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The Effect of Sawdust Vermicompost Extract on Growth of *Dracaena marginata*

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Abstract

This study investigated the effects of the sawdust vermicompost extract (aqueous extract) on yield and chemical quality of *Dracaena marginata* var. 'Tricolor' grown under four sawdust vermicompost extract solutions (0, 250, 500 and 1000 ppm). The sawdust vermicompost extract was prepared using non-aerated extraction methods with 1:10 (v/v) of sawdust vermicompost to water and was sprayed three times two weeks on the *D. marginata* plants. Sawdust vermicompost extract improved mineral nutrients of plants such as nitrogen (2.36%), phosphorus (0.42%), potassium (2.31%), calcium (2.76%), and magnesium (0.23%) compared to controls. When the sawdust vermicompost extract was sprayed on the *D. marginata* plants, it showed a significant growth of plants. The three-time spray of 1000 ppm vermicompost extract also reflected too great influence over the yield of *D. marginata*. Plants grown in pots sprayed with 1000 ppm vermicompost extract exhibited higher height (15.33 cm), leaf number (53.00), shoot and leaf fresh weight (66.00g), and shoot and leaf dry weight (13.90 g) than control treatments ($P < 0.05$). This practice should be adopted for obtaining a higher yield from *D. marginata*. This study confirmed that the sawdust vermicompost extract can positively influence plant yield.

Keywords: Earthworm, Foliar spraying, Organic waste, Vermicompost.

INTRODUCTION

Due to increasing population and development of human civilization, industrialization has aggravated the problem of environmental degradation. The rapid increase in the use of chemical fertilizers and pesticides has destroyed soil fertility and has been harmful to crops, leading to human disease. Various researchers have tested vermicompost in the horticulture and agriculture industries (Atiyeh *et al*., 2004; Arancon *et al.*, 2005; Azizi *et al.*, 2008). Mahboub Khomami et al. (2015) concluded that cow manure + sawdust were appropriate for feeding earthworms and its outcome was high-quality vermicompost. Mahboub Khomami and Mammadov (2014) reported that vermicomposting of sawdust provided an inexpensive, high-quality peat like substitute for *Dieffenbachia amonea* production. Vermicompost includes a lot of nutrients in plant-available forms such as nitrate, phosphate, soluble potassium, and exchangeable calcium (Edwards, 1998).

Earthworm processed material 'casts' contain several soil nutrients in forms easily available to plants (Taylor *et al.*, 2003). Earthworms rapidly convert the waste into humus-like substances with a finer structure than thermophilic compost, but possessing a greater and more diverse microbioactivity (Elvira *et al.*, 1996; Atiyeh *et al.,* 2000). A few plant growth-promoting substances have also been reported in casts (Krishnamoorthy and Vajranabhaian, 1986; Muscolo *et al.*, 1999). Krishnamoorthy and Vajranabhaian (1986) reported relatively higher ranges of plant nutrients such as ammonia, urea, oxidisable organic matter, and exchangeable forms of some essential plant nutrients. They also reported plant hormones, e.g. cytokinins and auxins in earthworm casts. Seed germination test is a widely accepted protocol for compost stability for the evaluation of phytotoxicity of compost (Zucconi *et al*., 1981; Tiquia *et al.,* 1996). Direct seed tests and germination tests have been performed on vermicompost extracts to evaluate any possible phytotoxicities that they could cause.

Biological properties of vermicompost can be measured in many ways, each of which can identify several characteristics that make compost safe or unsafe for plants. The first test was performed to estimate the germination index, and the second test to compare germination results between deionized water and sawdust vermicompost extract. The germination index was a compost extract modified biological maturity test that was used by Zucconi *et al.* (1981). Compost is comprised of a large and diverse community of microbes, humic acids and other chemical nutrients such as carbon and nitrogen that soil and healthy plant growth require.The Primary interest in application of compost tea versus compost is due to the fact that composts act more slowly over a long period of time and much larger amount is required. Effects of compost tea (compost extract) are short lived, and frequent and repeated applications are required to replenish plant or soil surface with nutrient and beneficial microbes (Ingham, 2005). Although the chemistry and microbiology of vermicompost extracts are complex, it is believed that soluble mineral nutrients extracted from vermicompost will have a positive effect on plant growth with foliar and soil applications of vermicompost extract (Ingham, 2005). Application of aqueous extract of vermicompost (vermicompost tea) has shown to improve plant health, crop yield, and nutritive quality (Gamaley *et al*., 2001; Pant *et al.*, 2009). This work is related to the influence of the sawdust vermicompost extract on growth and nutrition of *Dracaena marginata* plants.

MATERIALS AND METHODS

This experiment was conducted in the greenhouse of the Ornamental Plant Research Station of Lahijan (37° 11' 44" and 50° 01' 03"). Average night and day temperatures were 18±2 and 27±2°C, respectively, with relative humidity of 65-75% and medium light between 75 to 150 foot candles (Simon *et al*., 1976). The rooted *Dracaena marginata* var. 'Tricolor' cuttings were transplanted to 4 liter (about 10 cm diameters) plastic pots containing peat + perlite (volume ratio 1:1) mixtures. The leaves were sprayed with sawdust vermicompost extract in three stages with an interval of two weeks. According to Table 1, the first spray of leaves was performed fifteen days after planting the rooted *Dracaena marginata* cuttings. Every 10 days, 200 cm^3 OMEX (18-18-18

Table 1. Different concentration of sawdust vermicompost extracts solution and spraying time.

Spraying time	Control	250 ppm VE	500 ppm VE	1000 ppm VE
First time	6 liters DW	4.5 liters DW+1.5 liters VE	3 liters DW+3 liters VE	6 liters VE
Second time	12 liters DW	9 liters DW+3 liters VE	6 liters DW+6 liters VE	12 liters VE
Third time	18 liters DW	13.5 liters DW+4.5 liters VE	9 liters DW+9 liters VE	18 liters VE

*DW: distilled water; VE: Vermicompost extract.

N-P-K) solutions were used for each pot and irrigation was applied as needed.

At the end of the experiment, plants were cut from the 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 plant height, leaf area, shoot and leaf fresh and dry weight, leaf N, leaf P, leaf K, leaf Ca, and leaf Mg. The plants were cut from the surface of the pot to determine leaf and shoot fresh weight, and then they were oven-dried at 70°C for 2 days to determine their dry weight (Page *et al.*, 1982). The pH was determined by pH meter (Metro 691) in the ratio of 1:10 (w/v) for each mixture in double distilled water suspension after mechanically agitating for 30 min and filtered through Whatman filter paper No.1 (Verdonck and Gabriels, 1992). Total nitrogen was determined after digesting sample with concentrated H_2SO_4 and $HClO_4$ (9:1, v/v) by Bremner and Mulvaney (1982)'s procedure. For determination of other nutrients, each ground sample (2 g) was ashed in a muffle furnace at 550 °C (Horwitz, 1980). The white ash was dissolved in 2N HCl and made up to 100 ml with distilled water. Total P was analyzed using the colorimetric method with molybdenum in sulfuric acid according to Murphy and Riley (1962) by a spectrophotometer (CECIL 2041). After digesting the sample in the diacid mixture (concentrated HNO_3: concentrated $HClO_4$, 4:1, v/v), total K was analyzed according to Houba *et al.* (1989) by flame photometer type JENWAY PFP7. Total organic carbon was measured according to Nelson and Sommers (1982)'s method. Each data was analyzed statically by SAS software (SAS Institute Inc., 2001) and data means were compared statistically by Tukey's multiple range tests.

Phytotoxicity test

The phytotoxicity test was based on the method of Zucconi *et al.* (1981), with some modifications to assess vermicompost maturity. A 500-g sample of vermicompost mixed with 2.5 liter of distilled water was soaked for 48 hr. The extract was filtered by the tiffany. Cotton wool was placed in 20 sterilized glass petri dishes (15 mm) and wetted with 10 ml of either distilled water (control) or vermicompost water extract in 9 cm covered glass petri dish. Twenty *Zea mays* seeds were placed in the petri dishes and covered with petri dish lids. All petri dishes were sealed with parafilm (Laboratory Film Chicago, IL.60631) and incubated at 25°C for 120 hr under completely dark conditions.

The results were expressed as a seed germination percentage with vermicompost water extract considering the number with distilled water equal to 100%. The experimental design was completely randomized and the treatment was replicated four times. The average number of germinated seeds in each petri dish treated with sawdust vermicompost extract (G) was counted and the percent germination (PG) was calculated according to this formula:

$PG = (G/G_0) \times 100$,

where, is the average germinated seed number in the deionize water. The average root length of germinated seeds in each petri dish treated with sawdust vermicompost extract (L) was counted and the root length (RL) was calculated according to this formula: $RL= (L/L_0) \times 100$, where L_0 is the average germinated seed root length in the deionize water.

Germination Index: $(PG \times RL) \times 100$.

Vermicompost extraction and foliar spraying

The sawdust vermicompost extract was prepared using non-aerated extraction methods with

Table 2. Chemical characteristics of sawdust vermicompost and sawdust vermicompost extract.

Chemical characteristics	Sawdust vermicompost	Sawdust vermicompost extraction
N (%)	1.47	0.02
P (%)	0.40	0.10
K (%)	1.15	0.15
pH (1:10)	7.20	7.00

1:10 (v/v) sawdust vermicompost to water dilution and soaked for 48 hr. The extract was filtered by the tiffany and dry matter concentration was determined in the extract by centrifuge and the weighing method. This was equivalent to 8700 ppm. To prepare the necessary concentration levels of sawdust vermicompost extract, extract was brought to volume with distilled water. The leaves were sprayed at sunset. In control treatment, leaves were sprayed with distilled water. Foliar spray was conducted three times two weeks. The solution needed to wet the plants was determined by geysers 500 cc. Different levels of sawdust vermicompost extract solution are presented in Table 1. The experiment included four treatments of sawdust vermicompost extract: control, no spray of sawdust vermicompost extract, three sprays of 250 ppm sawdust vermicompost extract, three sprays of 500 ppm sawdust vermicompost extract, and three sprays of 1000 ppm sawdust vermicompost extract. The experimental design was a completely randomized block design with three replications. The analysis of sawdust vermicompost and sawdust vermicompost extract for N, P and K content was estimated on dry weight basis as mentioned below in Table 2.

RESULTS AND DISCUSSION

Phytotoxicity test

The results of seed germination study in a 120 hr period showed that the percentage of seed germination in the sawdust vermicompost extract was higher than that in deionize water. Calculated germination index in the sawdust vermicompost extract test was 76% (Table 3). Zucconi *et al.* (1985) suggested a germination index of ≥60% as a disappearance of phytotoxicity in composts. A germination index of 40% or less would denote phytotoxic potential (Lemus, 1998). The germination tests did not show that the sawdust vermicompost extract would cause any potential damage to plants. The composts with high levels of humic substances have the potential to act as growth stimulators (Schnitzer and Poapst, 1967; Lee and Bartlett, 1976).

Effect of vermicompost extract on plant growth

In accordance to analysis of variance results (Table 4) and mean comparison of sawdust vermicompost extract concentration effects on growth variables (Table 5), all concentrations of sawdust vermicompost extract increased height, leaf area, shoot and leaf fresh weight, shoot and leaf dry weight significantly as compared with the control. Plants grown in pots sprayed with 1000 ppm sawdust vermicompost extract showed higher height (27.13 cm), leaf number (53.00), shoot and leaf fresh weight (66.00 g), shoot and leaf dry weight (13.90 g) than control treatments signif-

Table 3. Mean germination in sawdust vermicompost extract.

	Mean germination (%)		Root length(cm)	
	Sawdust vermicompost extract	Deionize water	Sawdust vermicompost extract	Deionize water
	16.75	18.25	61.27	74.75
Germination and root length	91.7		82.4	
Germination index		76		

Table 4. Analysis of variance for growth variables and plant nutrient content.

S.o.V	df	MS									
		Plant height	Leaf diameter	Leaf number	Shoot and leaf fresh weight	Shoot and leaf dry weight	Leaf N	Leaf P	Leaf K	Leaf Ca	Leaf Mg
VE	3	40.52**	2.07*	61.06**	85.28**	9.64**	1.82**	0.006**	0.27**	0.63**	0.52**
Error	6	4.16	1.64	36.34	10.80	1.01	0.006	0.0001	0.036	0.0001	0.016
Total	11	-	-	-	-	-	-	-	-	-	-
CV (%)	-	7.93	1.33	13.64	2.23	3.44	8.9	6.4	9.23	5.37	8.32

*: significant at P < 0.05; **: significant at P < 0.01.

Table 5. Measured plant growth variables at the end of the experiment.

Spraying treatment	Plant height (cm)	Leaf diameter (mm)	Leaf number	Shoot and leaf fresh weight (g)	Shoot and leaf dry weight (g)
Control	18.99^{c}	10.00^{c}	38.80^{c}	57.48^{c}	9.60^{d}
250 ppm VE	22.60^{b}	12.1^{b}	40.69^{b}	59.61^{b}	11.58^{c}
500 ppm VE	24.41^{ab}	16.1^{ab}	44.48^{ab}	61.74^{b}	13.53^{b}
1000 ppm VE	27.13^{a}	18.6^{a}	53.00^{a}	66.00^{a}	13.90^{a}

*VE: vermicompost extract. In each column, means followed by similar letter(s) were not significantly different (P < 0.05) using Tukey's Test.

icantly (P < 0.05). Consistent with the findings of Hargreaves *et al.* (2008) and Sanwal *et al.* (2006), vermicompost extract consistently enhanced plant growth and mineral nutrient concentration in plant tissue under both fertilizer regimes.

Effect of vermicompost extract on plant nutrient content

The effect of sawdust vermicompost extract concentration on mineral nutrient uptake per plant is presented in Table 6. The spraying of 1000 ppm concentration sawdust vermicompost extract consistently increased total N (2.36%), P (0.42%), K (2.31%), and Mg (0.23%) content per plant as compared to control plants, but total Ca (2.76%) contents per plant were also higher in plants treated with 500 ppm sawdust vermicompost extract as compared to control. Pant *et al.* (2009) suggested that the sawdust vermicompost extract effect observed here was largely a response to mineral nutrient, particularly N, uptake by plants. Increased crop yields and dietary antioxidants of broccoli with the use of compost and compost extract have been reported (Sanwal *et al.*, 2006).

Table 6. Measured plant nutrient content at the end of the experiment.

Spraying treatment	Leaf N (%)	Leaf P (%)	Leaf K (%)	Leaf Ca (%)	Leaf Mg (%)
Control	1.52 ^{c}	0.31 ^{d}	1.60 ^{c}	1.95 ^{c}	0.11 ^{b}
250 ppm VE	1.82 ^{b}	0.34 ^{c}	1.77 ^{d}	2.07 ^{b}	0.12 ^{b}
500 ppm VE	1.97 ^{b}	0.39 ^{b}	1.85 ^{b}	2.76 ^{a}	0.15 ^{b}
1000 ppm VE	2.36 ^{a}	0.42 ^{a}	2.31 ^{a}	2.30 ^{b}	0.23 ^{a}

*VE: Vermicompost extract. In each column, means followed by similar letter were not significantly different (P < 0.05) using Tukey's Test.

CONCLUSIONS

The application of sawdust vermicompost extract enhanced plant production and mineral nutrient content. We suggest that sawdust vermicompost extract effect observed here was largely a response to mineral nutrient, particularly N, uptake by plants. On the basis of the experimental results, it could be concluded that for better growth and higher yields of *Dracaena marginata*, the plant should be sprayed with sawdust vermicompost extract. The three-stage spray of 1000 ppm sawdust vermicompost extract also exerted a great influence over the growth of *Dracaena marginata.* This should be adopted for obtaining higher growth from *Dracaena marginata*.

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