

Evaluation of sugar cane bagasse vermicompost as potting media on growth and nutrition of *Dieffenbachia amoena* 'Tropic Snow'

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Abstract

Vermicompost produced from sugar cane bagasse (SBV) were substituted at a range of different concentration into soil less bedding plant container medium, Peat: Vermiculite: Perlite (6:3:1), to evaluate their effects on the growth of *Dieffenbachia amoena* in 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. Plants were frequently treated with a nutrient solution for seven month. The greatest growth of *Dieffenbachia amoena* plant resulted from substitution of 60% SBV instead of peat in PE: VE: P (6:3:1) potting mixtures. There positive correlations between the increases in *Dieffenbachia amoena* growth and the concentration of nitrogen in leave tissue of plant. Because of these observation and analyses, we concluded that vermicompost cow manure and sugar cane bagasse was high quality substitutes for peat.

Keywords: Eisenia foetida, Cow manure, Sugarcane bagasse, physicochemical characteristics

Introduction

Utilization of earthworms to break down organic wastes is gaining increasing popularity in different parts of 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 are 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 most nutrient in Plant available forms such as nitrate, phosphates, and exchangeable calcium and soluble potassium (Edwards, 1998). Vermicompost are 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. Krishnamorthy and Vajrabbish (1986) reported the production of cytokinins and ouxins in organic wastes that were processed by earthworms. Vermicompost also contain large amounts of humic substances (Tomati *et al.*, 1987) and some of effects of these substances 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 humic-like substances, with production of a chemically stabilized

composted materials. 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 sugar cane 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 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 evaluation of sugar cane bagasse vermicompost Properties for Use as Potting Media to assess the growth of *Dieffenbachia amoena* 'Tropic Snow' plants, grown for 7 month in a potting medium PE: VE: P (6:3:1), in that peat substituted with different concentration of SBV under greenhouse conditions.

Methods

Plant experiment

The experiment was conducted in an ornamental plant research station greenhouse at the Lahijan. *Dieffenbachia*'s were grown in soil less greenhouse container medium PE: VE: P (6:3:1). The SBV was provided by vermicycle organics and consisted of separated cow manure + sugar cane bagasse (4:1 V/V) processed by earthworms (*Eisenia foetida*) in indoor beds. The physicochemical properties of PE: VE: P (6:3:1) and SBV over summarized in Table 1.

Table1.Composition of substrates tested

Number of treatment	substrates	composition
1	(Control)	60 % PE : 30% VE : 10% P
2	10% SBV	50 % PE : 10% SBV: 30% VE : 10% p
3	20% SBV	40 % PE : 20% SBV: 30% VE : 10% p
4	30% SBV	30 % PE : 30% SBV: 30% VE : 10% p
5	40% SBV	20 % PE : 40% SBV: 30% VE : 10% p
6	50% SBV	10 % PE : 50% SBV: 30% VE : 10% p
7	60% SBV	0 % PE : 60% SBV: 30% VE : 10% p

Control: (60% peat: 30%vermiculite: 10% perlite) ;SBV: sugercan bagasse vermicompost

Table2. Initial physicochemical characteristics of PE 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
SBV	1.91	0.56	0.86	23.24	12.16	8.47	4.11

SBV: sugar cane bagasse vermicompost; PE: peat; V; vermicompost.

Six week old *Dieffenbachia amoena* 'Tropic Snow' seedling were germinated in plastic pots (10 cm in diameter) containing PE: VE: P (6:3:1) substituted with 0% (control), 10%, 20%, 30%, 40%, 50% and 60% (by volume) SBV. There were three replicate pots, each containing one *Dieffenbachia* plant, for each PE: VE: P/SBV mixture (Table1). The plants were irrigated one time a month with a nutrient solution containing 130 mg/L N, 32 mg/L P, and 117 mg/L K. Plant height was measured every 2 week. At the end of experiment leaf area was measured by using leaf area meter (model MK₂ made in England) for all each plant leaves. All leaves were removed from the stems, oven dried at 70°C for 72h; dry shoots were weighed (Page *et al.*, 1982). Plants were cut from surface of pot, leaves fresh weight of leaves and shoot, and oven dried at 75 °C for 2 days to determine their dry weight. Every 10 day 200 cm³ solution consist of 130 mg/l N; 32 mg/l P and 117 mg/l K (as a KH₂PO₄, KNO₃, Ca (NO₃)₂) were used for each pot (Chen *et al.*, 1988; Azizi *et al.*, 2008), and irrigation was applied as needed. Amount of chlorophyll measured by chlorophyll meter model CCM-200. The amount of chlorophyll at the ten point of green leaf area (in leaf newly developed) measured and the mean was recorded for each plant. Growth index¹, was measured with this equation = $[(width1+width2)+2] \times height$. (Stamps,1997). The pH was determined by pH meter (Metrohm 691) in a double distilled water suspension of each mixture in the ratio of 1:5 (W/V) that had been agitated mechanically for 30 min and filtered through whatman No.1 filter paper. The same solution was measured for Electrical Conductivity (Metrohm 644) by a conductance meter that had been standardized with 0.01 and 0.1 M KCl (Verdonck and Gabriels, 1992). Total Kjeldal Nitrogen was determined after digesting the sample with concentrated H₂SO₄ and concentrated HClO₄ (9:1, V/V) by Bremner and Mulvaney (1982) procedure. For determination of other nutrients, each ground sample (2 g) was ashed in a muffle furnace at 550°C. The white ash was dissolved in 2 N HCl and made up to 100 ml with distilled water. Total P was analyzed using the colorimetric method with molybdenum in sulphuric acid by spectrophotometer type CECIL 2041 according to Murphy and Riley (1962). Total K after digesting the sample in diacid mixture (concentrated HNO₃: concentrated HClO₄, 4:1, V/V), by flame photometer type JENWAY PFP7 according to Houba *et al.* (1989). Total organic carbon was measured by using the method of Nelson and Sommers (1982). Ca, Mg, Zn, Fe, and Cu were determined in plants and substrats samples by inductively coupled plasma-atomic emission spectroscopy (ICP-AES) (Munter and Grande, 1981). Each sampling date, were analyzed statically by SAS (SAS Institute, 2001). The means data were compared statistically by using Tukey's multiple range tests. All the results reported in this paper were expressed as means of four replicates.

Biological experiment

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 # 113 wet strengthened 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 9cm 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 Petri dishes were sealed with parafilm (Parafilm "M" Laboratory Film Chicago, IL.60631). 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: $PG=(G/G_0) \times 100$
Where G₀ is the average number of germinated seeds for 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: $RL=(L/L_0) \times 100$
where L₀ is the average average root length of germinated seeds for the deionize water.
Germination Index=(PG×RL)×100

Results and Discussion

The seed germination test is a widely accepted protocol for evaluating the compost phytotoxicity as well as the compost stability (Tiquia *et al.*, 1996; Zucconi *et al.*, 1981). In the sugar cane bagasse

¹Height and Widths (two, taken at right angles) of the above ground portion of the plants were then measured.

vermicompost extracts test, the germination index was calculated 84.17 %. 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 sugar cane bagasse vermicompost extracts germination tests did not show that the sugar cane bagasse vermicompost extracts would cause any potential damage to plants. The composts contain high levels of humic substances that have the potential to act as growth stimulators (Lee and Bartlett 1977; Schnitzer and Poapst 1967). High activity of the microbial population may suggest increased growth response due to rhizosphere microorganisms.

Dieffenbachia grown in pots containing 60% SV has a most height from August onward (fig 2), and most diameter from September onward (fig 3). Chlorophyll amount was most in *Dieffenbachia* in pots containing 60% SV in during 7 month of plant growth duration (fig4). Figure 2 shows a view of plants affected by increased levels of sugarcane bagasse vermicompost at the end of the experiment. The various horticultural parameters measured at the end of the experiment are presented in Table3. Plants grown in pots containing 60% SV were higher growth index, shoot fresh weight, shoot dry weight, Leaf fresh weight, Leaf dry weight, leaf area , height, diameter and chlorophyll than ($p=0.05$) control treatments. This chlorophyll amount seems to correlate well with the photosynthetic ability and size and weight of the plants. Atiyh *et al.* (2002) reported significantly increased growth of marigold seedlings after substitution of 30% and 40% pig manure vermicomposts into Metro- Mix 360. Leaf analyses of *Dieffenbachia* plants (Table 4) grown in potting mixtures showed significant increase nitrogen concentration in potting mixtures containing 60% SBV compared to control treatment, this could possibly explain the significant increases in growth of *Dieffenbachia* after substitution of PE with 60% SBV (Table 3). Elemental composition of the leaves for other elements shows slight differences in nutrient concentrations between the treatments (Table4). To eliminate differences in mineral nutrient content between the SBV and PE all *Dieffenbachia* plants were supplied regularly with macro essential mineral nutrients. It seems likely that there are other plant growth influencing factors that caused significant effects from the substitution of relatively heavy concentration of SBV into the PE but this needs to be investigated further (Muscolo *et al.*, 1999; Atiyh *et al.*, 2002; Tomati *et al.*, 1987).

Table 3. Horticultural parameters of *Dieffenbachia amoena* in the various potting mixtures at end of experiment.

Potting mixtures	Height (cm)	Diameter (mm)	Chlorophyll amount	Growth index	Shoot fresh weight (g)	Shoot dry weight (g)	Leaf fresh weight (g)	Leaf dry weight (g)	Leaf area (cm ²)
Control	2.29 e	5.93 b	10.15 b	797 e	50.89 e	25.68 b	80.33 e	27.39 d	801 d
10% SBV	4.02 de	7.27 ab	11.76 b	1150 de	79.92 de	28.96 b	125.04 d	31.24 cd	1641 c
20% SBV	5.21 cd	7.43 ab	12.98 ab	1567 cd	104.31 cd	30.42 ab	168.19 c	32.93 bc	2049 bc
30% SBV	8.43 c	7.53 ab	14.59 ab	2008 bc	124.09 bc	31.62 a	172.64 bc	35.68 ab	2249 b
40% SBV	9.43 bc	8.07 ab	15.28 ab	2445 ab	128.52 ac	31.57 a	189.04 ac	36.21 ab	2431 ab
50% SBV	12.56 b	8.74 ab	15.46 ab	2457 ab	146.57 ab	32.13 a	193.49 ab	37.04 ab	2224 ab
60% SBV	15.91 a	9.53 a	17.61 a	22976 a	158.99 a	33.99 a	205.36 a	39.16 a	2680 a

PE: VE: P (6:3:1), Peat: Vermiculite: Perlite (6:3:1); SBV, Sugar cane bagasse Vermicompost. Means by the same letters do not significantly differ ($p=0.05$).

Table 4. Analyses of nutrient element concentration in *Dieffenbachia amoena* leaves.

Potting mixtures	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Cu (ppm)	Zn (ppm)	Fe (ppm)
(control)	2.10 bc	0.67 a	4.75 ab	1.56 a	0.98 a	12.13 a	79.25 a	167.91 b
10% SBV	2.14 ac	0.69 a	4.16 b	1.58 a	0.80 a	12.38 a	60.66 a	183.82 ab
20% SBV	2.08 bc	0.72 a	4.84 ab	1.23 a	0.90 a	12.53a	59.00 a	194.46 ab
30% SBV	2.24 ac	0.76 a	5.73 a	0.96 a	0.86 a	12.48 a	60.75 a	200.53 ab
40% SBV	2.39 ac	0.75 a	5.83 a	1.22 a	0.91 a	11.97 a	57.50 a	205.36 ab
50% SBV	2.43 ac	0.71 a	5.23 ab	1.10 a	0.88 a	12.03 a	66.75 a	215.15 a
60% SBV	2.70 a	0.79 a	5.08 ab	1.10 a	1.00 a	10.13 a	67.32 a	224.88 a

SV: sawdust vermicompost; SBV: sugercan bagasse vermicompost. Control: (60% peat: 30%vermiculite: 10% perlite)

Means followed by the same letters do not significantly differ ($p=0.05$).

Conclusions

Vermicomposting of cattle manure and sugar cane bagasse provides an inexpensive, high quality Peat substitute, as well as solution for environmental problems of waste disposal.

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Figure 1. From right to left, a view of plants affected by increased levels of SBV.

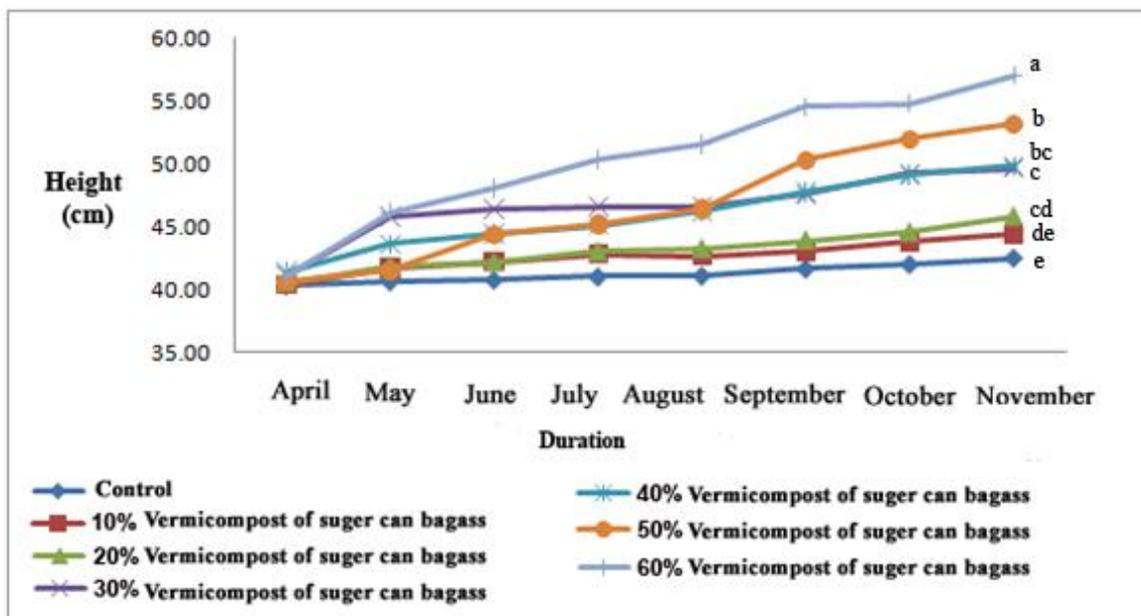


Figure 2. Plant height of *Dieffenbachia amoena* 'Tropic Snow' in vermicompost containing potting media (Numbers marked with the same letter were not significantly different ($p=0.05$) at the end of the experiment).

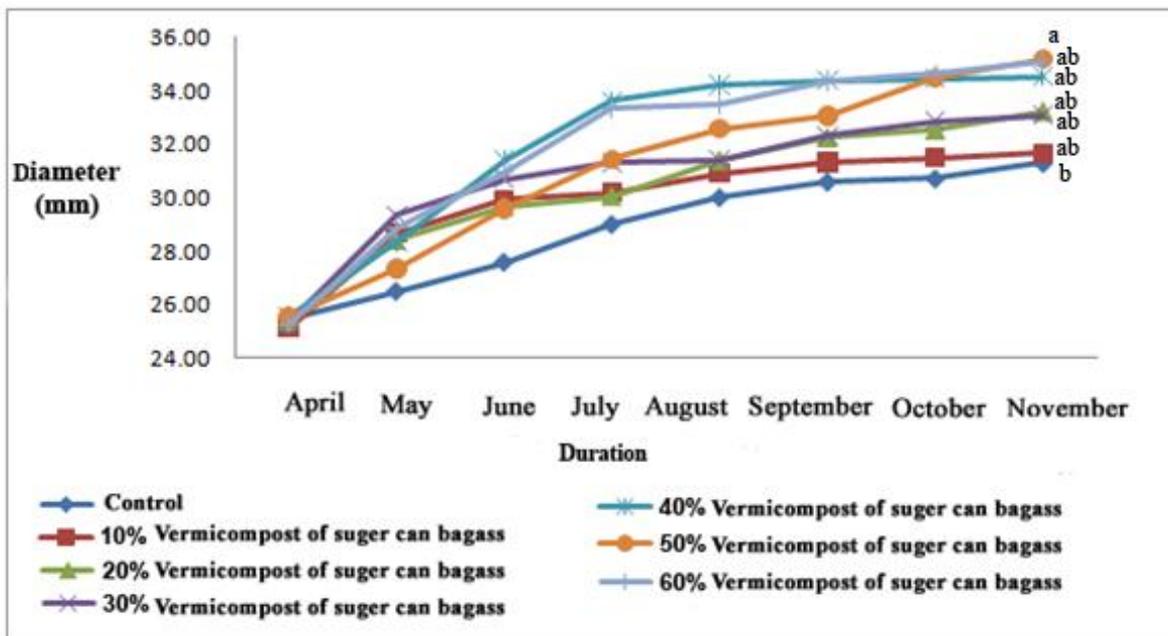


Figure3. Plant diameter of *Dieffenbachia amoena* 'Tropic Snow' in vermicompost containing potting media (Numbers marked with the same letter were not significantly different ($p=0.05$) at the end of the experiment).

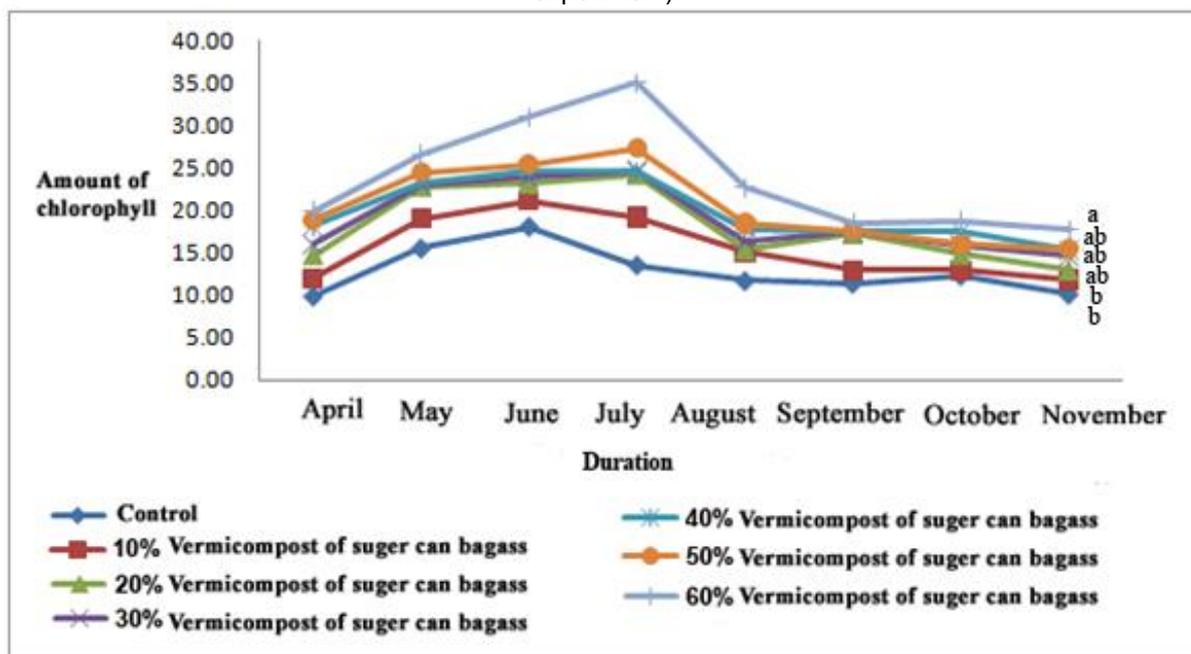


Figure 4. Amount of chlorophyll in leaves of *Dieffenbachia amoena* 'Tropic Snow' in vermicompost containing potting media (Numbers marked with the same letter were not significantly different ($p=0.05$) at the end of the experiment).

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