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THE COMPOST QUALITYAND ITS USED AS A GROWING MEDIA

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ABSTRACT

Compost quality is very important when composted material is used as a growing media. In this study, six different Compost types were collected from Delta Bio-Tec Company, Nile Company and Mahmoud (2003) to determine the physical and chemical characteristics, stability/maturity; and investigate the suitability of the Delta Bio-Tec composts as a growing media for vinca growth. The physical properties of the different Compost types except compost biosolid Compost (BC) were not close to those of an "ideal substrate" for plant growth. The compost (BC) was the highest in N and K contents, and the lowest in P content. The Delta Bio-Tec composts and Nile compost were not stabilized and still phytotoxic to cress seeds. Plant growth, indicated that vinca yields were greater for peat than for composts alone or composts mixed with peat. Plants were died in the compost chicken manure at the ratio of 1:1, 3:1 and 4:0 (compost : peat, v/v). The high salt concentration and low stability/maturity of the all compost types except compost (BC) were a major limitations for compost use in growing media. Application strategies for these composts must be designed to minimize salt and phytotoxic damage to the plants in growing media

INTRODUCTION

Composting is one method to increase the recycling of organic by-products generated in cities and the farm. Composting transforms organic by-products with undesirable properties into a final product, compost, that is a valuable commodity for soil improvement. High-quality composts are suitable for potting mixes, home gardens and amendments for food chain crop growth. High-quality composts are highly mature and stable and have consistent chemical and physical characteristics (Sikora and Sullivan, 2000). Compost stability and maturity are important factors affecting the successful application of compost for agricultural purposes (Inbar *et al.*, 1990 and Mathur *et al.*, 1993). Compost stability and maturity are comprehensive properties indicating the degree of organic matter decomposition and potential of phytotoxicity caused by insufficient composting (Wu and Ma, 2001). Application of unstable or immature compost may cause slow plant growth and damage crops by competing for oxygen or causing phytotoxicity to plants due to insufficient biodegradation of organic matter (Keeling *et al.*, 1994 and Hue *et al.*, 1995).

Peat is commonly used as a growing medium in horticulture. Increasing demand and rising costs for peat as potting medium in horticulture have led to search for high-quality, low cost substrates, i.e., organic waste materials such as bark, spent mushroom compost, leaf mould, ... etc. These organic materials have been introduced as an alternative to peat substrate in potting media after proper composting (Cull, 1981; Bik, 1983; Lohr *et al.*,

1984; Chen *et al.*, 1988 and Mahmoud, 2003). The objective of this study is to determine physical and chemical characteristics, stability, maturity of selected different types form compost; and assess the suitability of Delta Bio-Tec composts as a growing media for vinca growth.

MATERIALS AND METHODS

Compost samples were collected from the Delta Bio-Tec Company, Nile Company; and Mahmoud (2003). The composition of feed-stock of different types form compost used in this study are shown in Table (1). Three to five samples were collected from each type of compost, placed in polyethylene bags to Lab. A subsample was air-dried and ground to pass through a 2-mm screen for chemical analyses.

Table 1. Production and feed stocks of different types form compost used in this study.

Compost	Production	Feed stock
VW	Delta Bio-Tec Company	Vegetable wastes
CW	Delta Bio-Tec Company	Cow wastes
CHW	Delta Bio-Tec Company	Chicken wastes
OSW	Delta Bio-Tec Company	Ostrich wastes
BC	Mahmoud	Biosolids + crop residue
CR	Nile Company	Crop residues

Chemical and Physical Analyses

Ash content of air-dried samples was determined by heating (at 480°C for 8 h) in a muffle oven (NEYM-525). Organic matter was estimated by loss upon ignition at 480°C for 8 h (50% from O.M was considered organic C) (AFNOR, 1991). Dried and ground samples were wet digested with concentrated HNO_3+$HClO_4$ (Jones and Case, 1990). Total heavy metals, Ca^{++} and Mg^{++}, were determined using atomic absorption (Perkin Elmer AA model 2380) and total phosphorus was measured colorimetrically using spectrophotometer. Total nitrogen was determined by using Kjeldahl method (Stevenson, 1982). Electrical conductivity and pH values were determined in a compost-water extract solution (1:10, v/v) using CMD 830 conductivity meter and pH Controller model 5997, respectively. Bulk density, particle density, total porosity, container capacity, and air space were determined for selected composts by methods of Inbar *et al.*(1986).

Carbon Dioxide Evolution

Microbial respiration of compost sample, based on CO_2 evolution, was measured using a modified procedure of Iannotti *et al.*(1994). Approximately 5 g of screened sample with moisture content adjusted to 60% was sealed in a 0.5 L vessel along with a beaker containing a known volume of 1M NaOH solution. The samples were incubated at room temperature (22±3°C). Excess NaOH was titrated with 0.5M HCl through precipitation with barium chloride as barium carbonate.

Seed Germination Test:

Germination test on compost samples was measured in triplicate using cress seeds (*Lepidium sativum*). Compost layers of 5 mm thickness from each type were laid in Petri dishes, covered with filter paper, and then soaked to water saturation for the percent germination test as described by Mathur *et al.*(1986).

Compost as growing Media

A greenhouse trial was conducted to evaluate Delta Bio-Tec composts as growing media in Green Oasis nersury: 2.5 km after Abees gate - Khorsheed - Agriculture Road, Alexandria. Vinca (*Catharanthus roseus*) growing in trays (cell size 5x5x3.2 cm deep) for peat substrate and transplanted into (13.5 cm x 12 cm deep) pots using chicken, cow, and vegetable composts with peat at a volume ratio as potting substrate: (compost : peat) of 0:1 (0% compost), 1:3 (25% compost), 1:1 (50% compost), 3:1 (75% compost), 1:0 (100% compost) and arranged in a randomized complete block with 9 replications. All treatments were fertilized and watered equally by PGMix (14+16+18). After 40 days, plants were removed from media and washed, dried at 70°C, and weighted.

RESULTS AND DISCUSSION

Chemical Properties of Compost

The average values of composition and micro-nutrient elements (Fe, Cu, Zn and Mn) are shown in Table (2) for the different types of compost. The composts pH values ranged from 7.3 to 8.35, which are considered suitable for supporting growth of many plant species (Dick and McCoy, 1993). Electrical conductivity (EC) values in water extracts from composts were variable, and are higher than 3 dS/m in the chicken and crop residues composts. Such values could pose problems for seed germination, particularly if used in potting media (He *et al.*, 1995). The C/N ratio was above 15 : 1 of all different types the composts, except the ostrich and chicken composts, that is higher than C/N ratio of 15 which temporary net N immobilization of nitrogen may be induced after soil application (Gilmour, 1998). The compost (BC) was the highest in N and K contents, and the lowest in P content.

Chicken compost contained much higher concentrations of all elements except Fe, 60 mg/kg (Cu), 397 mg/kg (Mn) and 187.5 mg/kg (Zn). This may be due to using this elements in a feed materials for the chickens. On the other hand, the crop residues compost had the lowest contents of these elements. The average values of micro-elements of selected composts was lower than the pollutant concentrations (PC) regulated by USEPA (1993) for sewage sludge. For example, Zn in the present study ranged between(32.5-187.5 mg/kg) was lower than the 2800 mg/kg, and Cu (14-60 mg/kg) was below the 1500 mg/kg.

Table 2: The average values of chemical composition and micro-nutrients for the selected composts.

Parameter	OSW	VW	CW	CHW	CR	BC
pH (1:10)	8.35	7.30	7.80	8.00	7.50	7.40
EC (1:10)	1.91	0.21	2.43	6.00	4.11	0.60
dS/m	1.31	1.01	1.23	1.60	1.44	1.85
N %	0.51	0.49	0.56	1.83	0.63	0.48
P %	0.35	0.15	0.40	1.55	1.50	2.60
K %	8.10	46.30	29.2	13.47	17.30	16.40
C/N	21.26	93.47	71.94	43.11	49.90	61.00
O.M %	78.74	6.53	28.06	56.89	50.10	39.00
Ash %						
Micro-nutrient elements (mg/kg)						
Fe	2837.5	1155.0	2972.5	3115.0	3057.5	3415.0
Mn	145.0	12.5	62.5	397.5	277.5	141.0
Zn	52.5	32.5	35.0	187.5	65.0	107.5
Cu	42.5	50.0	22.5	60.0	40.0	14.0

Physical Properties

The bulk density and particle density of the compost (BC) were much lower than other types of compost (Table 3). The particle density of the ostrich and chicken composts had greater than other composts due to the presence of sand which was used as a bedding material. Total porosity decreased and as a result the bulk density/particle density increased in all compost types. The physical properties of all compost, types except compost (BC), were not close to those of an "ideal substrate" for plant growth and peat as suggested by de Boodt and Verdonck (1972) (Table 3).

Table 3. Physical properties of peat and different types of compost

Composts	Bulk density	Particle density	Total porosity	Container capacity	Air space
	g/cm^3		%		
OSW	0.726	2.305	68.47	33.30	35.20
VW	0.473	1.593	70.30	36.80	33.40
CW	0.647	1.754	63.11	38.20	24.90
CHW	0.646	2.029	68.16	34.50	33.70
BC	0.192	1.841	89.50	74.30	15.20
Peat	0.177	1.563	88.67	73.10	15.60
Ideal substrate*	-	-	85.00	55.75	20.30

* From de Boodt and Verdonck (1972).

Compost Stability and Maturity

Compost stability refers to the degree to which composts have been decomposed to more stable materials. Stability was tested by CO_2 evolution. Compost maturity refers to the phytotoxicity associated with compost. Compost phytotoxicity test was based on the seed germination.

Carbon Dioxide Evolution

The average values of accumulated CO_2 evolution after 6 days of incubation for selected composts are given in Table (4). The accumulated CO_2 evolution values of Delta Bio-Tec composts were higher than Nile and Mahmoud composts. The compost chicken manure was higher than other composts in the accumulated CO_2 evolution . Wu *et al.*(2000) found that the CO_2 evolution was markedly reduced as compost stabilized. The results showed that Delta Bio-Tec composts and Nile compost were higher in microbial activity than Mahmoud compost. Based on CO_2 evolution, all the Delta and Nile composts were not on obvious stabilization process. The much greater differences in values imply that source material and composting time have a great impact on the compost stabilization process.

Table 4. The average accumulated CO_2 evolution after 6 days of incubation and germination rate after 3 days.

Compost	CO_2 evolution* g/kg	Germination rate* %
OSW	38.6 ± 1.6	10 ± 8
VW	35.8 ± 0.8	30 ± 6
CW	78.2 ± 4.2	20 ± 3
CHW	137.0 ± 1.0	0 ± 0
CR	20.6 ± 0.2	40 ± 5
BC	2.5 ± 0.2	100 ± 3

* Mean of three replicates ±S.D.

Seed Germination

The average germination rate for selected composts is presented in Table (4). Mahmoud compost had high germination rate (100%) which corresponded well to their overall low CO_2 evolution and EC (Table 2,4). In contrast, the germination rates for the Delta Bio-Tec and Nile composts were low (10-40%), indicating that the Delta Bio-Tec composts and Nile compost were still phytotoxic to cress seeds despite their high CO_2 evolution and EC valuas.

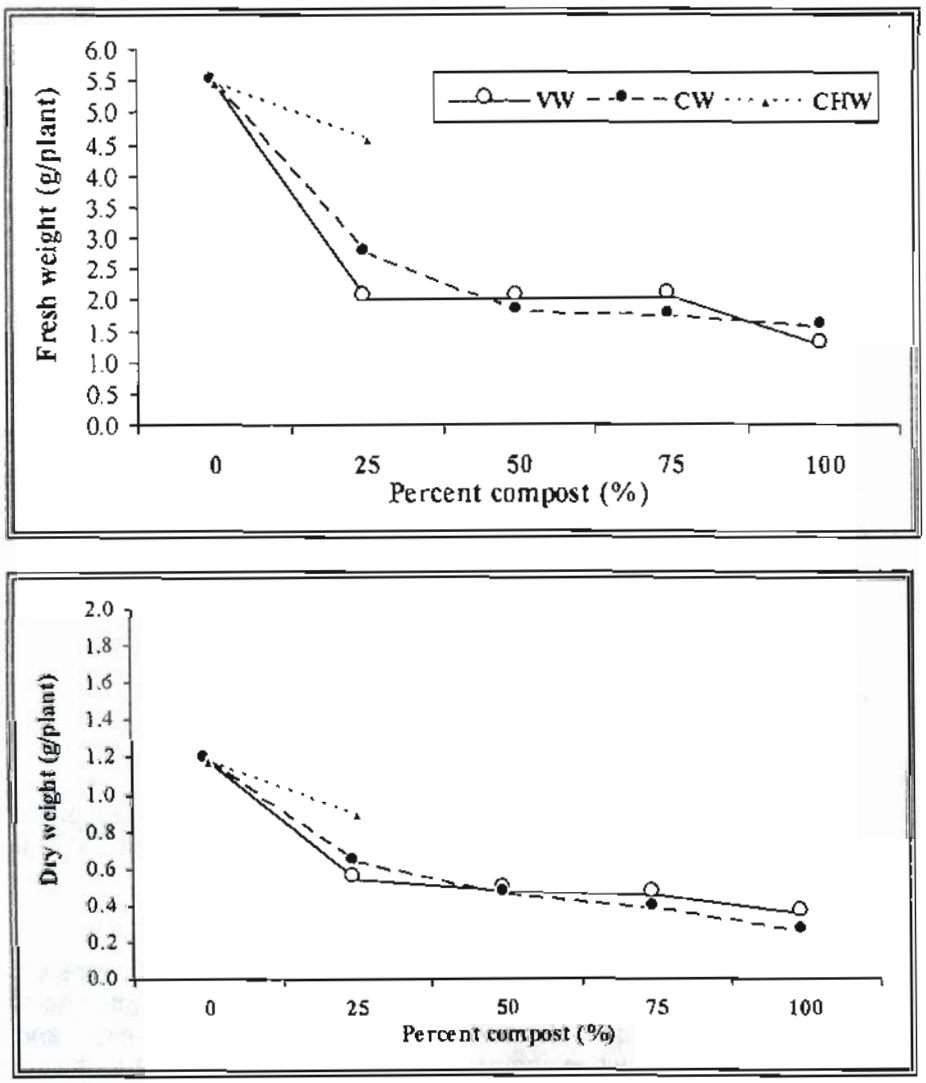
Many of the substances found in immature compost can result in the reduction in the seed germination rate with its magnitude depending on the source of waste material and composting process. For example, a variety of organic compounds, including short (Shiralipour *et al.*, 1997) and long-chain fatty acids (Sesay *et al.*, 1997), phenolic acids, salts, ammonia, and heavy metals (BBC Labs, 1999).

Vinca Growth

Generally, vinca yields were greater for peat than for composts alone or composts mixed with peat (Fig. 1). Plant fresh and dry weights decreased with increasing compost decomposition rate. Vinca fresh weight and dry weight were greatest when composts the were mixed with peat at the ratio of 1:3, 1:1, 3:1 and lowest at 4:0 the ratio of (compost : peat, v/v). Plants were died in the compost of chicken manure at ratio 4:0, 3:1, 2:1 (compost : peat).

It possibly due to the effect of increased EC in the chicken manure. EC values above 3.5 dS/m are, generally, considered to be high to support plant growth in containers (Eames, 1977 and Lemaire *et al.*, 1985). Results obtained with vinca indicate that the Delta Bio-Tec composts were not superior to peat as a growing media. Flynn *et al.*(1995) and Mahmoud (2003) showed that the compost was superior to peat as a substrate, but the compost + peat mixture gave better results; especially at the ratio of 2:1 (v/v).

Fig. (1): Fresh weight and dry weight of the vinca (*Catharanthus roseus*) plants grown in peat, compost and compost + peat.



Summary

In Egypt, the companies have begin in production of large quantities of composts, which are marketed as a growing media . The high salt concentration and low stability/maturity of composts were a major limitation for compost use in growing media. Application strategies for these composts must be designed to minimize salt hazard and phytotoxic damage to plants in potting media.

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جودة الكمبوست وإستخدامه كبيئة نمو للنباتات

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جودة الكمبوست مهمة عند إستخدامه كبيئة نمو. فى هذه الدراسة أختير ستة أنواع مختلفة من الكمبوست من إنتاج شركة دلتا Bio-Tec وشركة النيل، الكمبوست المنتج بواسطة محمـــود (٢٠٠٣) لتقدير الخصائص الفيزيائية والكيميائية ودرجة ثبات ونضج الكمبوست ودراســـة مـــدي امكانية استخدام الكمبوست المنتج بواسطة شركة دلتا Bio-Tec كبديل للبيت بزراعـــة نباتـــات الونكا .*Vinca* sp.

وأوضحت النتائج مايلي:-

أن الخصائص الفيزيائية لاتكون مثالية لنمو النباتات ماعدا الكمبوست (BC).

التركيز العالى من الأملاح فى كمبوست الداجنى ومخلفات المحاصيل المحدد الرئيســـى عند إستخدامه كبيئة نمو. الكمبوست (BC) محتواها عالى من البوتاسيوم والنتروجين ومـــنخفض فى الفوسفور. كمبوست شركة دلتا Bio-Tec وشركة النيل لم يصل إلى درجة الثبات والنضـــج التام مما أدى ذلك إلى سمية نبات Cress. محصول الونكا كان أكبر فى بيئة البيت عن الكمبوست أو مخلوط الكمبوست مع البيت.موت النباتات النامية في الكمبوست الداجنى عند نسبة ٤ : صفر ، ٣ : ١ ، ١ : ١ (الكمبوست : البيت (حجما)). التركيز العالى من الأملاح وقلة درجـــة الثبـــات والنضج للكمبوست المختبر ماعدا كمبوست (BC) هما المحددان لمستخدم الكمبوست كبيئة نمـــو بدل البيت.

والإستراتيجية لإستخدام هذا الكمبوست يجب أن تقنن لتقليل أثـــر الأمـــلاح والســـمية للنباتات النامية فى بيئة النمو.