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Growth of *Dieffenbachia amoena* 'Tropic Snow' in Growing Media Containing Sugarcane Bagasse and Sawdust Vermicompost

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Abstract

Vermicompost produced from sugarcane bagasse (SBV) or sawdust (S) were substituted at a range of different concentration in soilless bedding plant container medium, as a peat: vermiculite: perlite (6:3:1), to evaluate their effects on the growth of *Dieffenbachia amoena* in the greenhouse. *Dieffenbachia amoena* was grown in container medium PE: VE: P (6:3:1), in that peat substituted with 0%, 10%, 20%, 30%, 40%, 50% and 60% (by volume) SBV. The control consisted of PE: VE: P (6:3:1) alone without SBV or SV. Plants were frequently treated with a nutrient solution for seven months. The greatest growth of *Dieffenbachia amoena* plant resulted from substitution of 60% SBV or SV instead of peat in PE: VE: P (6:3:1) potting mixtures. We concluded that vermicompost of sugarcane bagasse or sawdust was high quality substitutes for peat.

Keywords: Cow manure, *Eisenia foetida*, Physicochemical characteristics.

INTRODUCTION

Utilization of earthworms to break down organic wastes is gaining increasing popularity in different parts of the world (Edwards, 1998). During ingestion, the earthworms fragment the waste substrate, accelerate the rates of decomposition of the organic matter, alter the physical and chemical properties of the material, leading to an effect similar to composting in which the unstable organic matter is oxidized and stabilized aerobically (Atiyeh *et al.*, 2000b). The end product, termed vermicompost, which is obtained as a result of such transformation, is very different from the original waste material, mainly because of the increased decomposition and mummification. Vermicompost is finely peat-like materials with high porosity, aeration, drainage, water holding capacity and microbial activity, which make them excellent soil amendments or conditioners (Edwards and Burrows, 1988; Atiyeh *et al.,* 1999).

They contain the most nutrients in Plant available forms such as nitrate, phosphates, and exchangeable calcium and soluble potassium (Edwards, 1998). Vermicompost is rich in microbial population and diversity. Partially fungi, bacteria and actinomycetes (Tomati *et al.*, 1987). Atiyeh (2000a) have shown in his laboratory that vermicompost consistently promote biological activity which can cause plants to germinate, flower, grow and yield better than in commercial container media, independent of nutrient availability. Vermicompost also contains large amounts of humic substances (Tomati *et al.*, 1987) and some of the effects of these substances on plant growth have been shown to very similar to the effects of soil applied plant growth regulators or hormones (Muscolo *et al.*, 1999). The disposal of large quantities of agro-based industrial waste causes, energy, economic, and environmental problems. However, since these wastes have a high content of organic matter and mineral elements, they can potentially be used to restore soil fertility. Composting is useful for waste recycling and produces a chemically stable material that can be used as a source of nutrients and for improving soil structure (Castaldi *et al*. 2005). During composting, most of the biodegradable organic compounds are broken down and a portion of the remaining organic material is converted into humus-like substances, with production of a chemically stabilized composted material. The agricultural application of partially decomposed or unstable compost causes nitrogen immobilization and decreases the oxygen concentration around root systems due to the rapid activation of microbes. In addition, chemically unstable compost is phytotoxic due to the production of ammonia, ethylene oxide, and organic acids (Mathur *et al*. 1993; Tam and Tiquia 1994). Therefore, evaluation of compost stability prior to its use is essential for the recycling of organic waste in agricultural soils. Compost quality lies at the core of the issue of composting and biological treatment in general, as it defines the marketing potential and the outlets of the product and in most cases, the viability of the treatment plant, but also the long-term acceptability of biological treatment as a valuable option in the waste hierarchy (Lasaridi, 1998). Germination tests with sugarcane bagasse vermicompost extract and direct vermicompost seed tests were performed to evaluate any phytotoxicity that the vermicompost could cause. Biological properties of vermicompost can be measured in many ways, and each one addresses a different characteristic that makes compost either safe or unsafe for plants. The first test was performed to calculate germination index, and the second test was performed to compare germination results over time between the vermicompost extract and deionized water. The first test for calculating the germination index was a compost extract modified biological maturity test by Zucconi *et al*. (1981). The methodology for this procedure is based on seed inhibition caused by toxic environmental conditions usually associated with immature compost. It yields percent germination, which is an average of the seeds germinated in the sample divided by the average of the seeds germinated in the control. It also gives the percent root length in the same way. When these two numbers are multiplied together, it gives the “Germination Index”. The idea of this germination index is to obtain a parameter that can account for both low toxicity, which affects root growth, and heavy toxicity, which affects germination (Zucconi *et al*., 1981). Various types of seeds have been occasionally used in compost phytotoxicity studies, with cress (*Lepidium sativum*) seemingly being the most common. A range of GIs, with the use of cress, between 30% and 120% was reported in a study that evaluated 28 composts in the Greek market (Lasaridi *et al.,* 2006). The above study mentioned that GI values above 80% indicate maturity. Another study used a GI of 50% as a threshold compost maturity index (Bernal *et al.*, 1998). However, no justification was given for the use of the above threshold values. The objective of this study in this paper was an evaluation of sugarcane bagasse vermicompost Properties for Use as Potting Media to assess the growth of *Dieffenbachia amoena* 'Tropic Snow' plants, grown for 7 months in a potting medium PE: VE: P (6:3:1), in that peat substituted with different concentration of SBV under greenhouse conditions.

MATERIALS AND METHODS

The experiment was carried out in fiberglass covered green house in factorial experiment with randomized block design, with two types of vermicompost (a_1 - vermicompost of sawdust, a_2 - vermicompost of sugarcane bagasse), seven levels of vermicompost (b_1- 0%vermicompost, b_2- 10% vermicompost, b_3-20% vermicompost, b_4- 30% vermicompost, b_5- 40% vermicompost, B_6- 50%vermicompost, and B_7-60% vermicompost) in four replications and three plants in any treatment for a total of 336 plants. A common lightweight potting mix that contained peat (PE), vermiculite (VE) and perlite (P) was used, and vermicompost was substituted for peat. Some of initial chemical characteristics of PE, SV and SBV medium presented in Table 1. The substitution was made from 0 to 60% by volume percentages to determine, whether sawdust vermicompost (SV) or sugar cane bagasse vermicompost (SBV) be a good container mix. The vermicompost were screened with a 1 cm screen to have a uniform product.Kekkila peat was used for the treatments. The following treatments were mixed by volume in the growth media mix (Table 2).

Table 1. Initial chemical characteristics of PE, SV and SBV.

Waste	N (%)	P (%)	K (%)	OC (%)	C:N ratio	pH (1:5)	EC (dS/m)
PE	1.27	0.02	0.03	51.10	40.34	3.83	0.30
SV	1.47	0.40	1.15	24.02	16.42	7.20	4.11
SBV	1.91	0.56	0.86	23.24	12.16	8.47	4.11

SBV: sugarcane bagasse vermicompost; PE: peat; V; vermicompost.

Table 2. Mixed volume of growth media.

Treatment number	%Vermicompost	Growth media mix
1	0 % SV	60 % PE + 0%SV+30% VE + 10% P
2	10 % SV	50 % PE + 10%SV+30% VE + 10% P
3	20 % SV	40 % PE + 20%SV+30% VE + 10% P
4	30 % SV	30 % PE + 30%SV+30% VE + 10% P
5	40 % SV	20 % PE + 40%SV+30% VE + 10% P
6	50 % SV	10 % PE + 50%SV+30% VE + 10% P
7	60 % SV	0 % PE + 60%SV+30% VE +10% P
8	0 % SBV	60 % PE + 0% SBV +30% VE + 10% P
9	10 % SBV	50 % PE + 10% SBV +30% VE + 10% P
10	20 % SBV	40 % PE + 20% SBV +30% VE + 10% P
11	30 % SBV	30 % PE + 30% SBV +30% VE + 10% P
12	40 % SBV	20 % PE + 40% SBV +30% VE + 10% P
13	50 % SBV	10 % PE + 50% SBV +30% VE + 10% P
14	60 % SBV	0 % PE + 60%SBV +30% VE + 10% P

SV: sawdust vermicompost, SBV: sugarcane bagasse vermicompost, VE: vermiculite, PE: peat, P: perlite

Table 3. SV and SBV extract germination test.

Replication	Germination(%)		Root length (cm)		Germination(%)		Root length (cm)	
	SV extract	Deionize water	SV extract	Deionize water	SBV extract	Deionize water	SBV extract	Deionize water
	16.75	18.25	61.27	74.75	19	18.25	60.45	74.75
% Germination and Root length (cm)	91.7		82.4		104.1		80.86	
Germination index	75.56				84.17			

Table 4. Analysis variance of seed germination

S.O.V	df	M.S. Seed germination
Treatment	2	4.33^{ns}
Error	9	4.028
Total	11	-
C.V.%	-	11.20

ns,*, **: respectively Non significant and significant at 5% and%1

Any rooted *Dieffenbachia amonea* cuttings were transplanted to 4 liter (about 10 cm diameter) plastic pots containing the potting mixes described above. Any 10 day 200 cm^3 solutions consist of 130 mg/l N; 32 mg/l P and 117 mg/l K (as a KH_2PO_4, KNO_3, Ca $(NO_3)_2$) were used for any pot (Chen and Griffiths, 1988), and irrigation was applied as needed. At the end of experiment plants were cut from surface of the pot and oven-dried at 75 °C for 2 days to determine their dry weight. The variables measured at the end of the experiment were: height, plant height, plant diameter and leaves, root and shoot fresh and dry weight. The phytotoxicity test to assess vermicompost maturity was based on the method of (Zucconi *et al*., 1981), with some modifications. One hundred grams of Every one of the dried vermicompost samples (oven dried for 72 h at 60°C) and 1 L of distilled water were mixed and shaken for 12 h at high speed (250 rpm) at 4 ± 1°C; then, centrifuged for 10 min at 4000 rpm. The extract was filtered through a Whatman filter paper. Cotton wool was placed inside 20 sterilized glass petri dishes (15mm) and wetted with 10 ml of either vermicompost water extract or distilled water (control) in a covered 9 cm glass petri dish. Then, twenty *Zea mays* seeds were placed in the petri dishes, covered with petri dish lids and incubated for 5 days, at 25°C under completely dark conditions. The results were expressed as the percentage of seed germination with compost water extract considering the number with distilled water equal to 100%. The experimental design was a completely randomized design and the treatment was repeated four times.

The average number of germinated seeds in each petri dish treated with vermicompost extract (G) was counted and the percent germination (PG) calculated according to the formula: $PG=G/G0\times100$

Where $G0$ is the average number of germinated seeds in the deionize water.

The average root length of germinated seeds in each petri dish treated with vermicompost extract (L) was counted and the root length (RL) calculated according to the formula:

$RL=L/L0\times100$

Where $L0$ is the average root length of germinated seeds in the deionize water.

Germination Index $=((PG \times RL))/100$

The means of each parameter measured was analyzed statically by SAS, and then separated

Table 5. Analysis variance of growth variables.

S.O.V	df	M.S.					
		Height	Diameter	Shoot fresh weight	Shoot dry weight	Leaf fresh weight	Leaf dry weight
V K	1	1.358 ns	0.939 ns	1589.83 ns	17.09 ns	1829.14 ns	12.333 ns
V L	6	193.298 **	13.643 **	11075.96 **	333.818 **	15897.01 **	129.640 **
V K*V L	6	2.605 ns	0.593 ns	73.92 ns	16.42 ns	290.94 ns	2.027 ns
Error	42	4.898	5.755	457.90	246.06	366.02	7.627
Total	55	-	-	-	-	-	-
C.V.%	-	26.72	30.29	19.76	8.03	12.32	8.21

ns,*, **:respectively Non Significant and Significant at 5% and%1, VK-Vermicompost Kind, VL- Vermicompost Level

statistically using Tukey's multiple range tests.

RESULTS AND DISCUSSION

In the SV and SBV extracts test the germination index was calculated respectable at 74.56 and 84.17 % (Table 3). It has been suggested that a germination index of ≥ 60% indicates the disappearance of phytotoxicity in composts (Zucconi *et al.*, 1985). A germination index of 40% or less would denote phytotoxic potential (Lemus, 1998). The SV and SBV extracts germination tests versus deionized water means separation analysis showed that (Table 4) the means from seeds germinated in deionized water and the means from seeds germinated in SV or SBV extracts were not significantly different. Biological tests did not show that the SV and SBV extracts would cause any potential damage to plants.

Various types of seeds have been occasionally used in compost phytotoxicity studies, with cress (*Lepidium sativum*) seemingly being the most common. A range of germination index between 30% and 120% was reported with the use of cress in a study that evaluated 28 composts in the (Lasaridi *et al*., 2006). The above study mentioned that the germination index above 80% indicate maturity. Another study used a germination index of 50% as a threshold compost maturity index (Bernal *et al.*, 1998). However, no justification was given for the use of the above threshold values.

In accordance with the results analysis variance of growth variables reported in Table 5, effect of vermicompost kind were not significant. According to analysis variance results (Table 5) and mean comparison of vermicompost rates on growth variables (Table 6), plants grown in pots containing 60% SV or SBV were higher height (16.2 cm), diameter (9.6 mm), shoot fresh weight (153.6 g), shoot dry weight (33.06 g), leaf fresh weight (203.7 g) and leaf dry weight (38.40 g)

Table 6. Mean comparison of vermicompost rates on growth variables.

Treatment	Height (cm)	Diameter (mm)	Shoot fresh weight(g)	Shoot dry weight (g)	Leaf fresh weight (g)	Leaf dry weight (g)
Control	2.2 c	5.8b	51.84e	25.88b	76.67e	27.00d
10%Vermicompost	3.7 de	6.8ab	70.83de	27.42b	116.5d	30.04cd
20%Vermicompost	6.1 cd	7.6ab	95.31cd	29.51ab	153.9c	32.41bc
30%Vermicompost	7.7 c	7.7ab	119.6bc	31.50a	168.5bc	35.48ab
40%Vermicompost	9.2 bc	8.4ab	126.1ac	31.62a	177.9ac	35.89ab
50%Vermicompost	12.6 b	9.1ab	140.7ab	31.92a	189.9ab	36.37ab
60%Vermicompost	16.2a	9.6a	153.6a	33.06a	203.7a	38.40a

SBV: sugarcane bagasse vermicompost; PE: peat; V; vermicompost.

than (p = 0.05) control treatments. Atiyh *et al*. (2002) reported significantly increased growth of marigold seedlings after substitution of 30% and 40% pig manure vermicompost in Metro- Mix 360. Results show that vermicomposting of sugarcane bagasse or sawdust provides an inexpensive, high quality peat like substitute for *Dieffenbachia amonea* production, as well as solutions for environmental problems of waste disposal.

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