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RESPONSE OF *Gardenia jasminoides* PLANTS GROWN ON VARIOUS GROWING MEDIA TO ORGANIC AMENDMENTS

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ABSTRACT

This investigation was conducted during two successive seasons of 2017 and 2018 to evaluate the efficacy of compost tea types prepared from different organic sources including filter mud, spent mushroom compost and vermicompost as well as the most suitable growing media on growth behavior and blooming of gardenia plants. The results showed that all organic fertilizers applied for *Gardenia jasminoides* plants grown in the mixture of sand and peat moss (1:2v/v) had the best results in comparison with the control plants grown in other growing media. Application of vermicompost tea fertilizer significantly improved all vegetative growth traits *i.e.* plant height, stem diameter, numbers of branches and leaves as well as increased leaf contents of total chlorophyll and elements of nitrogen, phosphorus and potassium. This reflected on producing flowers with good quality attributes of the plants. The highest populations of total bacteria, fungi and actinomycetes and dehydrogenase activity in the rhizosphere soil were attained by the application of vermicompost tea fertilizer for plants grown in sand and peat moss mixture.

Key wrds: *Gardenia jasminoides, peat moss, compost tea, NPK Fertilization.*

1. INTRODUCTION

Gardenia jasminoides is a fragrant flowering evergreen tropical shrub that belongs to the Rubiaceae family, characterized by glossy, bright green leaves and large double white highly fragrant flowers, cultivated in multiple areas in gardens worldwide (Bailey, 1969). Apart from the difficulties in creating the suitable conditions for the plant to live, gardenias need to be planted in an acidic soil (it is an acidophilic plant). It needs a moist soil with good drainage and desirable pH between 4.5 - 5.5 (Soliman *et al.,* 2013). It grows in many temperate regions (Gilam, 1999). It is not only used as natural yellow dyes for many years (Hong *et al.*, 2015), but also has various biological activities, such as anti-inflammatory (Lim *et al.*, 2008), anti-diabetic (Wu *et al.*, 2009), anti-depression (Tao *et al.,* 2014), improvement of the quality of sleep (Kuratsune *et al.,* 2010) and antioxidant properties (Debnath *et al.,* 2011). A number of chemical components of *G. jasminoides* have been isolated and characterized, including iridoids, iridoid glucosides, triterpenoids, organic acids, and volatile compounds. Geniposide, genipin, gardenoside, crocin, and iridiod are the major bioactive compounds found in *G. jasminoides*. For instance, the yield of geniposide reached 10.9% under certain extraction conditions (Yang *et al.,* 2009).

Using chemical fertilizers in agricultural production contaminates the soil and underground water. The movement of agrochemicals through soil to groundwater or their discharge to surface water represents an ecological risk (Allinson *et al.,* 2000). They also accumulate in food chain causing hazardous effects (Hegazi *et al.*, 2010).

Many solutions were suggested to reduce the chemical fertilizer problems, one of which is using organic fertilizers such as composts, which are low in costs and friendly environmental amendments. Composts applied to the soil, improves its quality by altering its chemical and physical properties, increasing organic matter content, water holding capacity, the overall diversity of microbes, providing macro and micro nutrients essential for plant growth and suppressing diseases, which indirectly contribute to plant growth enhancement (Heather *et al.*, 2006).

Compost tea is one of the alternative techniques extracted from composted materials by steeping or brewing the compost in water using various preparation methods (Ingham, 2005). It has been cited as an option for conventional and organic growers thought to enhance crop fertility by introducing microorganisms that might aid in soil nutrient retention and extraction, and by adding soluble nutrients, further adding to their potential value as a part of an integrated crop management plan (Kannangara *et al.,* 2006).

Filter mud compost, also called filter-cake, is the waste product in vacuum and press filters of the sugar industry which is about 3–8 % of processed sugarcane that can be used to increase organic material on the ground and provide benefits for the soil and plants (Jamil *et al.*, 2008).

Spent mushroom compost (SMC), otherwise known as the spent mushroom substrates, is the remains of the compost in which mushrooms are produced (McCahey *et al.,* 2003). It is composed of fungal mycelia, extracellular enzymes (such as cellulase and xylanase) secreted from mushrooms for degradation of substrates, and unused lignocellulosic substrates (Fasidi *et al.*, 2008). In field crop production, the principal uses of SMC are as an organic fertilizer and as a soil conditioner for enhancing physical and/or chemical properties of soil (Courtney and Mullen, 2008).

Vermicompost is a product derived from the accelerated biological degradation of organic wastes by earthworms and microorganisms (Arancon and Edwards 2005). Vermicompost improves soil aeration and texture thereby reducing soil compaction, enhances water retention capacity of soil because of its high organic matter content and also promotes better root growth, nutrient absorption and improves nutrient status of soil, both macro- and micro-nutrients (Chauhan and Singh, 2013).

Growing media, otherwise known as the plant substrates, are used to describe the materials used to grow plants in containers (Schroeder and Sell, 2009). A good growing medium provides a root environment that is initially free of plant pathogens and properties that ensure an adequate aeration, water, and nutrient supply (Savvas and Gruda, 2018).

Thus, the goal of the present study was to evaluate the efficacy of aerated compost teas prepared from filter mud, spent mushroom compost and vermicompost as the most suitable growing media on growth promotion and blooming of *Gardenia jasminoides* plant.

2. MATERIALS AND METHODS

2.1. Plant material

One hundred thirty-five uniforms and healthy *Gardenia jasminoides* plants with an average length of 12 cm resulting from tissue culture after their adaptation in a greenhouse shaded at the nursery of Horticulture Research Institute, Agricultural Research Center, Giza, Egypt were used. Plants were transplanted on the first week of October in pots of 18cm diameter containing different mixtures of peat moss and sand. All pots had bottom holes to allow excess water drainage.

2.2. Experimental lay out

The experiment was designed as a split plot with three replications in randomized complete blocks. The main plots were devoted to five organic fertilizer types; control (negative control), mineral NPK fertilizer (positive control), filter mud tea, spent mushroom compost tea and vermicompost tea and the sub plots were occupied by different growing media types containing three mixtures of sand and peat moss (1:1, 1:2 and 2:1 v/v).

* Control (un treated plants)
* Mineral NPK fertilizer (20:20:20) applied after one month from transplanting at a rate of 2 g/pot every two weeks until reaching the flowering stage.
* Organic fertilizer types included filter mud tea, spent mushroom compost tea and vermicompost tea.
* Compost teas extracted from the previous three different compost sources by completely submerging the respective compost in containers, in the ratio of 1: 10 (w/v) in tap water amended with 0.5 % (v/v) molasses are shown in Table (A) as described by Shrestha *et al.* (2018). All compost teas were added as 100 ml/plant after one month of adaptation and added continuously each two weeks till flowering stage.
* All plants were treated with chelated ferrous at the rate of 150 ppm every month along the growing season
* Analysis of peat moss and sand media were shown in Tables (A&B).

The following measurements were estimated at the end of each experimental season (2017, 2018):

1.Vegetative growth characteristics: Plant height (cm), stem diameter (cm), number of branches and number of leaves/plant.
2. Plant biomass characteristics: Stem fresh and dry weights (g) and root fresh and dry weight (g).
3. Flowering parameters: Flowering date, flowering plants (%), number of flowers/plant and fresh weight of flowers (g).
4. Leaf content of pigments: Chlorophyll a, b and total chlorophyll (Westein, 1957).
5. Leaf and soil contents of mineral elements
   * Total nitrogen (%):using the Kjeldahl method according to the method adopted by Pregl (1945).
   * Phosphorus (%):using spectrophotometer according to the method described by Snell and Snell (1967)
   * Potassium (%): using flame photometer according to the method described by Jackson (1967).
6. Biological activities in rhizospher soil of gardenia plants
   * The plate count technique using the suitable serial dilutions and specific media was applied for estimation of the examined microbial groups (total bacteria, fungi and actinomycetes) after one year (Defico Manual, 1989).
   * Dehydrogenase enzyme activity was assed according to Casida *et al.* (1964).

2.3. Experimental design and statistical analysis

The experiment was designed as a split plot with three replications in randomized complete blocks. The statistical analysis of the present data was carried out according to Snedecor and Cochran (1980). Averages were compared using the L.S.D. values at 5% level (Steel and Torrie, 1980).

Table (A): Physical, chemical and biological properties of compost teas and peat moss media.

	Parameters	Filter mud tea	Spent mushroom compost tea	Vermi-compost tea	Peat-moss
Physical and chemical properties	Density (Kg/m^3)	535	70	700	175
	Moisture content (%)	34	7	74	80
	pH (1:10) (%)	7.44	7.66	7.63	4.30
	EC (1:10) (dSm^{-1})	3.80	2.36	1.33	0.30
	Total nitrogen (%)	1.53	0.83	2.09	1.09
	Ammoniacel nitrogen (ppm)	84	700	56	70
	Nitrate nitrogen (ppm)	264	840	160	30
	Organic matter (%)	45.19	61.94	64.33	90.00
	Organic carbon (%)	26.21	35.93	37.31	52.20
	Ash (%)	54.81	38.06	35.67	10.00
	C/N ratio	17:1	34:1	18:1	48:1
	Total phosphorus (P_2O_5) (%)	4.60	0.40	2.42	0.23
	Total potassium (K_2O) (%)	0.41	0.80	0.76	1.70
Biological properties	Total bacteria (CFU/g)	8×10^6	2×10^6	5×10^6	5×10^2
	Total fungi (CFU/g)	9×10^3	3×10^3	6×10^3	1×10^1
	Total actionmysetes (CFU/g)	11×10^3	7×10^3	4×10^3	2×10^2

Results were calculated on oven dry basis.

Table (B): Physical and chemical properties of sandy soil sample.

Physical properties		Chemical properties								
pH (1:10) (%)	EC (1:10) (dSm^{-1})	Ca^{+2}	Mg^{+2}	K^+	Na^+	CO^{3-}	HCO^{3-}	Cl^-	SO_4^{--}	SP %
8.4	8.12	18.4	2.23	0.35	74	0.0	1.42	46.6	46.98	24

3. RESULTS AND DISCUSSION

3.1. Vegetative growth characteristics

Data presented in Table (1) show that application of organic fertilizers and different growing media either alone or in combination significantly improved all vegetative growth characteristics.

The highest significant values of all vegetative growth characteristics were attained by vermicompost tea fertilizer and filter mud tea and spent mushroom compost tea then mineral NPK fertilizer, while control plants resulted in significantly the least values in both seasons.

Plants grown in sand + peat (1:2) had significantly the highest values of those parameters followed by sand + peat (1:1). On the other hand, sand + peat (2:1) exhibited in significantly the least values in both season.

Application of vermicompost tea fertilizer for plants grown in sand + peat (1:2) had significantly the highest values of all parameters, while control plants grown in sand + peat (2:1) resulted in significantly the least values in both seasons.

These results are in accordance with those obtained by Putra *et al.* (2016) and Rahmad *et al.* (2019) on filter mud tea; Roy *et al.* (2015) and Wiafe-Kwagyan and Odamtten (2018) on spent mushroom compost tea. Tejada and Benítez (2015) and Mondal *et al.* (2017) on vermicompost tea, they found that these organic fertilizers promoted plant vegetative growth traits.

The utilization of various mineral elements present in the spent mushroom compost tea, may

Table (1): Effects of organic fertilizers and growing media on vegetative growth characteristics of *Gardenia jasminoides* during 2017 and 2018 seasons.

Organic fertilizers (A)	Growing media- Sand: Peat moss (v/v) (B)							
	1:1	1:2	2:1	Means (B)	1:1	1:2	2:1	Means (A)
	First season				Second season			
	Plant height (cm)							
Control	35.3	39.3	34.3	36.3	40.4	45.0	39.3	41.6
NPK	46.3	46.4	42.4	45.0	53.0	53.1	48.5	51.6
Filter mud tea	49.8	51.4	45.9	49.0	57.1	58.8	52.6	56.1
Spent mushroom compost tea	46.7	48.8	45.4	47.0	53.4	55.9	52.0	53.8
Vermicompost tea	49.6	55.8	47.1	50.9	56.8	63.9	54.0	58.2
Means (B)	45.5	48.3	43.0		52.2	55.4	49.3	
LSD 5%	A=4.4	B=3.4	AB=7.6		A=5.1	B=3.9	AB=8.8	
	Stem diameter (cm)							
Control	0.78	0.81	0.77	0.78	0.89	0.93	0.88	0.90
NPK	1.07	1.03	0.84	0.98	1.22	1.18	0.97	1.12
Filter mud tea	0.98	1.23	0.96	1.06	1.13	1.40	1.10	1.21
Spent mushroom compost tea	0.94	1.10	0.91	0.98	1.08	1.26	1.04	1.13
Vermicompost tea	1.10	1.27	1.10	1.16	1.26	1.45	1.26	1.32
Means (B)	0.97	1.09	0.92		1.11	1.24	1.05	
LSD 5%	A=0.08	B=0.07	AB=0.15		A=0.10	B=0.08	AB=0.17	
	No. of branches							
Control	7.00	6.43	5.43	6.29	8.02	7.36	6.22	7.20
NPK	7.50	7.53	7.17	7.40	8.59	8.62	8.21	8.47
Filter mud tea	8.30	8.47	8.13	8.30	9.50	9.70	9.31	9.50
Spent mushroom compost tea	8.20	8.23	7.87	8.10	9.39	9.43	9.01	9.28
Vermicompost tea	8.73	9.23	8.57	8.84	10.00	10.57	9.81	10.13
Means (B)	7.95	7.98	7.43		9.10	9.14	8.51	
LSD 5%	A=0.66	B=0.51	AB=1.15		A=0.76	B=0.59	AB=1.31	
	No. of leaves							
Control	86.8	87.2	60.9	78.3	99.4	99.8	69.7	89.6
NPK	103.2	100.3	89.4	97.6	118.2	114.9	102.4	111.8
Filter mud tea	111.3	123.4	110.7	115.1	127.5	141.3	126.7	131.8
Spent mushroom compost tea	80.5	121.3	108.0	103.3	92.1	138.9	123.7	118.2
Vermicompost tea	118.3	128.0	114.3	120.2	135.5	146.6	130.9	137.7
Means (B)	100.0	112.1	96.7		114.5	128.3	110.7	
LSD 5%	A=16.9	B=13.1	AB=29.3		A=19.4	B=15.0	AB=33.6	

be directly linked to good plant growth (Jonathan *et al.,* 2011). Moreover, the improvements in growth of plants could be attributed to that vermicomposts contribute to improvements in physico-chemical and biological characteristics of the planting media that favored better plant growth (Arancon and Edwards, 2005). In addition, the presence of a great diversity of microorganisms in vermicompost facilitates nutrient assimilation in roots and promotes plant growth by producing hormones and enzymes (Cabrera *et al.,* 2007). For this reason, vermicompost is considered a plant growth biostimulator and an excellent basis for the establishment of symbiotic and non-symbiotic beneficial microorganisms (Mondal *et al.,* 2017).

As to growing media, results are in agreement with those obtained by Abd El Gayed and Attia (2018) who found that the maximum beneficial effect on the vegetative

growth characteristics including number of leaves and branches was recorded in *Celosia argentea* plants grown in peat + sand (2: 1 v/v).

Peat moss generally tend to possess excellent physical, chemical and biological properties, which reflects on increasing nutrient retention, promoting vegetative growth and improving growth overall through the activity of meristematic tissue (Krucker *et al.,* 2010).

3.2. Plant biomass characteristics

As shown in Table (2), all the plant biomass characteristics i.e. fresh and dry weights of the stem and roots were significantly affected by the application of organic fertilizers and different growing media either alone or in combination in both seasons.

The promotion of plant biomass characteristics was associated with using vermicompost tea, spent mushroom compost tea, filter mud tea and mineral NPK fertilizer in descending order, whereas the least were attained by control plants in both seasons.

Plants grown in sand + peat (1:2) resulted in significantly the highest values of all parameters followed by sand + peat (1:1), sand + peat (2:1) had significantly the least values in both seasons.

Application of vermicompost tea for plants grown in sand: peat (1:2) resulted in significantly the highest values of all parameters. On the other hand, control plants grown in sand + peat (2:1) had significantly the least values in both seasons.

These results are in accordance with those obtained by Putra *et al.* (2016) and Rahmad *et al.* (2019) on filter mud tea; Wiafe-Kwagyan & Odamtten (2018) on spent mushroom compost tea as well as Arancon *et al.*, (2004) and Arancon and Edwards (2005) on vermicompost tea who found that accumulation of plant dry matter increased with increasing organic matter. The present results are in agreement with those obtained by Ercisli *et al.,* (2005) and Cros *et al.* (2007). They found that the highest stem and root dry weights were obtained from fern strawberry and common purslane plants grown in the peat moss medium.

3.3. Flowering parameters

3.3.1. Flowering date

Application of vermicompost tea and mineral NPK fertilizer induced early flowering (179, 178 and 177, 178 days, respectively) followed by filter mud tea and spent mushroom compost tea (185, 186 and 185, 187 days each), while the control plants exhibited late flowering (200 and 204 days) in both seasons.

No significant differences were observed among growing media concerning flowering date in both seasons.

Applications of vermicompost tea and mineral NPK fertilizer for plants grown in sand: peat (1:2v/v) had the earliest flowering date (178, 177 and 176, 177 days, respectively) followed by filter mud tea and spent mushroom compost tea for plants grown in sand: peat (1:2) (185, 184 and 184, 186 days, respectively), while control plants grown in sand: peat (2:1) recorded the latest (200 and 204 days) in both seasons.

These results are in accordance with those obtained by Edwards and Burrows (1988) who found that some ornamental plants such as chrysanthemums, salvias and petunias flowered earlier in vermicomposts compared to those grown in control planting media.

3.3.2. Flowering plants (%)

The highest significant percentages of flowering plants were attained by vermicompost tea followed by spent mushroom compost tea then filter mud tea. Both the control and mineral NPK fertilizer resulted in significantly the least percentages of flowering plants in both seasons.

Gardenia plants grown in sand + peat (1:2) had significantly the highest percentage of flowering plants followed by sand + peat (1:1). On the other hand, sand + peat (2:1) resulted in significantly the least percentage in both seasons.

Application of vermicompost tea for plants grown in sand + peat (1:2) had significantly the

Table (2): Effects of organic fertilizers and growing media on plant biomass characteristics of *Gardenia Jasminoides* during 2017 and 2018 seasons.

Organic fertilizers (A)	Growing media- Sand: Peat moss (v/v) (B)							
	1:1	1:2	2:1	Means (B)	1:1	1:2	2:1	Means (A)
	First season				Second season			
	Stem fresh weight (g)							
Control	23.3	28.6	22.6	24.8	26.7	32.7	25.9	28.4
NPK	31.2	36.9	29.2	32.4	35.7	42.2	33.4	37.1
Filter mud tea	32.7	39.9	29.0	33.9	37.4	45.7	33.2	38.8
Spent mushroom compost tea	39.3	43.3	33.5	38.7	45.0	49.6	38.4	44.3
Vermicompost tea	47.0	54.3	41.7	47.7	53.8	62.2	47.7	54.6
Means (B)	34.7	40.6	31.2		39.7	46.5	35.7	
LSD 5%	A=1.7	B=1.3	AB=2.9		A=1.9	B=1.5	AB=3.4	
	Stem dry weight (g)							
Control	11.4	14.8	11.2	12.5	13.0	16.9	12.9	14.3
NPK	11.6	15.6	11.9	13.0	13.2	17.9	13.6	14.9
Filter mud tea	15.0	18.8	14.5	16.1	17.2	21.6	16.6	18.4
Spent mushroom compost tea	18.7	21.0	15.5	18.4	21.4	24.1	17.8	21.1
Vermicompost tea	23.0	25.5	20.3	22.9	26.3	29.2	23.3	26.3
Means (B)	15.9	19.2	14.7		18.2	21.9	16.8	
LSD 5%	A=1.2	B=0.9	AB=2.0		A=1.3	B=1.0	AB=2.3	
	Root fresh weight (g)							
Control	21.5	26.3	18.3	22.1	24.7	30.1	21.0	25.3
NPK	22.2	28.4	19.3	23.3	25.4	32.5	22.1	26.7
Filter mud tea	30.0	34.0	27.6	30.5	34.4	38.9	31.6	35.0
Spent mushroom compost tea	31.7	34.7	30.3	32.2	36.3	39.7	34.7	36.9
Vermicompost tea	35.3	37.7	33.7	35.6	40.5	43.1	38.5	40.7
Means (B)	28.1	32.2	25.8		32.2	36.9	29.6	
LSD 5%	A=1.5	B=1.2	AB=2.7		A=1.8	B=1.4	AB=3.1	
	Root dry weight (g)							
Control	10.1	12.4	8.4	10.3	11.6	14.2	9.6	11.8
NPK	11.0	13.7	8.7	11.1	12.6	15.7	10.0	12.7
Filter mud tea	14.0	15.4	12.6	14.0	16.0	17.7	14.4	16.0
Spent mushroom compost tea	14.0	15.1	14.9	14.7	16.0	17.3	17.1	16.8
Vermicompost tea	16.9	18.2	16.6	17.2	19.4	20.8	19.0	19.7
Means (B)	13.2	15.0	12.2		15.1	17.1	14.0	
LSD 5%	A=1.8	B=1.4	AB=3.1		A=2.1	B=1.6	AB=3.6	

highest percentage of flowering plants, while mineral NPK fertilizer for plants grown in sand + peat (2:1) resulted in significantly the least percentage of flowering plants in both seasons.

3.3.3. Number of flowers/plant

The promotion of the number of flowers/plant was significantly associated with using vermicompost tea, spent mushroom compost tea and filter mud tea in descending order, whereas the least values occurred by both the control and mineral NPK fertilizer in both seasons.

Plants grown in sand + peat (1:2) resulted in significantly the highest value of the number of flowers/plant followed by sand + peat (1:1), while sand (2:1) had significantly the least value in both seasons.

Application of vermicompost tea for plants grown in sand: peat (1:2) resulted in significantly the highest number of flowers/plant. On the other hand, the control and mineral NPK fertilizer for plants grown in sand + peat (2:1) had significantly the least values in both seasons.

These results are in accordance with those obtained by Arancon *et al.* (2008) on petunias plants and Kist *et al.* (2019) on tomato plants who found that vermicompost produced significantly more flowers compared to inorganic fertilizers.

These results may also be attributed to the presence of plant growth regulating substances (PGRS) in vermicompost, which act directly on the plant physiology, providing more significant growth and development. However, earthworm intestine contains a wide range of microorganisms, enzymes, and hormones that are transferred to vermicompost during the organic waste degradations process (Nagavallemma *et al.,* 2004). These microorganisms can produce PGRS such as auxins, gibberellins, cytokinins, abscisic acid and ethylene in significant amounts (Karadeniz *et al.*, 2006). Among PGRS, the gibberellins are involved in flowering regulations and are essential for the development of fertile flowers in plants (Van Den Heuvel *et al.,* 2002).

As for growing media, the capability of peat moss for increasing flower number/plant was obtained by Basheer and Thekkayam (2012) on *Anthurium*; Naz *et al.* (2013) on *Antirrhinum majus*; Mousa (2015) on *Gardenia jasminoides* and Abd El Gayed and Attia (2018) on *Celosia argentea*

3.3.4. Fresh weight of flowers

The highest significant value of fresh weight of flowers was attained by Vermicompost tea followed by spent mushroom compost tea, filter mud tea then mineral NPK fertilizer, while the control plants resulted in significantly the least value in both seasons.

Plants grown in sand + peat (1:2) had significantly the highest value of fresh weight of flowers followed by sand + peat (1:1). On the other hand, sand + peat (2:1) resulted in significantly the least value in both seasons.

Aplication of vermicompost tea for plants grown in sand + peat (1:2) had significantly the highest value of fresh weight of flowers, while the control plants grown in sand + peat (2:1) resulted in significantly the least value in both seasons.

The role of NPK in increasing flowers weight was mentioned by Abdou (2002) on borage; Sayed (2004) and Dongardive *et al.* (2007) on gladiolus.

The capability of peatmoss in increasing flowers weight was attained by Basheer and Thekkayam (2012) on *Anthurium*; Naz *et al.* (2013) on *Antirrhinum majus*; Mousa (2015) on *Gardenia jasminoides* and Abd El Gayed and Attia (2018) on *Celosia argentea*.

3.4. Leaf contents of pigments

3.4.1. Chlorophyll (a)

The highest significant value of leaf content of chlorophyll (a) was attained by mineral NPK fertilizer and vermicompost tea, by spent mushroom compost tea then filter mud tea. Control plants exhibited significantly the least value of chlorophyll a in both seasons. No significant differences were observed among growing media in both seasons. Application of mineral NPK fertilizer for plants grown in sand + peat (1:2) had significantly the highest value of chlorophyll (a), while the control plants grown in sand + peat (2:1) resulted in significantly the least values in both seasons.

3.4.2. Chlorophyll (b)

The promotion of chlorophyll (b) was associated with using mineral NPK fertilizer, vermicompost tea, spent mushroom compost tea and filter mud tea in descending order, whereas the least value was significantly occurred by control in both seasons. No significant differences were observed among growing media in both seasons. Application of mineral NPK fertilizer for plants grown in sand+ peat (1:2) resulted in significantly the highest value of chlorophyll (b). On the other hand, the control plants grown in sand + peat (2:1) had significantly the least values in both seasons.

3.4.3. Total chlorophyll (a+b)

The highest significant value of leaf content of total chlorophyll was attained by mineral NPK fertilizer, vermicompost tea followed by spent mushroom compost tea then filter mud tea. Control plants exhibited significantly the least value in both seasons. Concerning the type of growing media, data showed that no significant differences were observed among them in both seasons. Application of mineral NPK fertilizer for plants grown in sand: peat mixture (1:2) had significantly the highest value of total

Table (3): Effects of organic fertilizers and growing media on flowering parameters of *Gardenia jasminoides* during 2017 and 2018 seasons.

Organic fertilizers (A)	Growing media- Sand: Peat moss (B)							
	1:1	1:2	2:1	Means (B)	1:1	1:2	2:1	Means (A)
	First season				Second season			
	Flowering date (Day)							
Control	201	199	200	200	205	203	204	204
NPK	177	176	179	177	179	177	179	178
Filter mud tea	185	185	186	185	186	184	187	186
Spent mushroom compost tea	185	184	185	185	187	186	188	187
Vermicompost tea	179	178	180	179	179	177	179	178
Means (B)	185	184	186		187	185	187	
LSD 5%	A=5	B=4	AB=9		A=4	B=3	AB=6	
	Flowering plants (%)							
Control	66.6	77.7	66.6	70.3	64.8	75.6	64.8	68.4
NPK	66.6	66.6	55.5	62.9	64.8	64.8	54.0	61.2
Filter mud tea	77.7	88.9	66.6	77.7	75.6	86.5	64.8	75.6
Spent mushroom compost tea	88.9	100.0	66.6	85.2	86.5	97.3	64.8	82.9
Vermicompost tea	88.9	100.0	77.7	88.9	86.5	97.3	75.6	86.5
Means (B)	77.7	86.6	66.6		75.6	84.3	64.8	
LSD 5%	A=23.6	B=18.3	AB=40.9		A=20.7	B=16.1	AB=35.9	
	No. of flowers/plant							
Control	3.77	5.53	2.99	4.10	4.31	6.34	3.42	4.69
NPK	4.13	4.97	2.97	4.02	4.73	5.69	3.40	4.61
Filter mud tea	4.67	5.27	3.17	4.37	5.34	6.03	3.63	5.00
Spent mushroom compost tea	5.00	6.00	3.00	4.67	5.73	6.87	3.44	5.34
Vermicompost tea	5.33	6.33	4.07	5.24	6.11	7.25	4.66	6.00
Means (B)	4.58	5.62	3.24		5.24	6.43	3.71	
LSD 5%	A=1.19	B=0.92	AB=2.06		A=1.36	B=1.06	AB=2.36	
	Average flower fresh weight (g)							
Control	1.87	1.60	1.50	1.66	2.14	1.83	1.72	1.90
NPK	1.67	2.53	2.10	2.10	1.91	2.90	2.40	2.40
Filter mud tea	2.50	2.90	2.33	2.58	2.86	3.32	2.67	2.95
Spent mushroom compost tea	2.70	3.03	2.43	2.72	3.09	3.47	2.79	3.12
Vermicompost tea	3.83	3.23	2.50	2.83	3.24	3.70	2.86	3.27
Means (B)	2.31	2.66	2.17		2.65	3.05	2.49	
LSD 5%	A=0.51	B=0.39	AB=0.88		A=0.58	B=0.45	AB=1.00	

chlorophyll, while control plants grown in sand + peat (2:1) resulted in significantly the least value in both seasons. These results are in accordance with those obtained by Abd El Gayed and Attia (2018) on *Celosia argentea* who found that the maximum beneficial effect on leaf content of total chlorophyll was occurred in plants received NPK fertilizer (20:20:20) compared to untreated plants.

3.5. Leaf contents of mineral elements

3.5.1. Nitrogen (% D.W)

Table (5) shows that organic fertilization of gardenia with vericompost tea or filter mud tea resulted in the highest significant N^- content, while the control plants recorded the lowest. Also, plants grown on a mixture of 2 sand + 1 peat contained higher significant nitrogen content than the two other media.

Plants grown on sand + peat moss (1:2) and treated with vericompost tea recorded the greatest value of N^- uptake. Whereas, the lowest significant levels were measured by the control plants grown in the mixture 2 sand: 1 peat.

3.5.2. Phosphorus (% D.W)

Growing media have no significant influence on phosphorus uptake (Table 5), while organic fertilization significantly affected it as the three organic fertilizers under investigation

Table (4): Effects of organic fertilizers and growing media on leaf contents of pigments of *Gardenia jasminoides* during 2017 and 2018 seasons

Organic fertilizers (A)	Growing media- Sand: Peat moss (v/v) (B)							
	1:1	1:2	2:1	Means (B)	1:1	1:2	2:1	Means (A)
	First season				Second season			
	Chlorophyll (A) (mg/g f.w)							
Control	0.87	0.72	0.68	0.76	0.99	0.83	0.78	0.87
NPK	2.51	2.64	2.41	2.52	2.88	3.03	2.76	2.89
Filter mud tea	1.93	2.11	2.11	2.05	2.21	2.42	2.41	2.35
Spent mushroom compost tea	2.03	2.31	2.25	2.20	2.33	2.65	2.58	2.52
Vermicompost tea	2.44	2.46	2.52	2.47	2.79	2.82	2.89	2.83
Means (B)	1.96	2.05	1.99		2.24	2.35	2.28	
LSD 5%	A=0.37	B=N.S.	AB=0.64		A=0.42	B=N.S.	AB=0.73	
	Chlorophyll (B) (mg/g f.w)							
Control	0.11	0.12	0.09	0.11	0.12	0.14	0.11	0.12
NPK	0.19	0.24	0.20	0.21	0.22	0.28	0.23	0.22
Filter mud tea	0.13	0.11	0.15	0.13	0.15	0.12	0.17	0.15
Spent mushroom compost tea	0.22	0.19	0.11	0.18	0.26	0.22	0.13	0.26
Vermicompost tea	0.19	0.22	0.16	0.19	0.22	0.25	0.18	0.22
Means (B)	0.17	0.18	0.14		0.12	0.14	0.11	0.12
LSD 5%	A=0.05	B=N.S.	AB=0.08		A=0.03	B=N.S.	AB=0.05	
	Total chlorophyll (A+B) (mg/g f.w)							
Control	0.98	0.85	0.77	0.86	1.12	0.97	0.88	0.99
NPK	2.71	2.88	2.61	2.73	3.10	3.30	2.99	3.13
Filter mud tea	2.06	2.22	2.26	2.18	2.36	2.54	2.58	2.50
Spent mushroom compost tea	2.26	2.50	2.36	2.37	2.58	2.86	2.71	2.72
Vermicompost tea	2.63	2.68	2.68	2.66	3.01	3.06	3.06	3.05
Means (B)	2.13	2.23	2.14		2.43	2.55	2.44	
LSD 5%	A=0.25	B=N.S.	AB=0.43		A=0.28	B=N.S.	AB=0.49	

significantly improved phosphorus content compared with the control and NPK fertilizer. Gardenia plants grown in 1 sand: 2 peat moss contained the highest phosphorus level, while those grown in 2 sand: 1 peat or the control plants recorded the lowest significant content.

3.5.3. Potassium (% D.W)

As shown in Table (5), K^+ content significantly untreated plants was affected by application of organic fertilizers and different growing mixture either alone or in combination compared to the control in both seasons. The highest significant leaf content of K^+ was detected in plants fertilized with vericompost tea, while the lowest significant one was measured for the control plants. Gardenia grown on a medium of sand + peat (1:2) contained the highest significant potassium content.

Gardenia plants grown in mixture of 1 sand: 2 peat and revived vericompost tea contained the highest significant concentration of potassium.

These findings may be attributed to the ability of compost tea to improve the absorption and translocation of N, P and K by leaves tissues. As previously mentioned, the use of tea compost increased plant macronutrient contents, and this is related to a positive effect on increasing the root surface area per unit of soil volume, water use efficiency and photosynthetic activity, directly affect physiological processes. Compost tea sources increased N, P and K uptake (Siddiqui *et al.*, 2011). The same trend was observed by Fouda and Ali (2016) who reported that the application of tea compost increased the N uptake of radish leaf by about 30.1% over the control, compost tea also increased the P and K uptake by 12.6 and 51.5%, respectively.

3.6. Soil content of mineral elements

Data in Table (6) show the effects of growing media and organic fertilizers on soil contents of N, P and K in the rhizosphere zone of gardenia plants.

Table(5): Effects of organic fertilizers and growing media on leaf contents of N, P and K of *Gardenia jasminoides* during 2017 and 2018 seasons

Organic fertilizers (A)	Growing media- Sand: Peat moss (v/v) (B)							
	1:1	**1:2**	**2:1**	**Means (B)**	**1:1**	**1:2**	**2:1**	**Means (A)**
	First season				**Second season**			
	Nitrogen (% d.w)							
Control	1.024	1.126	0.811	0.987	1.028	0.912	0.921	0.954
NPK	1.061	1.529	0.833	1.141	1.088	1.181	1.223	1.164
Filter mud tea	1.262	1.690	1.215	1.389	1.281	1.757	1.302	1.447
Spent mushroom compost tea	1.065	1.197	1.008	1.090	1.025	1.131	1.011	1.056
Vermicompost tea	1.452	1.901	1.256	1.536	1.432	1.877	1.551	1.620
Means (B)	1.173	1.489	1.025		1.171	1.372	1.202	
LSD 5%	A=0.053	B=0.041	A×B=0.091		A=0.063	B=0.042	A×B=0.098	
	Phosphorus (% d.w)							
Control	0.112	0.116	0.065	0.098	0.111	0.117	0.068	0.099
NPK	0.113	0.178	0.111	0.134	0.121	0.166	0.108	0.132
Filter mud tea	0.166	0.207	0.163	0.179	0.182	0.212	0.162	0.185
Spent mushroom compost tea	0.159	0.187	0.160	0.169	0.177	0.191	0.161	0.176
Vermicompost tea	0.217	0.244	0.216	0.226	0.219	0.249	0.211	0.226
Means (B)	0.153	0.186	0.143		0.162	0.187	0.142	
LSD 5%	A=0.055	B= N.S.	A×B=0.097		A=0.0501	B= N.S.	A×B=0.091	
	Potassium (% d.w)							
Control	0.668	0.676	0.629	0.658	0.655	0.681	0.608	0.648
NPK	0.725	0.973	0.634	0.777	0.698	0.992	0.655	0.782
Filter mud tea	1.144	1.181	1.008	1.111	1.151	1.210	1.013	1.125
Spent mushroom compost tea	1.007	1.098	0.848	0.984	1.009	1.091	0.865	0.988
Vermicompost tea	1.221	1.806	1.170	1.399	1.201	1.758	1.188	1.382
Means (B)	0.953	1.147	0.858		0.943	1.146	0.866	
LSD 5%	A=0.068	B=0.053	A×B=0.119		A=0.061	B=0.047	A×B=0.107	

3.6.1. Nitrogen (% D.W)

The mixture of sand and peat at ratio of 1: 2 (v/v) resulted in the highest nitrogen contents. Vermicompost tea did not significantly differ from filter mud tea in their effect on N-content. The lowest significant value of N% was recorded for the control plants without fertilization. Vermicompost tea applied to the mixture of 1 sand: 2 peat resulted in the highest significant soil nitrogen content.

3.6.2. Phosphorus (% D.W)

Soil P^- content took the same trend of soil N^- content. Fertilization with vermicompost tea recorded the highest significant soil content of phosphorus, and 1 sand: 2 peat resulted in the highest phosphorus contents. The highest significant soil phosphorus content was detected for 1 sand: 2 peat recived vermicompost tea.

3.6.3. Potassium (% D.W)

Both organic fertilization and growing media have significant effect on soil potassium content. The highest significant value of potassium content in the soil was detected for 1:2 sand + peat amended with vermicompost tea fertilization.

Fouda and Ali (2016) mentioned that there were greater N, P and K in soil receiving compost of compost tea, and the contents increased with increasing compost tea ratios. Siddiqui *et al.* (2011) found that application of compost tea increased N, P and K soil content compared with inorganic fertilizer alone, and the increase depended on compost tea ratios

Table (6): Effects of organic fertilizers and growing media on soil contents of N, P and K of *Gardenia jasminoides* during 2017 and 2018 seasons.

Organic fertilizers (A)	**Growing media- Sand: Peat moss (v/v) (B)**							
	1:1	**1:2**	**2:1**	**Means (B)**	**1:1**	**1:2**	**2:1**	**Means (A)**
	First season				**Second season**			
	Nitrogen (%)							
Control	0.58	0.78	0.39	0.58	0.51	0.73	0.40	0.55
NPK	1.08	1.12	1.08	1.09	0.91	1.07	1.04	1.01
Filter mud tea	1.18	1.29	1.11	1.19	1.15	1.26	1.04	1.15
Spent mushroom compost tea	0.90	0.93	0.89	0.91	0.90	1.04	0.85	0.93
Vermicompost tea	1.18	1.40	1.14	1.24	1.34	1.35	1.05	1.25
Means (B)	0.98	1.10	0.92		0.96	1.09	0.88	
LSD 5%	A=0.11	B=0.08		A×B=0.19	A=0.13	B=0.10		A×B=0.23
	Phosphorus (%)							
Control	0.003	0.004	0.001	0.003	0.004	0.004	0.002	0.003
NPK	0.010	0.014	0.007	0.010	0.013	0.024	0.008	0.015
Filter mud tea	0.035	0.115	0.016	0.055	0.018	0.138	0.014	0.057
Spent mushroom compost tea	0.015	0.022	0.007	0.015	0.018	0.034	0.009	0.020
Vermicompost tea	0.141	0.166	0.099	0.135	0.107	0.152	0.102	0.120
Means (B)	0.041	0.064	0.026		0.032	0.070	0.027	
LSD 5%	A=0.030		B=0.026	A×B=0.053	A=0.031	0.028		A×B=0.059
	Potassium (%)							
Control	0.032	0.033	0.013	0.026	0.030	0.056	0.013	0.033
NPK	0.032	0.044	0.021	0.032	0.031	0.061	0.022	0.038
Filter mud tea	0.045	0.141	0.033	0.073	0.044	0.132	0.031	0.069
Spent mushroom compost tea	0.042	0.064	0.021	0.042	0.035	0.075	0.025	0.045
Vermicompost tea	0.071	0.173	0.033	0.092	0.048	0.166	0.035	0.083
Means (B)	0.044	0.091	0.024		0.038	0.098	0.025	
LSD 5%	A= 0.04	B= 0.031		A×B=0.075	A= 0.041	B= 0.029		A×B=0.077

3.7. Biological activities in rhizospher soil of gardenia plants

Both growing media and organic fertilization significantly influenced microbiological counts and dehydrogenase activity of the soil (Table 7).

3.7.1. Bacterial counts

The highest counts were found in vermicompost tea fertilized soil, being 58.16 x 10^5 and 56.30 x 10^5 $CFUg^{-1}$ during the two seasons respectively. The growing medium consists of 1 sand: 2 peat recorded the highest bacterial count (55.26 and 53.08 x 10^5 cfu/g for the two seasons, respectively).

Applying vermicompost tea to 1 sand: 2 peat growing medium resulted in numbers of bacteria representing 111.20 and 110.85 x 10^5 cfu/g soil, respectively.

3.7.2. Fungal counts

The highest fungal number was detected in the soil fertilized with vermicompost tea, being 90.93 and 87.59 x 10^3 cfu/g soil, in the first and second seasons, respectively. Using a medium consisting of sand + peat at ratio of 1:2 supported fungal growth with counts 49.79 and 47.10 x 10^3 cfu/g for the two seasons.

The greatest soil fungal count was detected in rhizosphere soil of gardenia plants grown in 1 sand: 2 peat soil mixture and fertilized with vermicompost tea reaching 102.1 and 98.53 cfu /g during the two seasons respectively.

3.7.3. Actinomycets counts

The best treatment achieved the highly counts of actinomycetes in rhizosphere was vermicompost tea that recorded 98.84 and 94.68 x 10^3 cfu /g during two seasons, respectively. Using media consisting of sand + peat at ratio of 1:2 favored for actinomycetes to reach the maximum counts (70.86 and 68.42 x 10^3 cfu/g, respectively). and. The highest counts were detected for the treatment of vermicompost tea

Table (7): Effects of organic fertilizers and growing media on microbial counts in rhizospher of *Gardenia jasminoides* **during 2017 and 2018 seasons.**

Organic fertilizers (A)	Growing media- Sand: Peat moss (v/v) (B)							
	1:1	1:2	2:1	Means (B)	1:1	1:2	2:1	Means (A)
	First season				Second season			
	Bacterial count (10^5 cfu/g)							
Control	11.60	25.03	10.60	15.74	12.04	25.88	9.25	15.72
NPK	19.07	43.83	12.77	25.22	20.22	32.58	13.99	22.26
Filter mud tea	30.30	50.73	23.73	34.92	26.05	53.55	25.22	34.94
Spent mushroom compost tea	27.30	44.53	16.53	29.45	25.62	42.55	17.32	28.50
Vermicompost tea	34.97	112.20	27.30	58.16	29.69	110.85	28.35	56.30
Means (B)	24.65	55.26	18.19		22.72	53.08	18.83	
LSD 5%	A=1.44	B=1.12	A×B=2.49		A=1.39	B=1.13	A×B=2.55	
	Fungal count (10^3 cfu/g)							
Control	18.62	25.78	11.2	18.53	19.34	24.89	10.33	18.19
NPK	20.05	32.24	11.98	21.42	21.11	29.55	10.88	20.51
Filter mud tea	32.73	56.18	19.2	36.04	31.55	52.18	20.11	34.61
Spent mushroom compost tea	22.38	32.64	14.52	23.18	22.09	30.36	15.25	22.57
Vermicompost tea	98.22	102.1	72.47	90.93	94.88	98.53	69.35	87.59
Means (B)	38.40	49.79	25.87		37.79	47.10	25.18	
LSD 5%	A=1.81	B=1.40	A×B=3.14		A=1.91	B=1.42	A×B=3.21	
	Actinomycetes (10^3 cfu/g)							
Control	30.62	35.39	15.83	27.28	31.25	34.51	17.33	27.70
NPK	33.17	50.73	22.62	35.51	31.25	48.61	25.15	35.00
Filter mud tea	48.83	90.73	43.25	60.94	49.33	88.31	45.25	60.96
Spent mushroom compost tea	33.32	64.27	25.73	41.11	32.55	62.15	28.21	40.97
Vermicompost tea	100.1	113.20	83.21	98.84	95.17	108.51	80.35	94.68
Means (B)	49.21	70.86	38.13		47.91	68.42	39.26	
LSD 5%	A=3.11	B=2.41	A×B=5.39		A=3.22	B=2.51	A×B=5.45	

and 1sand: 2 peatmoss growing medium (113.20 and 108.51 x 10^3 cfu/g during the two seasons, respectively).

Microbial communities are usually considered as important indicators of soil fertility because of their association with plant nutrition (Lei *et al*., 2016). Compost tea contains a high population of microbes, which may enhance growth and yield of crops. Besides, these microbes produce plant growth hormones and chemical compounds (siderophores, tannins and phenols) which are antagonistic to various soil pathogens. In addition, other microbes may benefit plants through mechanisms such as N^- fixation and phosphate solubilization. The use of compost extract is also claimed to increase soil carbon levels, improve soil structure, nutrient cycling, and water holding capacity and suppress plant diseases. So, compost tea applied as foliar spray with plowing rice straw on barely plants gave the highest values of all soil biological activity parameters. Where, total bacteria count 135 x 10^7 and 176 x 10^7 cfu g^{-1} dry soil while, total fungi 1.8 x 10^3 and 28 x 10^3 cfu g-1 dry soil and total actinomycetes were 91x10^3 and 192 x10^3 cfu g^{-1} dry at 50 and 90 days from sowing, respectively (Khalil *et al*., 2014). Also, compost tea application had different influences on soil microbial population. In this concern, Taha *et al.* (2016) reported that population of bacteria, and fungi were significantly affected by the compost tea treatments, whereas actinomycetes were not significantly affected by these treatments. Also, Heather *et al.* (2006) stated that bacterial counts were higher in the soil treated with compost and compost tea; this can be explained by the increased nutrition supplement due to the compost and compost tea. On the other hand,

Table (8): Effect of organic fertilizers and growing media on dehydrogenase enzyme activities in rhizospher of *Gardenia jasminoides* during 2017 and 2018 seasons.

Organic fertilizers (A)	Growing media- Sand: Peat moss (v/v) (B)							
	1:1	1:2	2:1	Means (B)	1:1	1:2	2:1	Means (A)
	First season				Second season			
Control	4.07	6.08	3.80	4.65	4.11	5.89	3.58	4.53
NPK	7.27	11.59	6.45	8.44	7.33	13.1	6.81	9.08
Filter mud tea	13.19	19.55	12.68	15.14	13.25	20.25	12.35	15.28
Spent mushroom compost tea	12.99	13.28	12.26	12.84	13.19	13.69	11.92	12.93
Vermicompost tea	20.52	21.18	16.13	19.28	21.25	22.55	16.01	19.94
Means (B)	11.61	14.34	10.26		11.83	15.10	10.13	
LSD 5%	A=0.22	B=0.17	A×B=0.4		A=0.24	B=0.18	A×B=0.9	

Hegazy *et al.* (2013) reported that the total fungal counts in soil were decreased by compost tea treatment.

3.7.4. Dehydrogenase enzymes activity

Highly significant values of dehydrogenase activities were detected as a result of vermicompost tea application recording 21.18 and 22.55 µg TPF/g soil during two seasons, respectively. Also, the growing media had a significant influence on the enzyme activity where the highest activities were detected for 1 sand: 2 peat (14.34 and 15.10 µg TPF/g soil, respectively). In respect to the interaction effect, the highest significant values of dehydrogenase were reported by applying vermicompost tea to growing medium of 1 sand: 2 peat being 21.18 and 22.55 µg TPF/g soil for the two seasons as shown in Table (8).

Many studies showed that the application of organic fertilizers increases overall enzyme activity. Dehydrogenase enzyme increased from 337.04 to 512.59 µg TPF g-1 dry representing increase percentages from 91.89 to 245.68 µg g^{-1} dry soil with combination between compost tea and PGPR treatments at 50 and 90 day respectively (Khalil *et al*., 2014). Soil dehydrogenase activity reflects the oxidative activity of soil microflora and is consequently used as an indicator of microbial activity (Masciandaro *et al.*, 1994).

Conclusion

It could be recommended that fertilization vermicompost tea of plants grown in sand + peat (1: 2 v/v) medium magnified growth traits and increased leaf contents of total chlorophyll and mineral elements which reflect on producing high flowers with a good quality attributes of *Gardenia jasminoides* plants.

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استجابة نباتات الجاردينيا جاسمينويدز النامية في أوساط مختلفة لمحسنات عضوية

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ملخص

أجرى هذا البحث لمدة موسمين متتاليين (2017، 2018) لتقييم فعالية مستخلصات الكمبوست المجهز من مصادر عضوية مختلفة وتشمل الطين المرشح الناتج من صناعة قصب السكر، ومخلفات فطر عيش الغراب وكمبوست الديدان الأرضية بالإضافة إلى تحديد أنسب بيئة زراعة على سلوك النمو والتزهير لنباتات الجاردينيا. أظهرت النتائج أن جميع الأسمدة العضوية للنباتات المزروعة في وسط الزراعة والمتكون من الرمل + البيتموس بنسبة (1: 2) أعطت أفضل النتائج مقارنة بالنباتات الغير معاملة والمزروعة في بيئات الزراعة الأخرى. كما أدى استخدام سماد كمبوست الديدان الأرضية للنباتات المزروعة في وسط الرمل + البيتموس بنسبة (1: 2) إلى تحسن كبير في جميع صفات النمو الخضري والممثلة فى ارتفاع النبات وقطر الساق وعدد الأفرع وعدد الأوراق بالإضافة إلى زيادة محتوى الأوراق من الكلوروفيل الكلي ومحتوى النبات من ا لنيتروجين والفوسفور والبوتاسيوم والتي انعكست فيما بعد في إنتاج أزهار عالية الجودة ذات صفات جيدة من نباتات الجاردينيا. وفيما يتعلق بالنشاط الميكروبيولوجي في التربة ، تم الحصول على أكبر عدد من الكائنات الحية الدقيقة الكلية بما في ذلك البكتيريا والفطريات والأكتينوميسيس والنشاط الكلي لإنزيم الديهيدروجينيز في منطقة الجذور نتيجة استخدام سماد كمبوست الديدان الأرضية للنباتات المزروعة في وسط الرمل + البيتموس بنسبة (1: 2) حجما.

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