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Comparison Study between Compost and Vermicompost Application on Lettuce Production under Potassium Fertilization

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ABSTRACT

The experiment was conducted under greenhouse condition, to evaluate the effect different rates of compost (C_1= 0.5 ton fed^{-1}, C_2= 1 ton fed^{-1} and C_3= 2 ton fed^{-1}) and vermicompost (V_1= 0.5 ton fed^{-1}, V_2= 1 ton fed^{-1} and V_3= 2 ton fed^{-1}) combined with various levels of potassium fertilization (120,140 and 160 kg fed^{-1}) on yield parameters and leaf nutritional content in lettuce (*Lactuca sativa* L. cv Batavia) in the greenhouse of the National Research. The results showed the superiority of vermicompost compared to the traditional compost, with its high effect on the lettuce yield. The values of the yield parameters were high under the high rate of vermicompost (2 ton fed^{-1}), especially under second rate of potassium fertilization(140 kg fed^{-1}) . The effect of vermicompost was also evident on the nutritional status of lettuce leaves. Vermicompost increased N, P and K uptake as compared with application of compost. The highest values of N, P and K uptake was noticed with high rate of vermicompost (2 ton fed^{-1}) combined with second level of potassium fertilization (140 kg fed^{-1}) as compared with other treatments.

KEY WORDS: Vermicompost, Compost, Lettuce plants, Yield parameters, Nutrients uptake

INTRODUCTION

Composting and vermicomposting are adequate technologies which turn into waste to wealth [**1**]. Conventional composting and vermicomposting are perfectly distinguished processes in particular with appertain to optimum temperatures for each operation and the kind of decomposer microbial societies that outnumber during strong processing. While 'thermophilic bacteria' outnumber in conventional composting, 'mesophilic bacteria and fungi' predominate in vermicomposting. Vermicomposts have much 'finer structure' than common compost and contain nutrients in forms that are easily available for plant uptake. Vermicomposts have fabulous chemical and biological properties with 'plant growth regulators' (lacking in other composts) [**2**].

Atiyeh**[1]**indicated that the compost was higher in 'ammonium', but the vermicompost higher in 'nitrates', which is the more available form of nitrogen. Ansari**[3]**and Narkhede**[4]** They indicated that vermicompost has higher N availability than the compost,as well as the outfit of some nutrients such as P,K, S and Mg, were increased by adding vermicompost as compared to compost to soils.

Biological degradation of organic wastes by earthworms andsome microorganisms produces vermicompost, which is highly humified through the avalanche of the origin waste materials by earthworm and entity of microbes **[5]**.

Vermicompost played a major role in improving growth and yield of different field crops, including vegetables, flowers and fruit crops. Arancon**[6]** reported that increasing in the growth rates of tomato, lettuce, and pepper, in response to much lower substitutions of 8%–10% of vermicompost into peat mixtures. Jahan**[7]** studied that the effects of various doses of vermicompost(0, 1.5, 3 and 6 ton/ha) on cauliflower plants have been investigated. According to the results, the maximum yield was obtained from the field on which 6 ton/ha of vermicompost was applied. Adiloğlu**[8]**showed that significant rise in the plant width, the number of leaves, leaf size, leaf width, and the plant fresh weight was observed upon the increasing doses of vermicompost application. On the other hand, upon the vermicompost application decrease in the height and root size of the lettuce plant was determined comparing to the control group. Bai and Malakout**[9]** reported that increase in N,P, and K uptake of the some vegetables were determined with the application of increasing doses of vermicompost.

The paper aimed to comparison study between compost and vermicompost application on lettuce production under potassium fertilization

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MATERIAL AND METHODS

A greenhouse study was conducted to study the effects of different rates of compost (C_1= 0.5 ton fed^{-1}, C_2= 1 ton fed^{-1} and C_3= 2 ton fed^{-1}) and vermicompost (V_1= 0.5 ton fed^{-1}, V_2= 1 ton fed^{-1} and V_3= 2 ton fed^{-1}) combined with various levels of potassium fertilization (120,140 and 160 kg fed^{-1}) on yield parameters and leaf nutritional content in lettuce (*Lactuca sativa* L. cv Batavia) in the greenhouse of the National Research Centre, Dokki, Egypt.

Plastic pots (30 cm in diameter) were filled with 10 kg soil. Some chemical properties of the soil used in Table (1). The vermicompost was produced in the Soil and Water Use Laboratory - National Research Centre- and using only different plant residues and using one species of earthworm (*Eisenia foetida*). Also, the compost was produced from plant residues (produced by Egyptian Company for Solid Waste Recycling).Vermicompost and compost were determined Table(2) using the standard procedures outlined by Cottenie**[10]**.As well as growth regulator analyses of compost and vermicompostwere determined (Table,3) using the standard procedures outlined by **Larsen [11].**

Table (1): Some chemical properties of soil used:

Soil property	Value
pH (1:2.5 soil suspension)	7.50
EC (dS m^{-1}), soil paste extract	1.20
Soluble ions (mmol L^{-1})	
Ca^{++}	5..73
Mg^{++}	4.21
Na^{+}	1.54
K^{+}	0.52
CO_3^{--}	nd*
HCO_3^{-}	1.10
Cl^{-}	0.96
SO_4^{--}	9.94

* nd = not detected

The transplant of Lettuce (*Lactuca sativa* L.cv Batavia) were obtained from Al Hagag farms. The experiment laid out in a randomized complete block design with five replications. The transplant was done when the seedlings were with four true leaves.

Table (2): Some chemical properties of compost and vermicompost used:

Analyses	Compost	Vermicompost
pH	6.40	6.50
EC (dS m^{-1})	4.94	2.80
Moisture content (%)	15	15
Organic matter (%)	46.48	75.1
Organic carbon (%)	27.02	43.6
Ash (%)	53.52	24.9
C/N ratio	1:19.3	1:18.2
N (%)	1.40	2.40
P (%)	0.54	0.66
K (%)	0.9	1.20

Table (3): Plant growth regulator analyses of compost and vermicompost used:

Plant growth regulators (ppm)	Compost	Vermicompost
Indol Acetic Acid	3.692	50.82
Abscisic Acid	8.560	78.70
Cytokinin	nd*	40.79
Gibrilic Acid	nd	75.80

* nd = not detected

The lettuce plants samples were collected and the following measurements were recorded: fresh weight of leaves (g/plant), dry weight of leaves (g/plant), fresh weight of roots (g/plant), dry weight of roots(g/plant), leaf area (cm^2), leaves number $plant^{-1}$, root length (cm). Sample of leaves were oven dried at 70 °C then fine grinded and wet digested N, P and K contents of leaves.

All data obtained were subjected to analysis of variance according to Snedicor and Cochran**[12].** The least significant differences (LSD) at P= 0.05 level was to verify the difference between means of the treatments.

RESULTS AND DISCUSSION

Data in Table (4) showed that the main effect of compost rates (C_1, C_2 and C_3) and vermicompost rates (V_1, V_2 and V_3) on yield parameters (fresh and dry weight of leaves, fresh and dry weight of roots, leaf area, leaves number, root length).

The results indicated that the best effect and the significant increase was for all rates of vermicompost compared to the same rates of the compost on all total growth parameters of lettuce plant. The V_3 (2 ton fed^{-1}) gave high value of fresh weight of leaves, dry weight of leaves, fresh weight of roots, dry weight of roots, Leaf area, leaves number, root length (252.2 g, 28.5 g, 21.78, 68.54 cm^2, 11.76 cm, 12.94g and 1.46 g, respectively). The effective role of vermicompost for good growth and high yield production of lettuce was due to vermicompost has a high nutrients content and growth regulators comparing it with compost, because the vermicompost contained a suitable concentration of different growth regulators such as indole acetic acid and cytokinin which significantly improved plant growth and increasing yield of lettuce by comparing it with the compost.

Table (4): Main effect of vermicompost and compost rates on yield parameters of lettuce plant.

Organic fertilizer ton fed^{-1}	Fresh weight of leaves	Dry weight of leaves	No. of leaves	Leaf area	Root length	Fresh weight of root	Dry weight of root
	g			cm^2	cm	g	
V_1	227.3	25.7	19.33	50.11	9.757	12.48	1.41
V_2	242.5	27.4	21.00	67.28	11.02	13.07	1.44
V_3	252.3	28.5	21.78	68.54	11.76	12.94	1.46
C_1	219.7	24.8	17,44	36.83	7.433	11.42	1.29
C_2	231.6	26.2	20.00	44.19	9.423	11.61	1.31
C_3	242.9	27.4	20.67	53.00	9.033	11.76	1.33
$LSD_{0.05}$	8.42	0.88	0.96	1.18	0.70	0.259	0.063

Vermicompost significantly ameliorate plants growth when applied even in small amounts and it is effectively used in both floriculture and horticulture **[13]**. Vermicompost not only makes plants hygienic, competent and productive, it also detects plant development with hormones. More importantly, it contributes in soil fertility and quality by rising microbial activity and microbial biomass levels and also prohibits annihilation of soil borne pests and diseases **[14]**.

Data in Table (5) showed that the main effect of potassium fertilization levels on yield of lettuce plants. Increasing potassium fertilization levels increased significantly all yield parameters. The second level of potassium fertilization (140 kg fed^{-1}) was gave higher values of fresh and dry weight of leaves , number of leaves , leaf area, fresh and dry weight of root and root length (242.3 g, 27.38 g, 23.06, 64.21 cm^2, 12.60 g, 1.424 g and 11.00 cm, respectively).

Table (5): Main effect of potassium fertilization on yield parameters of lettuce plants

K fertilization Kg fed^{-1}	Fresh weight of leaves	Dry weight of leaves	No. of leaves	Leaf area	Root length	Fresh weight of root	Dry weight of root
	g			cm^2	cm	g	
120	227.7	25.73	16.83	40.28	8.438	11.77	1.330
140	242.3	27.38	23.06	64.21	11.00	12.60	1.424
160	238.1	26.90	30.22	55.48	9.775	12.26	1.385
$LSD_{0.05}$	5.71	0.302	0.676	0.836	0.495	0.183	0.044

Data in Table (6) showed that di interaction effect of organic fertilization rates (compost and vermicompost) and potassium fertilization rates on yield parameters of lettuce plants. Increasing K fertilization level under compost and vermicompost led to significantly increasing of all yield parameters. But the highest values of all lettuce yield parameters were achieved under vermicompost condition, especially at the third rate of vermicompost (2 ton fed^{-1}) combined with second level of K fertilization (140 kg K_2O fed^{-1}).Vermicompost is a sustainable source of some nutrients such as N, P, K and Fe**[1]**, and the nutrients in vermicompost are easily absorbed by plants **[15].**

Table (6): Di-interaction effect of compost and vermicompostrates and potassium fertilization levels onyield parameters of lettuce plants.

Organic fertilizer ton fed^{-1}	K fertilization Kg fed^{-1}	Fresh weight of leaves	Dry weight of leaves	No. of leaves	Leaf area	Root length	Fresh weight of root	Dry weight of root
		g			cm^2	cm	g	
V_1	120	224.4	25.36	16.3	41.6	8.23	12.2	1.38
	140	225.9	25.53	22.3	58.4	9.97	12.6	1.42
	160	231.7	26.18	19.3	50.3	11.1	12.7	1.44
V_2	120	231.7	26.18	18.7	50.5	9.60	12.4	1.40
	140	249.9	28.24	23.0	83.4	11.3	13.3	1.50
	160	245.9	27.79	21.3	67.9	12.2	13.4	1.51
V_3	120	240.0	27.12	18.7	45.6	9.70	12.6	1.42
	140	266.6	30.13	27.0	84.1	12.07	13.0	1.47
	160	250.3	28.28	19.7	75.9	13.5	13.2	1.49
C_1	120	216.2	24.43	14.0	27.9	6.70	11.1	1.25
	140	223.3	25.23	19.7	41.9	7.37	11.5	1.30
	160	219.5	24.80	18.7	40.7	8.23	11.7	1.32
C_2	120	225.7	25.50	16.3	36.8	8.27	11.1	1.25
	140	232.9	26.32	22.0	50.3	8.97	11.4	1.29
	160	236.1	26.68	21.7	45.5	11.0	12.2	1.38
C_3	120	228.4	25.81	17.0	39.2	8.13	11.2	1.27
	140	255.1	28.83	24.3	67.2	8.97	11.7	1.32
	160	245.3	27.72	20.7	52.6	10.0	12.3	1.39
$LSD_{0.05}$		4.184	0.495	1.656	2.049	1.213	0.448	0.109

Furthermore, vermicompost has an exact granular build with a great surface area, which allows it to absorb and hold nutrients **[16]**. A large number of plant hormones are found in vermicompost such as indole acetic acid and kinetin **[17]**. The application of vermicompost has been found to be an effective method for rejuvenation of soil fertility, enrichment of available nutrient pools, and conservation of water **[18].**Vermicompost amendments can rise the growth and yield of greenhouse crops **[19] [20].**

Nutritional status:

It is clear from data presented in Table (7) revealed that application of compost and vermicompost combined with potassium fertilization led to increasing nitrogen, phosphorus and potassium uptake of leaves lettuce plants. The increasing in nutrients uptake of leaves may be due to the increase in dry matter production. vermicompost increased N, P and K uptake as compared with application of compost. The highest values of N, P and K uptake was noticed with high rate of vermicompost (2 ton fed^{-1}) combined with second level of potassium fertilization (140 kg fed^{-1})as compared with other treatments. The increasing of N, P and K uptake seemed to be due to the increasing of biomass. Thus, positive impact of vermicompost implementation on both these aspects lately led to higher piling up of nutrient. These results are in line with the findings of **[21] [22]**..

Table (7): Effect of compost and vermicompost rates on N, P and K uptake of leaves lettuce plants under different levels of potassium fertilization.

Organic fertilizer ton fed^{-1}	K fertilization Kg fed^{-1}	N	P	K
		mg plant^{-1}		
V_1	120	64.5	7.22	82.82
	140	86.84	11.02	96.92
	160	65.25	10.6	97.60
V_2	120	97.62	9.28	85.70
	140	110.2	11.74	97.80
	160	103.9	11.48	98.02
V_3	120	100.4	9.49	90.55
	140	111.2	12.08	96.90
	160	114.7	11.91	101.2
C_1	120	51.08	6.77	72.92
	140	53.50	8.55	84.59
	160	52.99	10.05	85.86
C_2	120	81.08	8.50	89.67
	140	96.50	9.26	90.83
	160	90.57	9.23	91.92
C_3	120	82.60	7.700	89.9
	140	111.5	10.07	91.2
	160	106.3	10.03	92.5
$LSD_{0.05}$		15.6	2.20	7.10

Conclusion:
The results showed the superiority of vermicompost compared to the traditional compost, with its high effect on the lettuce yield. The values of the yield parameters were high under the high rate of vermicompost (2 ton fed^{-1}), especially under second rate of potassium fertilization(140 kg fed^{-1}). The effect of vermicompost was also evident on the nutritional status of lettuce leaves.

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