals. Producers claim that coir drains easier than peat and that with coir there seems to be increased productivity and less disease occurrence. We have obtained excellent rooting results using coir mixed with perlite (unpublished data).

Since different sources of waste or compost, or even batches from the same source, may differ in chemical properties, we recommend that you check the salt reading of the material and/or prepared medium before use. If the reading is higher than 0.2 dS · m^{-1} (1 substrate : 2 water by volume extract), leach it and use it only after the reading is below or very close to this value, or if you have prior knowledge that cuttings are tolerant of higher salt levels (Chong, 2000). We have also observed that some composts and paper mill sludges leach easier than others.

Table 1. Chemical and physical analysis of traditional rooting medium components (columns 2-4), waste by-products (5-10) and composts (11-14).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Variable	Desirable values for container culture	Sand	Perlite	Peat	Bark	Wood chips	Hemp chips	Coir	Sawdust	Paper mill sludge	Leaf and yard waste compost	Household waste compost	Spent mushroom compost	Turkey litter compost
pH[z]	5.5-7.0	7.8	7.6	4.0	6.3	7.9	7.3	5.4	5.8	7.2	8.4	8.4	8.2	8.7
Salts (dS·m-1)[z]	≤1	0.1	<0.1	0.1	0.1	0.3	0.4	1.0	0.1	1.2	1.7	3.0	4.0	4.1
Nutrients														
NH_4-N (ppm)[y]	≤10	0.5	0.02	2	0.02	0.2	2.0	0.3	0.5	37	-	4	15	103
NO_3-N (ppm)	100-200	5	0.02	3	0.02	0.2	50	0.1	0.01	0.02	3	0.02	89	232
P (ppm)	6-9	0.05	0.05	0.3	8	0.1	11	3	0.5	8	1	2	6	27
K (ppm)	150-200	6	0.8	0.6	42	25	420	173	54	89	733	1166	2066	2792
Ca (ppm)	200-300	30	1.3	3	34	40	33	5	9	409	114	165	871	100
Mg (ppm)	70-200	16	0.6	1	12	6	13	3	1	83	48	50	220	153
Na (ppm)	0-50	10	6	5	10	20	2	75	6	387	89	139	511	501
Cl (ppm)	0-50	14	6	7	19	8	-	203	25	136	986	848	1328	1656
SO_4 (ppm)	0-80	10	-	-	3	-	-	-	-	159	-	29	894	316
Fe (ppm)	0.3-3.0	0.5	0.2	0.2	0.5	0.4	1.2	0.4	0.4	1.4	0.2	1.5	1.9	11.4
Mn (ppm)	0.3-3.0	0.05	0.1	0.1	0.6	0.2	0.3	0.1	0.3	1.4	0	0.1	0.9	2
Zn (ppm)	0.3-3.0	0.05	0.1	0.1	0.05	0.2	0.3	0.1	0.2	0.5	0.1	0.1	0.4	6.3
Physical Analysis														
Bulk density (g·cm-3)	0.2-0.75	1.50	0.12	0.11	0.20	0.15	-	0.1	0.23	0.43	0.57	0.55	0.39	0.31
Aeration porosity (%)	15-30	14	32	30	46	41	-	29	18	40	-	32	40	45
Water retention capacity (%)	25-35	13	24	58	32	26	-	56	53	31	-	34	31	28

[z]pH and salts measured in 1 substrate:2 water (vol/vol) extracts.
[y]Concentrations of all nutrients measured in saturated medium extraction (greenhouse) procedure.

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